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Dunmore Quarry

Annual Review

2015-2016

Document Control			
Version	Prepared by	Date	Distribution
1.0	Ronnie Lawton Environmental Coordinator Boral CMC	November 2016	Department of Planning and Environment Environment Protection Authority Available on the Boral Dunmore Quarry Website

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1. Introduction

1.1. Purpose/Scope

This report has been prepared to address Annual Review requirements in accordance with Condition 5, of Schedule 5 (Condition 5(5)) in Development Consent DA 470-11-2003 for Boral Dunmore Quarry. The review and associated report accounts for the period between 1 July 2015 and 30 June 2016. Condition 5(5) and all other relevant conditions required as part of the Annual Review are outlined in Table 1 with reference to the section of this report where each has been addressed.

Table 1: Relevant Conditions of Approval

Condition of Approval	Condition Requirements	Where addressed in this report
5(5)	The Applicant shall prepare and submit an Annual Review to the Secretary and the relevant agencies. This report must: a) identify the standards and performance measures that apply to the development; b) describe the works carried out in the last 12 months; c) describe the works that will be carried out in the next 12 months; d) include a summary of the complaints received during the past year, and compare this to the complaints received in previous years; e) include a summary of the monitoring results for the development during the past year; f) include an analysis of these monitoring results against the relevant: • impact assessment criteria; • monitoring results from previous years; and • predictions in the EIS; g) identify any trends in the monitoring results over the life of the development; h) identify any non-compliance during the previous year; and i) describe what actions were, or are being taken to ensure compliance.	Entire Document Section 2.0 Section 2.0 and 5.2 Section 3.1 Section 4.0 Section 4.0 Section 4.0 Section 5.0
4(30)	Each year, the Applicant shall: (a) review the site water balance for the development against the predictions in the EIS; (b) re-calculate the site water balance for the development; and (c) report the results of this review in the Annual Review.	Section 2.3
4(51)	The Applicant shall include a progress report on the implementation of the Flora and Fauna Management Plan in the Annual Review.	Section 2.4
4(58)	The Applicant shall include a progress report on the Rehabilitation Management Plan in the Annual Review.	Section 2.5
4(72)	The Applicant shall describe what measures have been implemented to minimise the amount of waste generated by the development in the Annual Review.	Section 2.6.1
4(78)	The Applicant shall: (a) provide annual production data to the DRE using the standard form for that purpose; and (b) include a copy of this data in the Annual Review.	(Provided to the DRE) Section 2.2.1

1.2. Background and Site Description

The Dunmore Hard Rock Quarry, owned and operated by Boral Resources (NSW) Pty Ltd, is located at Tabbita Road Dunmore, approximately 12 kilometres north-west of Kiama in the Shellharbour Local Government Area. The Quarry produces hard rock from Bumbo Latite Member, a fine-grained intermediate volcanic rock similar to basalt, which is crushed to produce coarse aggregates, road construction materials and fines

Development Consent (DA 470-11-2003), issued 19 November 2004 by the Minister for Infrastructure and Planning, allows Boral to produce up to 2.5 million tonnes of hard rock a year (Mtpa), and transport it offsite by road and rail to local and regional markets.

Dunmore Hard Rock Quarry (the site) covers approximately 248 hectares and is surrounded by private property, predominantly agricultural grazing land and tracts of remnant native vegetation, to the south, north and west (The Boral owned and operated Dunmore Lakes Sand Project adjoins the site to the east).

The extraction method involves drilling and blasting to produce broken rock, that is transported to the primary crusher feed bin. The primary-crushed rock is further reduced in size in a series of crushers, before being conveyed to the tertiary screen house where the crushed rock is sized according to product specifications. The sized products are then stockpiled within the various stockpile areas on site, until they are transported to local and regional markets.

Extraction has occurred in an area known as Original Dunmore Quarry and Rail Infrastructure Corporation (RIC) Slot. Extraction operations are currently centred on the Croome Farm Pit. A layout of the site is illustrated in Figure 1.

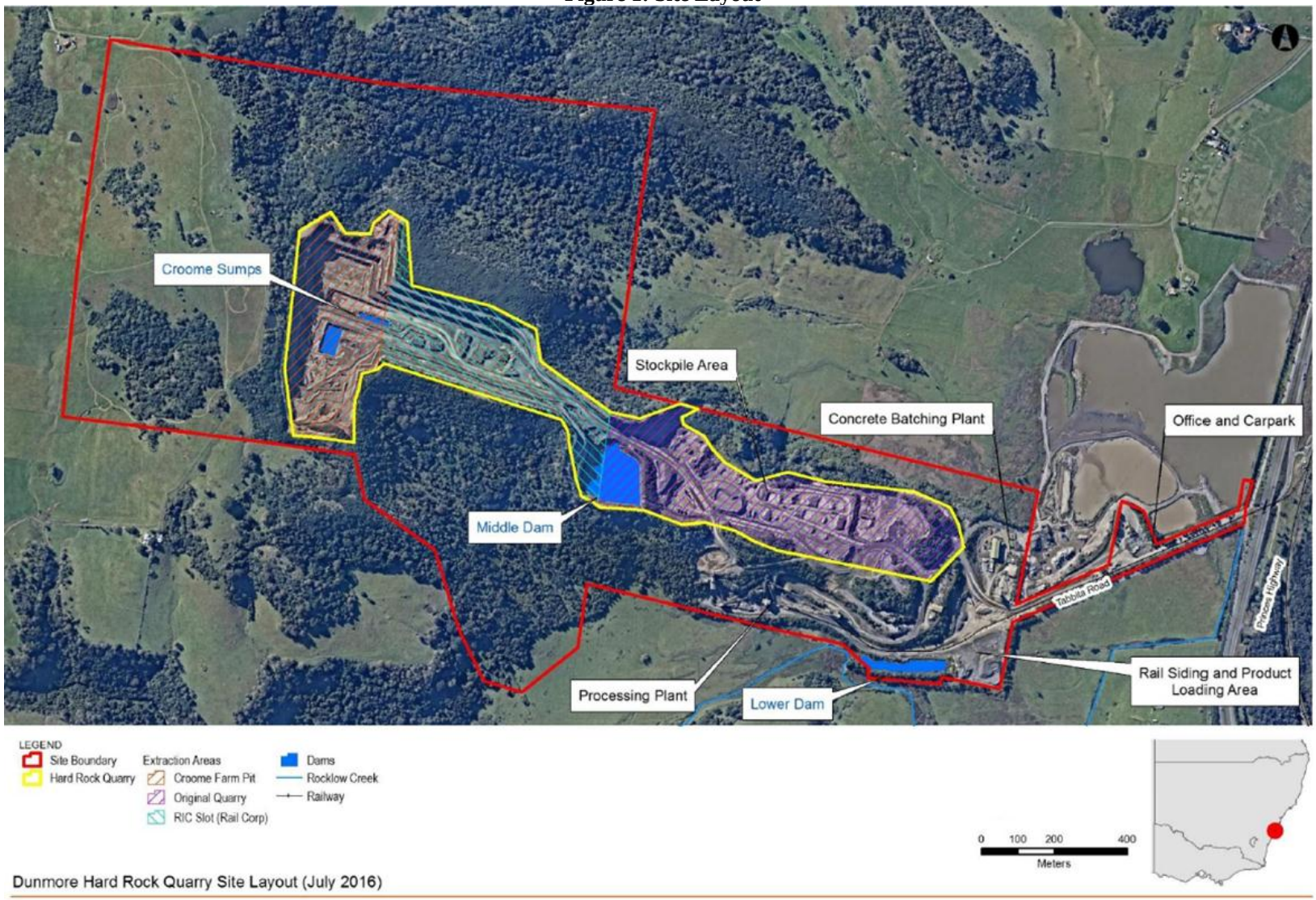
A summary of all the approvals relevant to the Dunmore Quarry are provided in Table 2.

Table 2: Summary of Approvals

Approval Type	Approval Authority	Approval No.	Date Granted
Development Consent	Department of Planning & Environment	470-11-2003	30/09/2004
Environment Protection Licence (EPL)	Environment Protection Authority	77	31/08/05
Water Extraction Licence	Department of Primary Industries - Water	WAL25152 (Previously 10SL050221)	01/07/2011

Approval of modification 7 of the development consent was granted in October 2015. This modification related primarily to approval of installation and operation of a blending plant and the cessation of the continuous real-time noise monitor station at the Stocker residence.

Figure 1: Site Layout



2. Quarry Operations

2.1. Quarry Development

2.1.1. Last 12 Months

Throughout this reporting period, quarrying continued within the Croome Farm extraction area. The majority of extraction took place within the North and South Croome Farm extraction areas. As the consented resource is reaching depletion levels, the site focused on tidying up all areas and ensured the full extent of material was quarried at all extraction limits that have been reached.

2.1.2. Next 12 Months

The next 12 months will focus on quarrying all remaining resource left, which is predominantly in the South Croome region. Pending approval of planned development consent modifications for expansion to the West, works will begin for the further development. At this preliminary stage expansion works will potentially include the construction of a required noise and visual bund, and the commencement of quarrying in the Croome West Expansion area.

2.2. Production, Sales & Transport

2.2.1. Last 12 Months

Table 3 details the production figures for the reporting period. In total the quarry produced 1,447,145 tonnes during the reporting period. This is below the potential consented capacity of the quarry. 1,223,301 tonnes of quarry product was sold via road, whilst 142,594 tonnes was transferred to the adjacent Boral owned Dunmore Lakes Sand Project for blending with sand products and internal application. It should be noted that natural sand product is transferred to the quarry for distribution via rail. This product mass has not been represented in Table 3. Table 4 provides the production data as it will be reported to the Department of Resources and Energy (DRE).

Table 3: Production Data

Month	Production (t)	Sales (t)	
		Road	Transfers
Jul-2015	87,882	106,294	12,350
Aug-2015	100,007	93,855	8,439
Sep-2015	149,019	91,528	21,085
Oct-2015	131,003	121,655	10,468
Nov-2015	147,784	98,879	4,500
Dec-2015	94,069	83,399	5,336
Jan-2016	89,720	62,580	11,548
Feb-2016	123,392	114,595	13,387
Mar-2016	113,075	103,182	12,199
Apr-2016	117,011	113,052	15,557
May-2016	152,519	130,458	15,264
Jun-2016	141,664	103,824	12,462
Total	1,447,145	1,223,301	142,594
		1,365,895	

Table 4: Production Data (DRE Annual Return Format)

		Total Sales / Disposals	
Product	**Type of Material**	**Quantity (Tonnes)**	**$ Value of Sale***
Virgin Materials Crushed Coarse Aggregates			
Over 75mm	Latite		*
Over 30mm to 75mm	Latite	72,193	*
5mm to 30mm	Latite	873,487	*
Under 5mm	Latite	154,856	*
Natural sand	Latite		*
Manufactured Sand	Latite		*
Prepared Road Base & Sub Base	Latite	78,624	*
Other Unprocessed Materials	Latite		*
Total		1,179,159	*

**This information is commercially sensitive and has been omitted*

2.2.2. Next 12 Months

Overall production is dependent on the outcome of planned development consent modifications for quarry expansion into the Croome Farm West area. Pending approval, it is expected that production volumes will increase slightly on the 2015-2016 reporting period production.

2.3. Water Management

2.3.1. Site Water Balance Review

Water consultants Evans and Peck prepared a site water balance as part of the amended Site Water Management Plan submitted in 2008. These water demands are presented below.

- Plant dust suppression (sourced from dam) 93 kL/day
- Plant dust suppression (mains back-up) 50-55 kL/day
- Water cart (from dam, un-metered) 450 kL/day

The site water balance will be reviewed and updated upon collection of data from the operation of the dam configurations and water transfer systems onsite. To establish improved baseline data for use in future water balance updates, within the next 12 months the quarry will:

- Install meters on all pumping locations (including to water carts); and
- Install and maintain real-time water level loggers at the Lower Dam and Middle Dam.

2.4. Flora and Fauna Management

2.4.1. Flora and Fauna Management Plan

2.4.1.1. Summary

In accordance with Condition 4(47), a Flora and Fauna Management Plan (FFMP) was prepared by Cumberland Ecology for Boral in 2009. This FFMP incorporated a Vegetation Clearing Protocol, a Compensatory Habitat Management Plan and a Remnant Vegetation Conservation Plan. A review of the FFMP commenced in this reporting period.

2.4.1.2. Vegetation Offset Area

As a result of the vegetation being cleared for the southern extension of the Croome Farm extraction area, and in recognition of Condition 4(46) of DA 470-11-2003, a Vegetation Offset Strategy was prepared to set out how the impacts of the clearing would be offset.

A Conservation Agreement between the Minister administering the National Parks and Wildlife Act (1974) and Boral Resources for Dunmore Quarry was signed by NSW Minister for the Environment on February 2011. The NSW Minister for the Environment confirmed signing the Dunmore Quarry Conservation Agreement acknowledged that the Conservation Agreement satisfied condition 46(a) of DA 470-11-2003, for the long term security of the biodiversity offset.

The Offset Area has been fenced to exclude cattle and facilitate natural regeneration outside of the active management zone. A number of actions plan to be undertaken to manage conservation values of the Offset Area. These actions include weed management, feral animal control, bushfire management, and restoration and maintenance of native vegetation.

2.4.1.3. Compensatory Habitat Management

The primary management objectives of the Compensatory Habitat are to:

- Establish at least twice the area of EECs cleared for the quarry extension in nearby areas of modified vegetation that support similar geology/soil type and landform.
- Improve the connectivity of native vegetation communities by establishing vegetation on land that has previously been cleared for grazing activities. Isolated patches of remnant vegetation will be linked by revegetating areas of cleared grazing (predominantly exotic grassland) land between remnant patches.

The most recent monitoring completed determined that coverage of tube stock did not exceed 25% across the regeneration area. Height and coverage of natural regeneration had increased. Healthy growth of tubestock which survived initial grazing was continuing. *Melaleuca armillaris* dominated, with smaller numbers of surviving eucalypts, wattles and other species. Weeds and kikuyu grass continued to dominate the ground layer, although in the area of translocated soil, there was an increasing but still small coverage and diversity of native species.

A number of management actions plan to be undertaken to conserve and maintain EECs within the Compensatory Habitat Area over the next reporting period. These include weed management, monitoring of revegetated areas and undertaking supplementary tube stock planting.

2.4.1.4. Remnant Vegetation Conservation Area

The remnant vegetation conservation area contains 33.25 hectares of Illawarra Subtropical Rainforest (ISR) EEC. Cumberland Ecology (2009) identified weed invasion and degradation of native vegetation resulting from edge effects as potential risks to ISR EEC within the remnant vegetation conservation area.

The primary management objectives of the Remnant Vegetation Conservation Area are to:

- Remove dense infestations of noxious and environmental weeds, including *Lantana camara* (Lantana), *Araujia sericifera* (Moth Vine), *Delairea odoratam* (Cape Ivy) and *Passiflora subpeltata* (White Passionfruit).
- Reconstruct ISR EEC in the kikuyu pasture adjoining the south-east of Remnant Vegetation Conservation Area,

In this reporting period, Dunmore Quarry undertook weed management tasks in the grazing paddock directly adjacent the remnant vegetation conservation. This weed management campaign focused on noxious weeds with the aim to reduce potential edge effects leading to weed invasion and degradation of native vegetation.

Over the next reporting period, a range of management actions plan to be undertaken to continue conserving, maintaining and enhancing existing vegetation within the Remnant Vegetation Conservation Area. These include weed management, monitoring of revegetated areas, and increasing the condition and extent of the ISR EEC.

2.4.1.5. Vegetation Clearing

No vegetation clearing associated with Quarry progression was undertaken through this reporting period.

Over the next reporting period, pending expansion approval, vegetation clearing will be taking place in the proposed Croome Farm West expansion area. These areas will primarily be associated with disturbing the area for the proposed noise and visual bund, access tracks and quarrying operations moving west.

2.5. Rehabilitation Management

2.5.1. Summary

Dunmore Quarry aims to progressively encourage a sustainable vegetative cover in accordance with the rehabilitation objectives for the site, as outlined in the site Rehabilitation Management Plan. Progressive rehabilitation work will be undertaken when reshaped, benched and topsoiled areas become available. Only small areas can currently be rehabilitated to avoid conflict with future extraction and sterilisation of resource production potential.

2.5.2. Rehabilitation Management Progress Report

Most areas of the site are currently operational and as such rehabilitation is not able to commence on the majority of areas until the completion of extraction activities. When practical, progressive rehabilitation of the site has been undertaken in conjunction with on-going quarrying works. Rehabilitation activities undertaken to date have been in accordance with the Flora and Fauna Management and Rehabilitation Plan prepared by Cumberland Ecology (2009). Current locations of extraction include Croome Farm Pit South and Croome Farm Pit North. Throughout this reporting period, rehabilitation works have begun along the western wall of the Original Quarry adjacent the Middle Dam. Landform construction on the western wall, adjacent the Middle Dam, is now complete.

A review of the rehabilitation Management Plan commenced in this reporting period.

2.5.3. Next 12 Months

Over the next reporting period Dunmore Quarry intends to continue rehabilitation of the area adjacent the Middle Dam. This will include the placement of soil and vegetation establishment. Rehabilitation of the southern benches located between the Middle Dam and Croome Farm Pit extraction area will be investigated and potentially carried out. Placement methods that account for safety and effectiveness of vegetation establishment will be considered due of the narrow benches and access limitations.

The site Rehabilitation Management Plan will be updated and re-submitted to the Department of Planning and Environment for approval.

2.6. Waste Management

2.6.1. Waste Minimisation Measures

Boral is committed to ensuring its extraction and processing activities produces minimal waste rock material. Approximately 30% of the hard rock processed at Dunmore Quarry becomes material of less than 4mm in diameter, which is known as quarry fines. In the past, quarry fines were considered a product waste and stockpiled due to having no steady market, however the material is now used in manufactured sand (as opposed to natural sand) production. Dunmore Quarry transfers quarry fines to the Boral owned Dunmore Lakes Sand Project site for blending to produce manufactured sand.

At the end of this reporting the stock level of quarry fines was approximately 64,480 tonnes. On average throughout the reporting period 10,234 tonnes was transferred to the DLSP site for manufactured sand production.

Boral is also committed to continuing non-production waste management minimisation in accordance with the waste hierarchy, and minimising the amount of waste sent to landfill. To achieve this, all liquid and solid wastes are classified and sorted so they can be appropriately re-used or recycled. Table 5 outlines the site identified waste streams and associated management. These waste management practices will continue over the next 12 months, with a particular focus on managing quarry fines stock levels and maximising quarry fines transfers for manufactured sand production.

Table 5: Waste Streams

Waste Stream	Action/End use
Waste Oils	Recycled by EPA licensed contractors.
Steel	Either reused on site by boiler makers or recycled.
Vehicle Batteries	Stored on pallets and picked up by contractors for re-use/recycling.
Paper and Cardboard	All paper and cardboard waste is recycled.
Heavy Vehicle Tyres	The majority of heavy vehicle tyres are re-used on site for safety purposes, with others returned to the tyre fitting contractor for recycling.
Conveyor Belt	Stored in a designated area and periodically transported for recycling.
Timber Waste	Stored in a designated area and periodically transported for recycling.
General garbage	All other municipal waste that cannot be reused or recycled is sent to the Shellharbour Waste Depot.

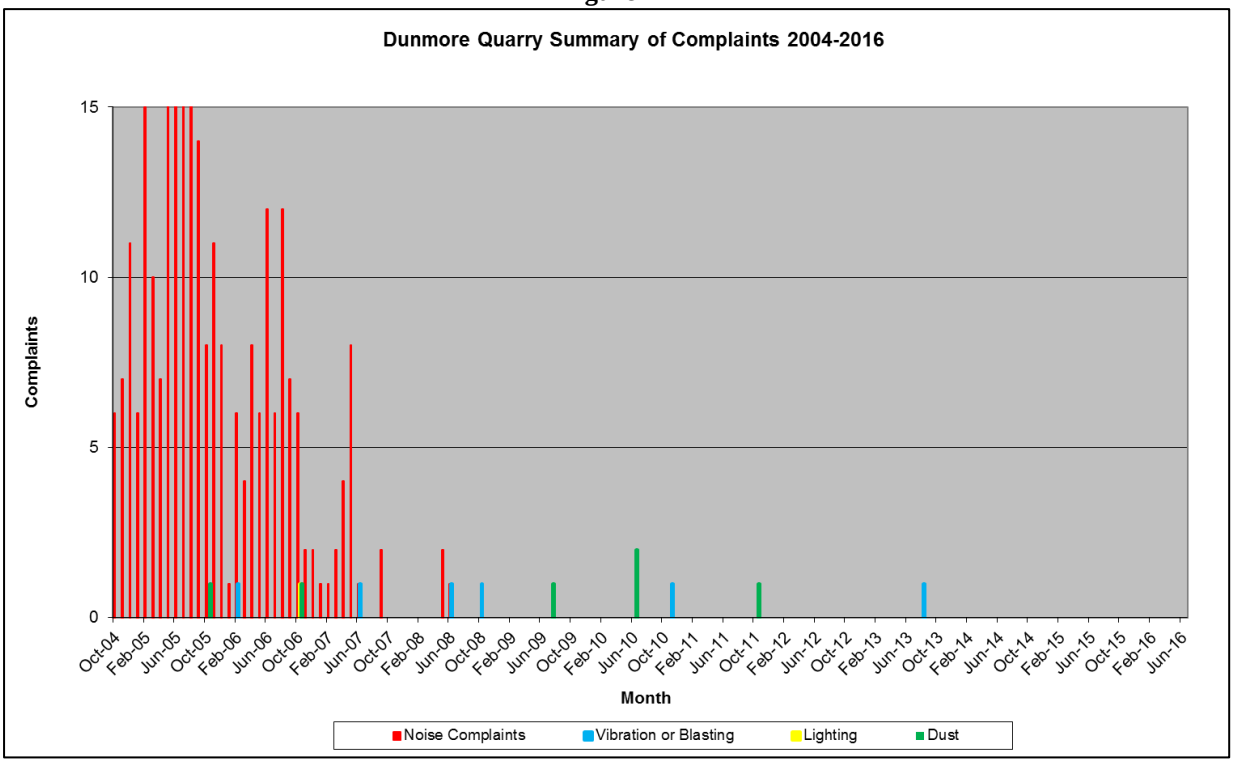
3. Complaints and Community Management

3.1. Complaints Summary and Analysis

Dunmore Quarry maintains a complaints register that identifies actions required to resolve issues and concerns raised by the community. The complaints register is also published on the Boral website.

No complaints were received for the 2015-2016 reporting period. Figure 2 provides an overview of the noise, vibration and dust complaints received since 2004. It is clear that in recent years there have been minimal complaints. The figure also illustrates a major decline in noise complaints over the entire period, with the last noise complaint received in June 2008.

Figure 2



3.2. Community

The Dunmore Quarry Community Consultative Committee (CCC) continues to serve as a valuable dialogue between Boral and the local community with valuable input and feedback being provided by the community regarding quarry operations and plans. Members are informed of the environmental performance of the site, provided with an update on operations and given a chance to tour the site and ask questions they may have regarding the operation. CCC members have also been diligent in disseminating the information from the meetings to other interested community members in the local area. The minutes of each meeting is published in the Boral website.

The CCC met twice during the 2015-2016 reporting period. The meeting conducted on the 2nd of February 2016 included an introduction to the proposed Croome West Expansion works, whereby the community represented were informed on the completed preliminary assessments and the proposed approval pathway.

4. Environmental Monitoring

4.1. Noise

A noise monitoring program was prepared in recognition of Condition 4(14) to monitor noise at the three receiver locations specified in the consent and EPL. These locations are displayed in Appendix 1. The noise monitoring program includes:

Continuous directional real-time noise monitoring at Location K (Condition 4(12)); and annual attended noise monitoring surveys at all receiver locations during winter conducted by a specialist noise consultant (Condition 4(13)).

A directional noise monitoring system (BarnOwl) was installed at Location K during May 2005, which had the ability to measure noise in the direction of the quarry. Operators in the control room used this real-time data to inform them on the performance of the quarry. This conditional requirement was deleted from the development consent in Modification 7.

A Noise Compliance Assessment Report was prepared by SLR Consulting Australia and presents results of attended noise monitoring surveys undertaken during August 2016 at receiver locations A (McParland), K (Stocker) and O (Dunmore Lakes Estate).

The report found that the quarry achieved compliance with the licence noise limits at all locations during all monitoring periods. This is in line with previous reporting periods. The noise levels monitored are consistent with the majority of EIS predictions, with only Location O noise levels slightly higher than predicted. It should be noted however the Annual Noise Compliance assessment reports that noise generated from road traffic was the dominant noise source at this residential location. Quarry operations were only observed to be audible during the morning shoulder and evening noise monitoring periods. A copy of the Noise Compliance Assessment Report is attached as Appendix 6 of this report.

4.2. Blasting

A total of 63 blasts were conducted throughout the 2015-2016 reporting period. All blasts were compliant with Airblast Overpressure and Ground Vibration blasting criteria. Figure 3 and Figure 4 provide a graphical representation of the blast monitoring results. The location of the blasting monitor is displayed in Appendix 2.

Five blasts did not exceed trigger levels set on the monitoring instruments indicating they are of low level and in compliance with the assessment criteria. These blasts are represented as absent bars in Figure 3 and 4.

Figure 3

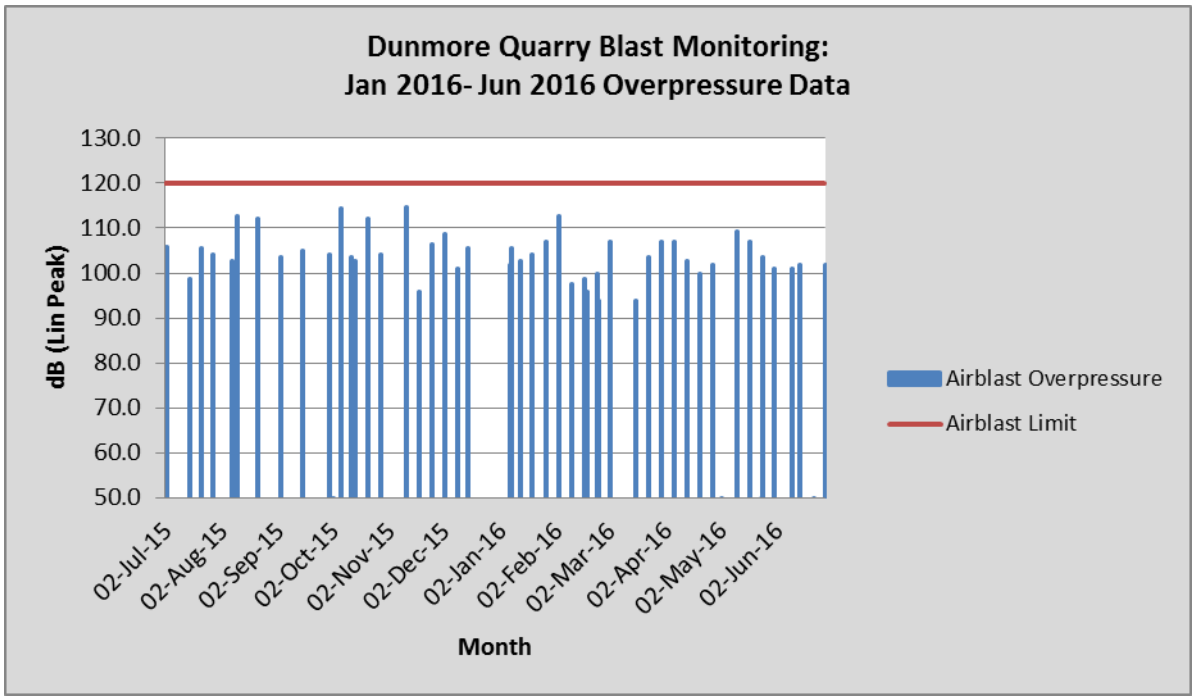
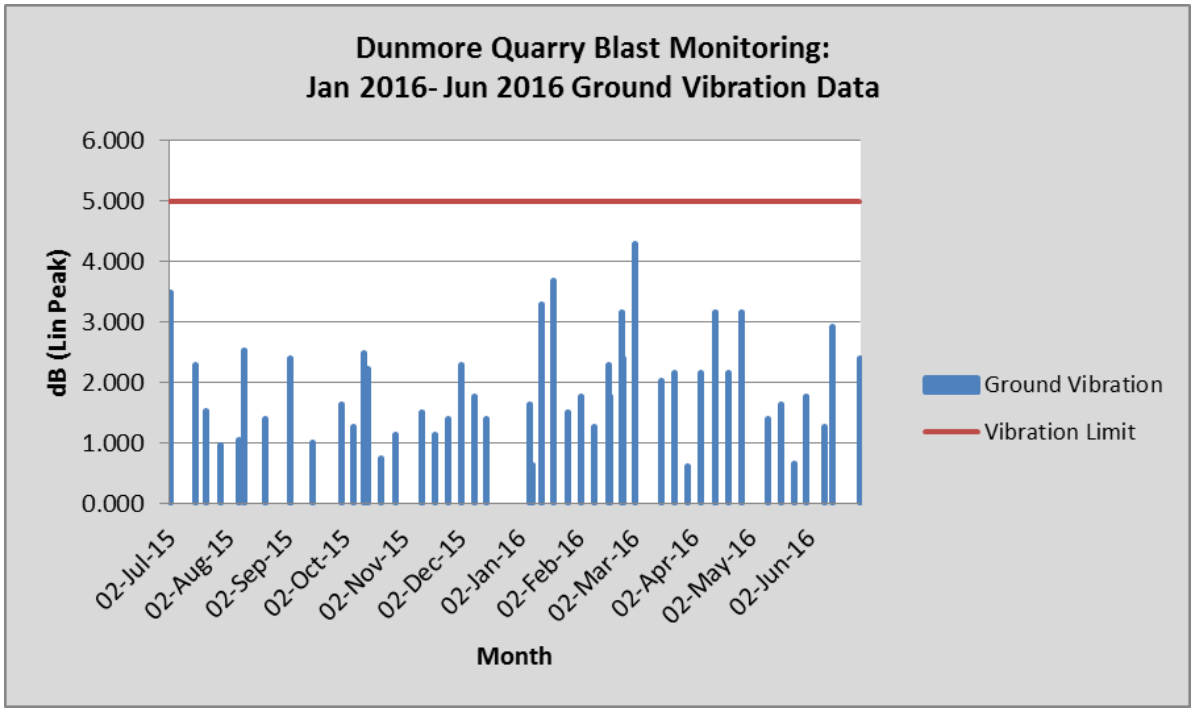


Figure 4



4.3. Air Quality

4.3.1. Deposited Dust

The air quality monitoring program includes 4 deposited dust gauges that have been in operation for 10 years. The location of these dust gauges can be seen Appendix 3. Table 7 present the results of deposited dust monitoring during the reporting period content as well as averages for previous 5 reporting periods.

4.3.1.1. Site 1

Site 1 yielded an annual average of 5.75 g/m2/month insoluble solids, with an average ash content of 2.09 g/m2/month.

The assessment criteria for insoluble solids was exceeded on four (4) occasions over the reporting period, however of these only two (2) occasions recorded an ash content greater than 4g/m2/month (Insoluble Impact Assessment Criteria).

It is evident it Table 7 that the dominant wind direction and the direction of strongest winds for each month. It is clear for months where criteria was exceeded that wind directions were primarily from the WSW and NNE, and not generally from the direction of the quarry (generally SSE). This suggests that quarry contribution to this location is minor. It is also noted that the December 2015 result is much higher than other results in the reporting period and the higher result does not reflect the below average production volume. Additionally, prior to December 2015 the insoluble solids rolling average (for results without contamination) was 3.87 g/m2/month. It is considered that the December 2015 result is a contaminated result. When the reporting period is analysed without this result, Site 1 yields an annual average of 3.46 g/m2/month insoluble solids, with an average ash content of 1.66 g/m2/month.

The adjusted annual average insoluble solid and ash content for Site 1 is consistent with last year's annual averages, whilst it is higher in comparison to the Dunmore Quarry EIS predicted annual dust deposition.

4.3.1.2. Site 2

Site 2 yielded an annual average insoluble solid content of 3.12 g/m^2/month and annual average ash content of 1.77 g/m^2/month suggesting that the quarry contribution was relatively minor.

The assessment criterion for insoluble solids was exceeded on three (3) occasions over the reporting period, with none of these exceedances returning an ash content greater than 4g/m^2/month, further suggesting that the quarry contribution to this monitoring location is minor.

Table 7 indicates that the dominant wind direction and the direction of strongest winds for each month, where criteria was exceeded were primarily from the WSW and NNE, and not generally from the direction of the quarry (generally NE).

The adjusted annual average insoluble solid and ash content for Site 2 is consistent with last year's annual averages, whilst it is higher in comparison to the Dunmore Quarry EIS predicted annual dust deposition.

4.3.1.3. Site 3

Site 3 yielded an annual average of 8.25 g/m2/month insoluble solids, with an average ash content of 5.53 g/m2/month.

Eleven (11) months recorded insoluble solids above 4g/m^2/month, with seven (7) of those months recording an ash content greater than 4g/m^2/month. Wind directions for these months were largely from the NNE and WSW, not from the direction of the Quarry (generally NW) suggesting that the quarry contribution to this location is minor.

Prior to June 2016, the Site 3 insoluble solids and ash rolling 12 month annual average was 6.94 g/m^2/month and 4.32 g/m^2/month respectively. Based on this information the measurement for June 2016 is assumed to be contaminated. When the reporting period is analysed without this result, Site 1 yields an annual average of 7.20 g/m2/month insoluble solids, with an average ash content of 4.45 g/m2/month.

The adjusted annual average insoluble solid and ash content for Site 3 is consistent with last year's annual averages, whilst it is high in comparison to the Dunmore Quarry EIS predicted annual dust deposition. As such, it should be noted that Monitoring point 3 is located within the footprint of the Dunmore Lakes Sand Project (DLSP) Stage 3 operations. The existing DLSP Air Quality Monitoring Program stipulates that Monitoring Point 3 be decommissioned with the commencement of Stage 3 extraction operations. Given that Stage 3 preparation works were undertaken throughout the year, with the construction of access roads and process infrastructure, monitoring point 3 is considered to include localised dust generated from this work. Site 3 will be removed from future analysis once the Air Quality Monitoring Program for Dunmore Quarry is updated and approved. The DLSP monitoring point EPA identification number 4 from EPL 11147 is proposed to take the Site 3 locations place in future monitoring as it is approximately 200m away from monitoring point 3 and is adjacent the next sensitive receiver residence on privately owned land, as illustrated in Figure 2. With all of these factors being considered, a comparison of monitoring results for the DLSP monitoring site, EPA identification number 4 from EPL 11147, is provided in Table 6.

Table 6

Month	Dunmore Quarry - Site 3		Dunmore Lakes Sand Project- Site 4	
	Insoluble solids ($g/m^2/month$)	Ash ($g/m^2/month$)	Insoluble solids ($g/m^2/month$)	Ash ($g/m^2/month$)
Jul-2015	5.77	3.24	2.12	1.43
Aug-2015	2.91	2.85	2.07	0.93
Sep-2015	9.30	4.86	0.72	0.40
Oct-2015	8.65	5.11	0.77	0.43
Nov-2015	5.11	2.50	2.92	1.62
Dec-2015	11.89	5.83	2.77	1.56
Jan-2016	10.45	6.39	8.71	3.95
Feb-2016	9.13	7.00	1.86	1.25
Mar-2016	5.95	4.40	2.38	1.24
Apr-2016	5.01	2.96	1.36	1.04
May-2016	5.06	3.86	2.13	0.97
Jun-2016	19.76	17.32	3.42	2.48
Average	8.25	5.53	2.59	1.44

Note: An insoluble impact assessment criterion is 4 $g/m^2/month$.

There are also certain characteristics of the monitoring site which have been considered in this analysis. The dust deposition gauge is situated in an active livestock grazing paddock which is regularly slashed by the land manager. The gauge is also adjacent a well-worn (i.e. a dirt track) paddock transfer point which is always open for livestock to move from one paddock to another, and as such creates potential for localised dust. All of these characteristics are considered non-quarrying related potential contributors to the dust deposition results.

4.3.1.4. Site 4

Site 4 yielded an average insoluble solid of 3.01 g/m^2/month with an average ash content of 1.84 g/m^2/month for the reporting period.

The assessment criteria was exceeded on two (2) occasions for insoluble solids over the reporting period, however each sample returned an ash content below 4/g/m2/month suggesting that the quarry contribution to this location is minor.

The adjusted annual average insoluble solid and ash content for Site 4 is consistent with last year's annual averages, whilst it is only slightly higher in comparison to the Dunmore Quarry EIS predicted annual dust deposition. It should be noted that this gauge is located adjacent the Stage 2 operations of the Dunmore Lakes Sand Project.

Table 7: Deposited Dust Measurements

Month	Site 1 grams/m^2/month		Site 2 grams/m^2/month		Site 3 grams/m^2/month		Site 4 grams/m^2/month		Dominant Wind Direction	Direction of Strongest Winds	Production Tonnes (t)
	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	Ash	Insoluble Solids	Ash			
2010/2011 Average	3.35	1.43	5.86	3.92	3.43	2.09	2.53	1.60			
2011/2012 Average	3.74	1.92	3.28	1.70	5.03	3.44	2.75	1.81			
2012/2013 Average	3.73	1.65	2.61	1.65	5.87	3.60	3.36	2.36			
2013/2014 Average	9.56	4.94	3.63	1.79	4.61	3.28	3.20	2.00			
2014/2015 Average	5.63	2.72	2.38	1.44	7.36	4.42	3.10	1.98			
Jul-2015	3.23	1.07	1.93	0.98	5.77	3.24	2.26	1.40	WSW	WSW	87,882
Aug-2015	1.86	1.36	0.52	0.21	2.91	2.85	0.77	0.60	WSW	SW,WSW	100,007
Sep-2015	2.82	1.60	2.78	1.71	9.30	4.86	3.81	2.35	WSW	WSW, SW	149,019
Oct-2015	9.71	4.06	4.06	2.60	8.65	5.11	5.49	2.11	WSW	WSW, NNE, NE	131,003
Nov-2015	2.90	1.87	7.69	3.87	5.11	2.50	2.90	1.85	NNE	NNE, WSW	147,784
Dec-2015	30.96	6.77	4.81	2.82	11.89	5.83	7.20	3.68	WSW	NNE, WSW	94,069
Jan-2016	4.16	1.69	3.75	2.33	10.45	6.39	3.09	1.87	WSW	NE, E, WSW	89,720
Feb-2016	1.68	1.14	3.90	1.59	9.13	7.00	2.56	2.04	NNE	variable	123,392
Mar-2016	1.68	1.06	2.46	1.46	5.95	4.40	1.38	1.00	NNE	NNE	113,075
Apr-2016	5.42	1.87	2.63	1.72	5.01	2.96	2.09	1.41	WSW	NNE, variable	117,011
May-2016	3.30	1.59	1.53	1.06	5.06	3.86	1.17	0.85	WSW	WSW	152,519
Jun-2016	1.32	0.99	1.43	0.83	19.76	17.32	3.43	2.95	WSW	WSW	141,664
2015-2016 Average	5.75	2.09	3.12	1.77	8.25	5.53	3.01	1.84			
2015-2016 Adjusted Average	3.46	1.66	3.12	1.77	7.20	4.45	3.01	1.84			

Note: Shaded values indicate contaminated sample. An adjusted average has been provided for comparison. Insoluble impact assessment criterion is 4 g/m^2/month.

4.3.1.5. Deposited Dust Summary and Opportunities for Improvement

Analysis of the deposited dust records suggest that whilst there were exceedances recorded at each of the deposited dust monitoring sites, it is evident that the quarry contribution may be limited. Site 3 is clearly a site which needs to be moved as extraction operations will begin at the DLSP during the next reporting period.

To continue managing air quality and dust levels the site will continue dust management; via maintained dust suppression sprays throughout the processing plant area; application of the water cart on haulage roads and the entrance road and the use of the wheel wash for exiting vehicles. Further, the site will continue to actively manage dust on site through supervisor inspections and control room video surveillance to monitor dust emissions from the plant to slow or stop production until the issue is resolved.

Measures planned for the coming year include:

- Upgrade light vehicle wheel wash facilities
- Install sprinkler system at site entrance area
- Investigate installing sprinkler system at product stockpiling area
- Continual upgrades of product transfer points (dust baffle & micro spray installation)

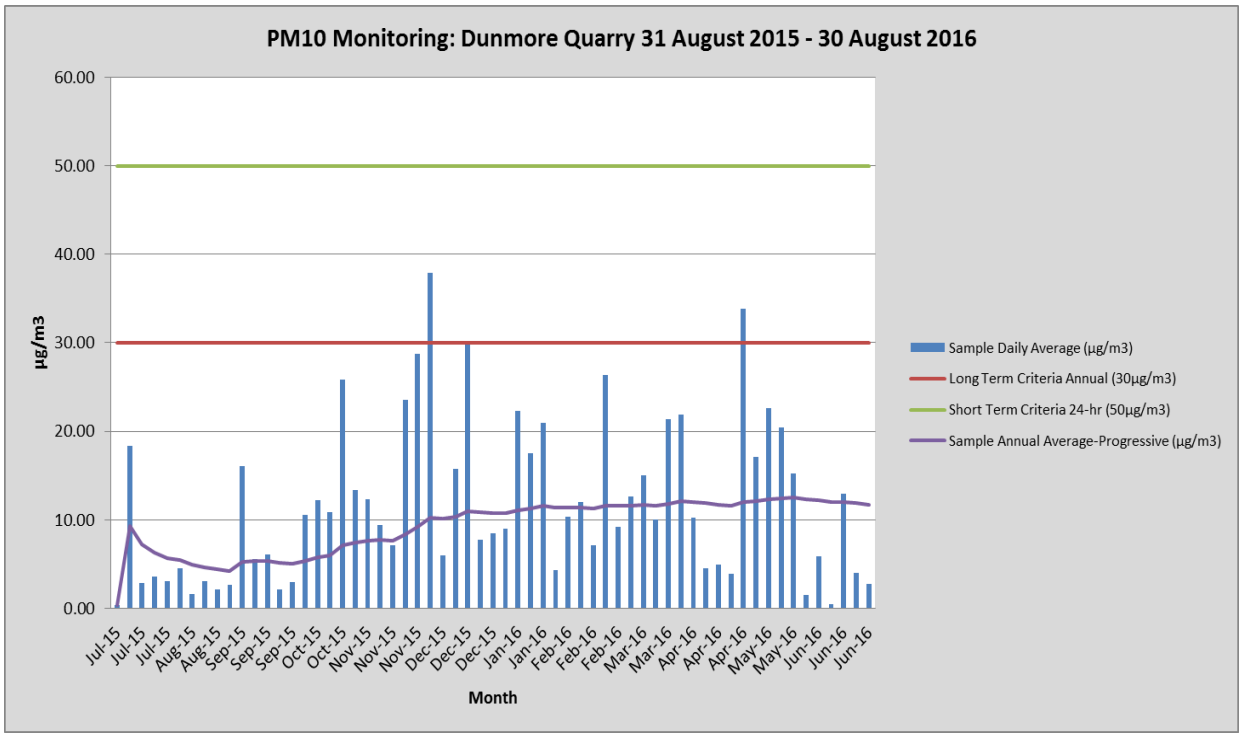
4.3.2. PM_{10}

The monitoring program for finer particulates includes monitoring of dust finer than 10 micron through use of a high volume air sampler (HVAS). The HVAS runs for a 24 hour period every 6 days in accordance with EPL conditions. Please refer to Appendix 3 for an indication of the where the HVAS is located (identified as monitoring point 5).

The PM_{10} monitoring results for the 2015-2016 reporting period are represented graphically in Figure 5.

The annual average of recorded results of was 11.72 µg/m^3. The lowest recorded result was 0.42µg/m^3 on 10 June 2016, and the highest being 37.92µg/m^3 on 1 December 2015. The short term impact assessment criterion of 50µg/m3 was not exceeded during the reporting period. These results indicate that PM_{10} dust levels are well below long term impact assessment criteria; consistent with previous years reporting; and consistent with the EIS predicted maximum 24 hour PM_{10} concentration.

Figure 5



4.4. *Meteorology*

A meteorological monitoring station has been operating at Dunmore Quarry since 2002. Table 8 presents a summary of the results of rainfall received during the reporting period against that received in previous years and regional averages. Seasonal wind roses showing the local wind movements are available in Appendix 5.

Table 8: Rainfall Data

Month	Rainfall (mm)						Regional Averages* (mm)
	2010-11	2011- 12	2012-13	2013-14	2014-15	2015-16	
July	78	194	39	57.9	5	48	63.4
August	72	85.5	4.5	17	252	327	83.3
September	145.5	58.5	11.5	85.5	150.5	82	67.4
October	126	124.5	83.5	6.5	102.5	36.5	100.5
November	198	165.5	25	173	24	48	115.6
December	147.5	60.5	32	71.5	232.5	116.5	94.6
January	59.5	52	183	42.5	192.5	155.5	130.3
February	48	307.5	142.5	59	99.5	29.5	156.4
March	362.5	146.5	23.5	326	57	145	160.4
April	37.4*	85	136	64.5	308.5	37.5	129.3
May	58.3*	9.5	81	13	49	35.5	106.4
June	74	88	239	34	76	429	112.4
Total	**1407**	**1377**	**1000.5**	**950.4**	**1549**	**1490**	**1320**

** Source: Bureau of Meteorology, Climate Statistics for Australian Location, Wollongong University http://www.bom.gov.au/climate/averages/tables/cw_068188.shtml. Red values indicate month received higher than the regional average rainfall.*

4.5. Water

4.5.1. Surface Water

Water quality results were taken from the upgraded existing dam on a monthly basis over the reporting period. Water quality in the lower dam was analysed for turbidity, pH, total suspended solids (TSS), conductivity and a visual inspection for oil and grease as part of the monthly sampling routine. Table 9 provides summary of the annual average as well as the maximum and minimum results recorded for the routine monitoring completed at the upgraded existing dam.

Table 9: Lower Dam Summary

Parameter	Sample Average	Minimum	Maximum
pH	8.0	6.6	8.7
Conductivity (µS/cm)	447.0	362.0	496.0
Turbidity (NTU)	153.2	65.0	398.0
TSS (mg/L)	70.7	33.0	217.0
Oil and Grease	Not visible	Not visible	Not visible

Over the reporting period there were two (2) uncontrolled discharge events from the lower dam. Whilst TSS at the uncontrolled discharge point was greater than the water discharge limit stipulated in the development consent (50 mg/L), these events are not considered true reflections of quarry discharge as they occurred when Rocklow Creek flooded resulting in the creek floodwaters rising up and over the spillway in to the dam, which in turn has filled up and spilled over. As such it is considered that the site may not have discharged if Rocklow Creek floodwaters did not flow into the dam. Further, upstream and downstream monitoring conducted in association with the uncontrolled discharge indicates that there was minimal impact to Rocklow Creek water quality. The location of relevant surface water monitoring locations is displayed in Appendix 4.

Table10 provides the results for the discharge event at monitoring location points; discharge point; upstream Rocklow Creek and downstream Rocklow Creek.

Table 10

	Date of Uncontrolled discharge (Rocklow creek water levels entered the dam)					
	27/08/2016			06/06/16		
Parameter	**Discharge Point (EPL#7)**	**Upstream Rocklow**	**Downstream Rocklow**	**Discharge Point (EPL#7)**	**Upstream Rocklow**	**Downstream Rocklow**
pH	7.17	7.06	6.87	7.3	7.3	7.4
Conductivity (µS/cm)	275	183	174	200	183	150
Turbidity (NTU)	871	102	28	150	102	33
TSS (mg/L)	266	665	14	77	6.4	8.8
Oil and Grease	Not visible	-	-	Not visible	-	-

In order to prevent uncontrolled discharge, when required, water is transferred from the lower dam to the middle storage dam to allow for maximum water storage onsite. In addition to this, water is pumped from the lower dam to the water cart for dust suppression. The practice of transferring water to prevent discharge from the spillway will continue until critical storage levels are achieved onsite, in which case controlled discharge through the bio-retention swale will take place to ensure sufficient capacity remains onsite for storm run-off management. Additionally, over the next reporting period the Quarry will install and maintain real-time water level loggers in Rocklow creek to provide a better understanding of Rocklow creek flow.

4.5.2. Ground Water

The existing water management plans for Dunmore Quarry stipulate that data from the Boral owned Dunmore Sand and Soil groundwater monitoring program be reviewed to determine if there is a significant impact on groundwater levels or quality as a result of both operations. Environmental Earth

Sciences NSW were engaged by Boral to undertake a review of the surface and groundwater environmental monitoring data undertaken during the 2015 – 2016 period.

The analysis completed by Environmental Earth Sciences NSW indicates that groundwater levels have remained stable over the course of seven years, including from bores located directly adjacent to and down-gradient of mining activities. While some minor exceedances of site criteria for native cations were recorded in both the shallow and deep aquifers these are considered to be natural features of regional groundwater under tidal fluctuations.

It is also noted that due to the Dunmore Quarry Western Expansion proposal, EMM Consulting Pty Ltd has undertaken groundwater assessment and groundwater monitoring. The monitoring bores are located up hydraulic gradient from current quarrying activities and are therefore considered representative of baseline conditions (both water levels and quality). Groundwater quality and level monitoring was undertaken from the established groundwater monitoring network at the Quarry. This data will contribute to inform future site assessment for the proposed Quarry extension.

5. Compliance

5.1. Independent Audit Summary

An independent environmental audit was conducted in response to Condition 5(6) of the Development Consent. The audit considered conditions of the Development Consent and Environment Protection Licence (EPL), reviewed the adequacy of strategies, plans and programs prepared under the consent and EPL, assessed the environmental performance of development and recommended actions and measures to improve environmental performance. The audit was completed in 2014 with the associated report issued in June 2015. A summary of non-compliances determined are outlined below:

- Six (6) conditions and two (2) sub-conditions of the development consent were found to be non-compliant. These are addressed in section 5.2.
- Between 2006/07 and 2014, 42 non-compliances have been recorded across a range of EPL conditions, of which none resulted in the issue of a penalty notice. Most of the non-compliances related to deficiencies in monitoring and reporting, rather than exceedances of limits. There were no EPL non-compliances in the 2015-2016 reporting period.
- The majority of plans, strategies and programs developed in response to the conditions of consent were found to be lacking, either in terms of meeting the requirements of the relevant condition, being implemented appropriately and/or representing best practice. This is primarily due to a number of the plans and strategies being developed as consultancy reports, rather than as operational documents.

5.2. Response to Non-Compliance

Non-Compliance Item		Identified Non-Compliance	Response to Non-Compliance
Development Consent (470-11-2003)	Condition 4(42)	The site Erosion and Sediment Control Plan (ESCP) does not address this condition.	A review and update of the Water Management Plan (WMP) and associated sub-plans, including the ESCP, commenced in the 2015-2016 reporting period. The updated plan was submitted to the DP&E for approval on the 29th September 2016.
	Condition 4(44)	The Ground Water Monitoring Program (GWMP) does not cover any of the required details as there is not an existing groundwater monitoring program on the site.	A review and update of the WMP and associated sub-plans, including the GWMP, commenced in the 2015-2016 reporting period. The updated plan was submitted to the DP&E for approval in September 2016. An administrative modification was submitted in the 2016-2017 reporting period to delete condition 4(44D).
	Condition 4(54)	The Rehabilitation Management Plan (RMP) was lacking detail and does not fully address the requirements of this condition.	A review and update of the RMP commenced in the 2015-2016 reporting period. The updated plan was submitted to the DP&E for approval on the 29th September 2016.
	Condition 4 (57)	The latest Rehabilitation and Conservation Bond review was not undertaken in the correct timeframe.	A review and revision of the bond will be conducted as soon as practical.
	Condition 5(2)	No evidence that the Environmental Management Strategy (EMS) was submitted to the local council or made publically available.	Provide a copy of the approved EMS to the council and make the EMS available to the public via Boral Dunmore Quarry Website.
	Condition 5(12)	None of the required information for Dunmore Quarry was available on Boral's website.	Populate the Boral Dunmore Quarry Website with all required information as soon as practical.
	Condition 4(40a)	Water transfers across the site, dam and water structures levels are not adequately measured.	Install flow meters on pumping lines, and install and maintain real-time water level loggers on the lower and middle dam.
	Condition 4(40c)	Flows in Rocklow creek are not monitored adequately.	Install and maintain real-time water level loggers in Rocklow creek.
	Condition 4(40d)	Regional groundwater levels and quality are not monitored adequately.	A review and update of the WMP and associated sub-plans, including the GWMP, commenced in the 2015-2016 reporting period. The updated plan was submitted to the DP&E for approval in September 2016. An administrative modification was submitted in the 2016-2017 reporting period to delete condition 4(44D).

6. Conclusion

Dunmore Quarry has continued to focus on ensuring the environment and neighbouring community are not adversely impacted by quarry operations.

Throughout this reporting period extraction and processing of quarry materials has remained consistent with previous years, with no vegetation clearing undertaken. As consented resource is reaching final volumes, the operation focused on ensuring the full extent of material was quarried at all extraction limits that have been reached.

Approval of modification 7 of the development consent was granted in within the reporting period. This modification related primarily to approval of installation and operation of a blending plant and the cessation of the continuous real-time noise monitor station at the Stocker residence. The reporting period also included completing preliminary investigations and commencing environmental assessments of the proposed Croome West Expansion.

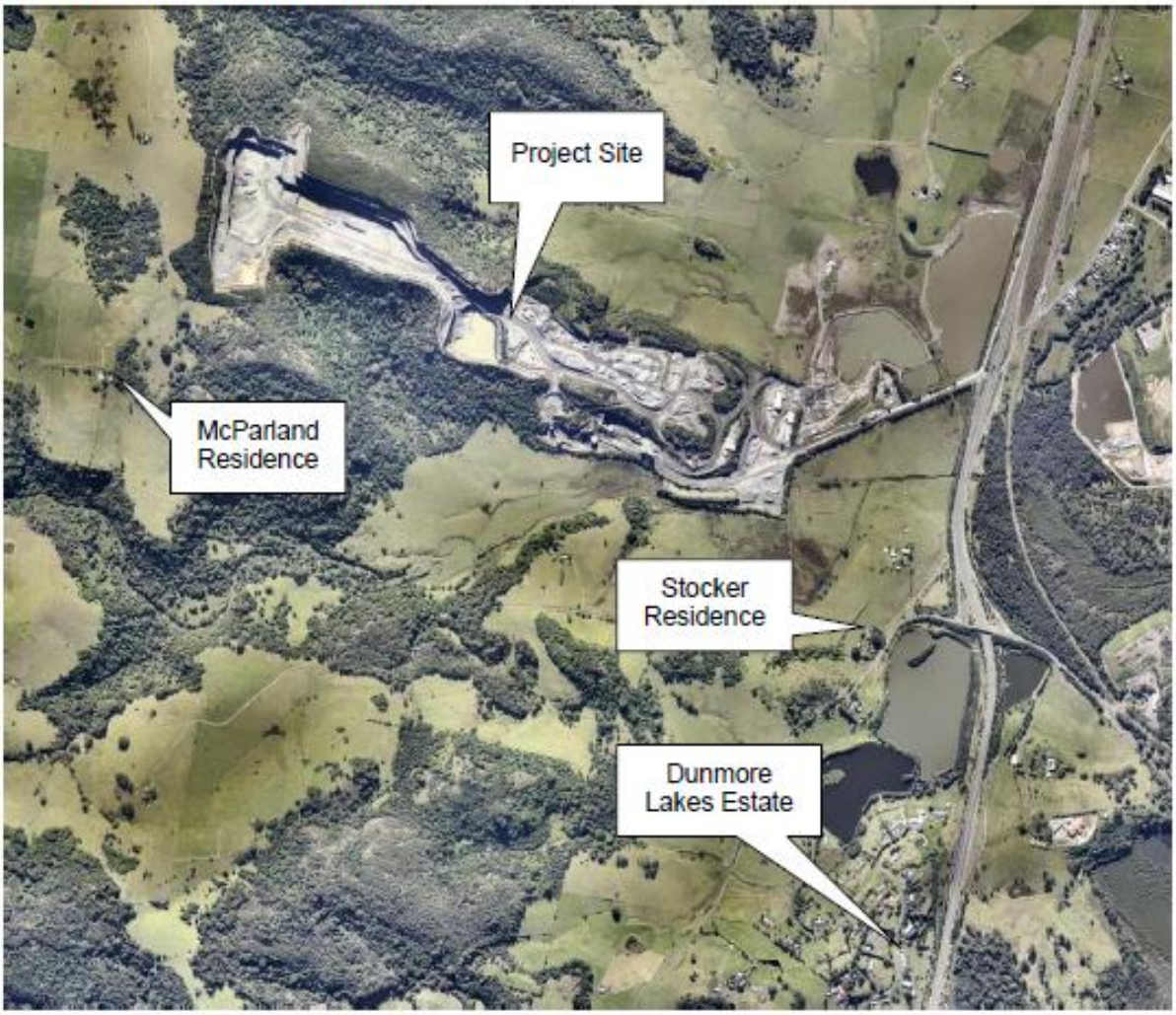
The 2015-2016 reporting period also contained a strong focus on maintaining regulatory compliance. A number of opportunities for improvement were identified and will be addressed and implemented during the 2016-2017 reporting period, with a particular focus on the development of compliance tools and document management systems.

Appendix 1 – Noise Monitoring Locations

Table 1 Monitoring Locations

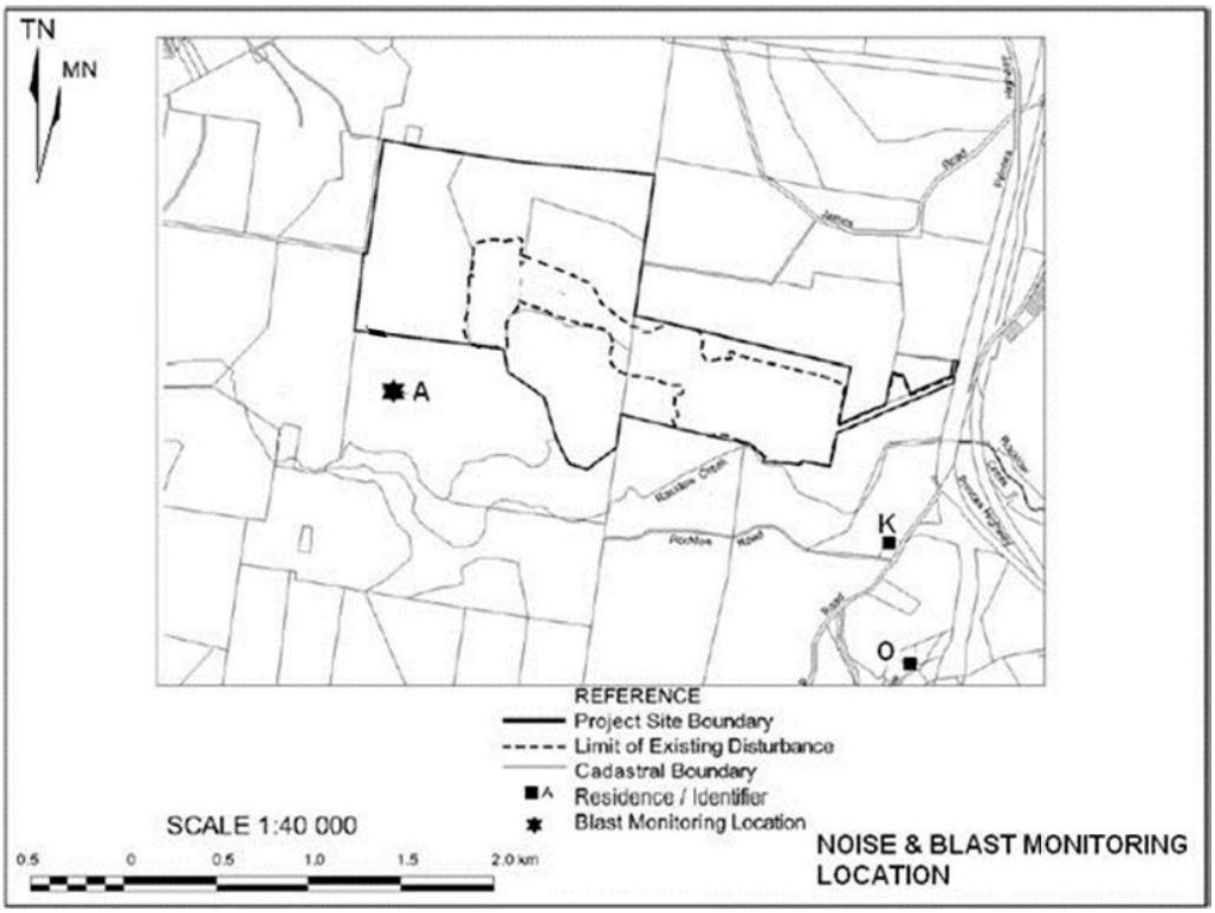
Location	Description
A	McParland Residence
K	Stocker Residence
O	Dunmore Lakes Estate

Figure 1 Noise Monitoring Locations

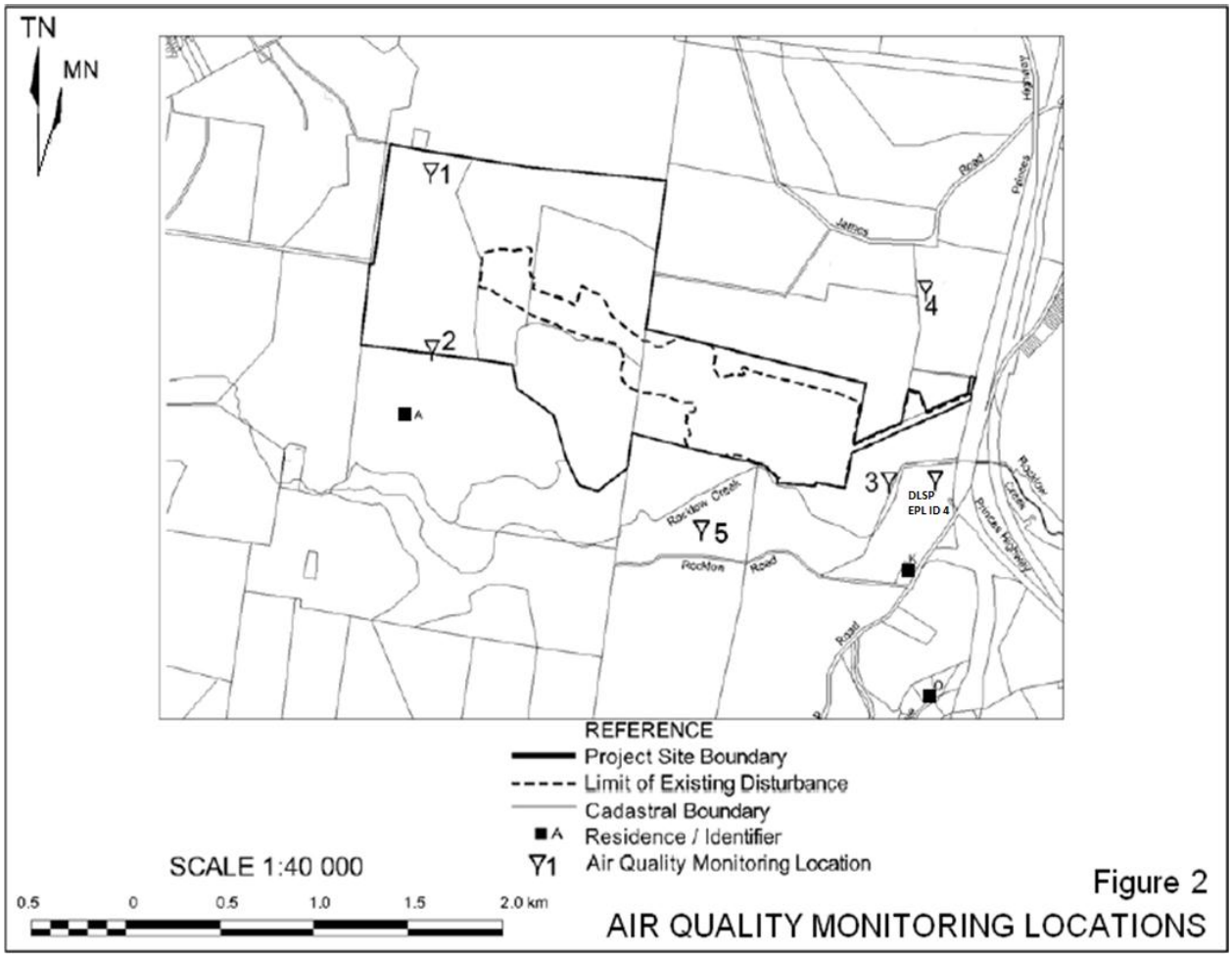


Note: Image courtesy of Nearmap (dated 21 June 2014).

Appendix 2 – Blast Monitoring Location


TN
MN
A
K
O
REFERENCE
Project Site Boundary
Limit of Existing Disturbance
Cadastral Boundary
Residence / Identifier
Blast Monitoring Location
SCALE 1:40 000
0.5
0
0.5
1.0
1.5
2.0 km
NOISE & BLAST MONITORING LOCATION

Appendix 3 – Air Quality Monitoring Locations

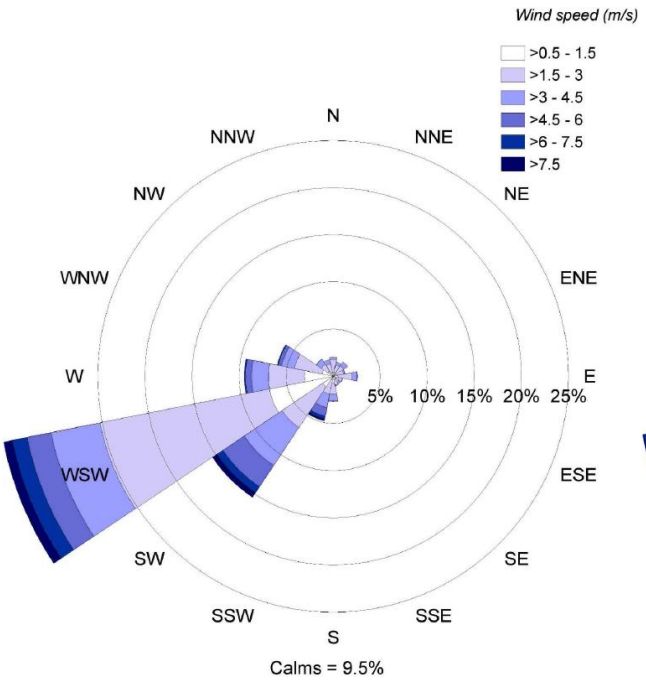

TN
MN
1
2
3
4
5
DLSP
EPL ID 4
REFERENCE
Project Site Boundary
Limit of Existing Disturbance
Cadastral Boundary
Residence / Identifier
Air Quality Monitoring Location
SCALE 1:40 000
0.5
0
0.5
1.0
1.5
2.0 km
Figure 2
AIR QUALITY MONITORING LOCATIONS

Appendix 4 – Surface Water Quality Monitoring Locations


EPL#7
Rocklow Upstream
EPL#8
Rocklow Downstream

Appendix 5 – Wind Roses

July 2015



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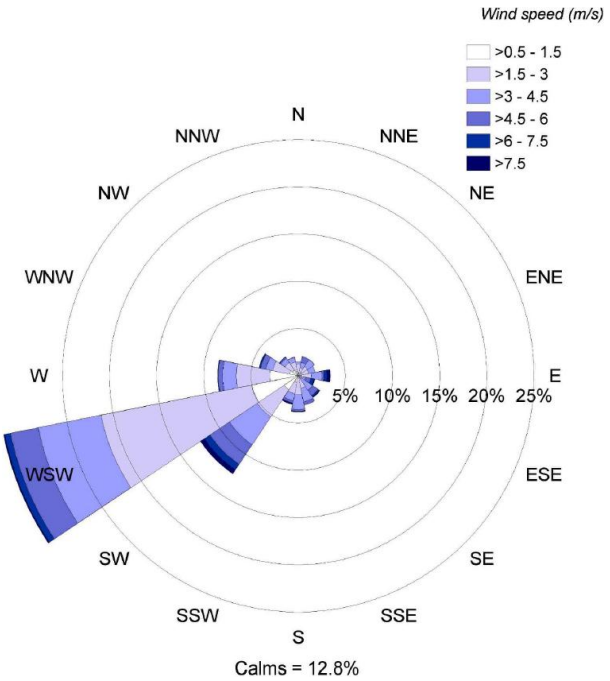

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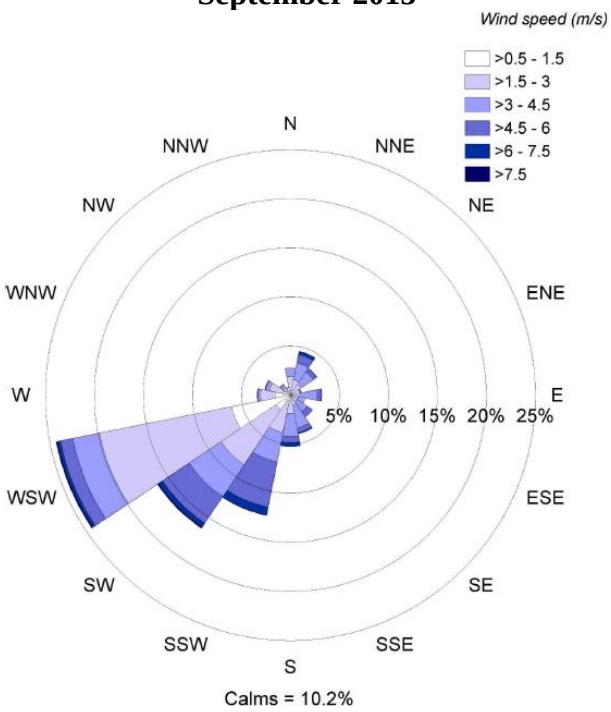
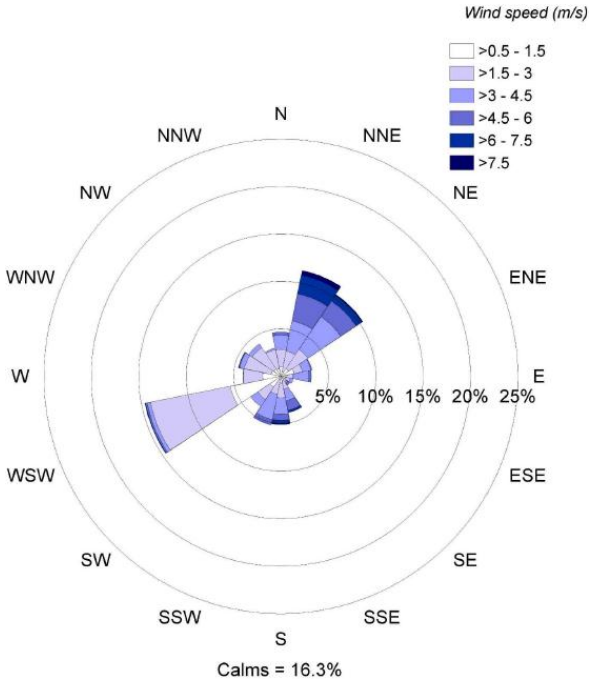


October 2015



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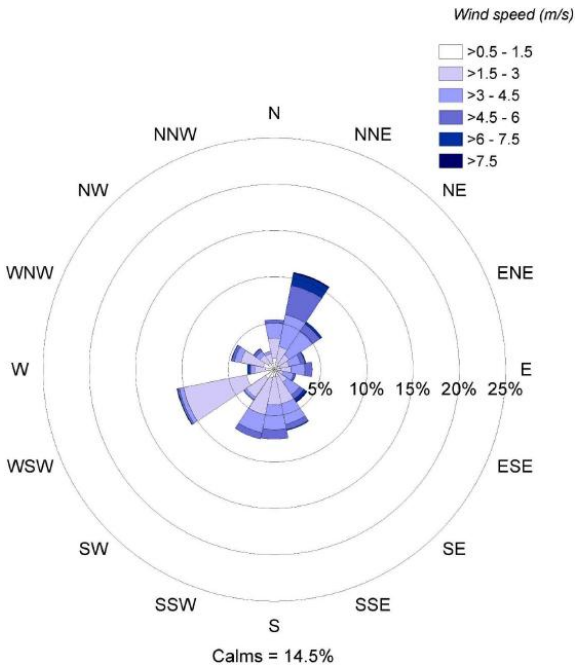

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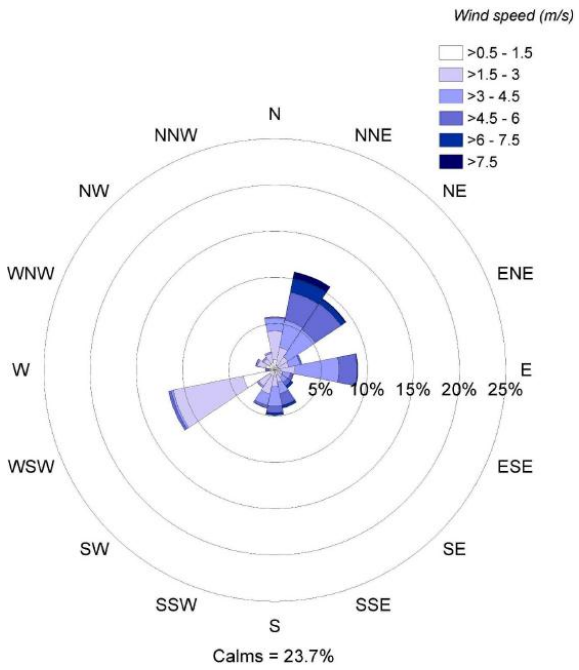
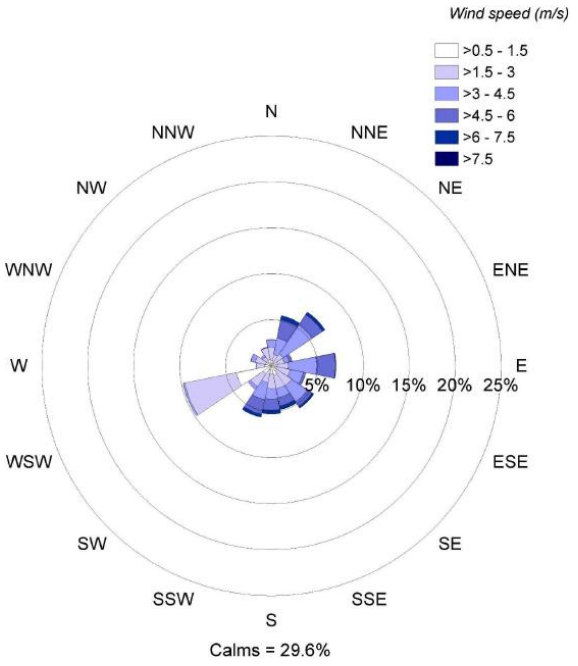
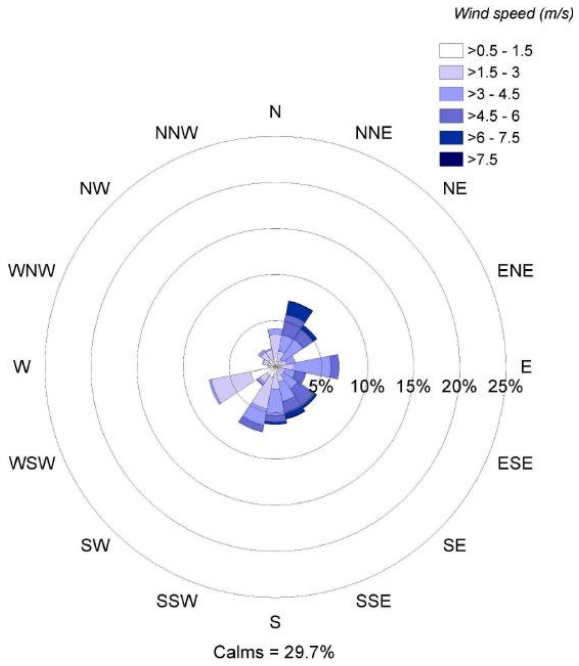


January 2016



February 2016



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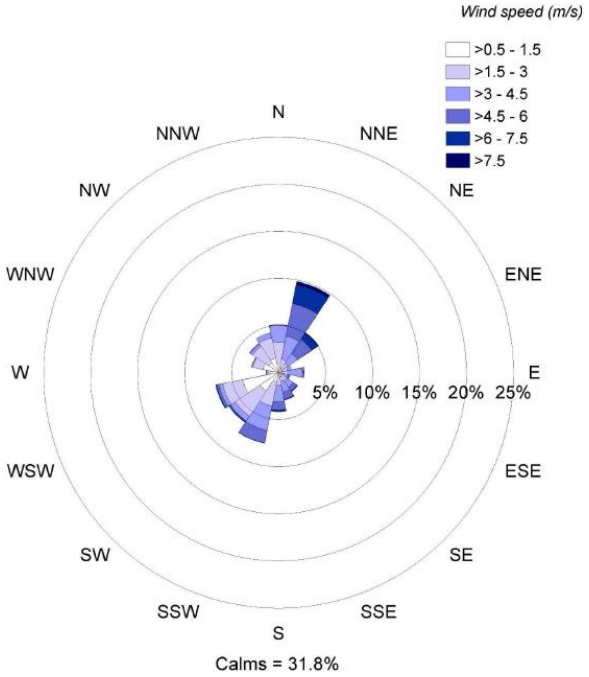

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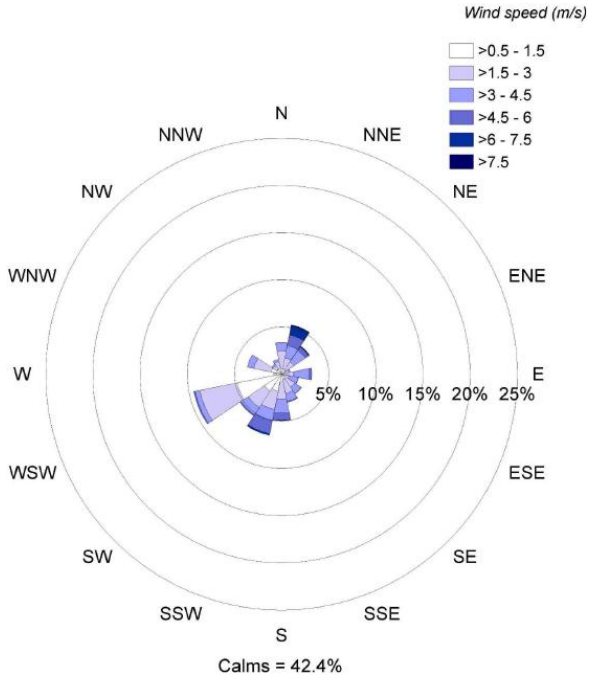

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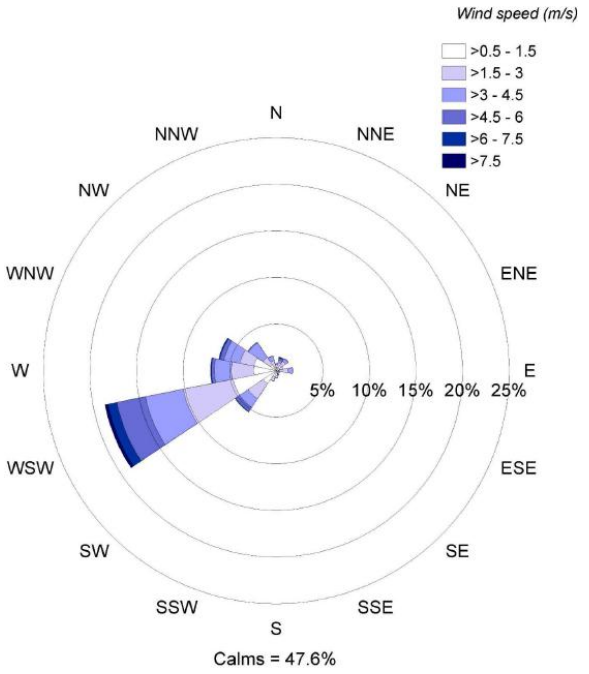

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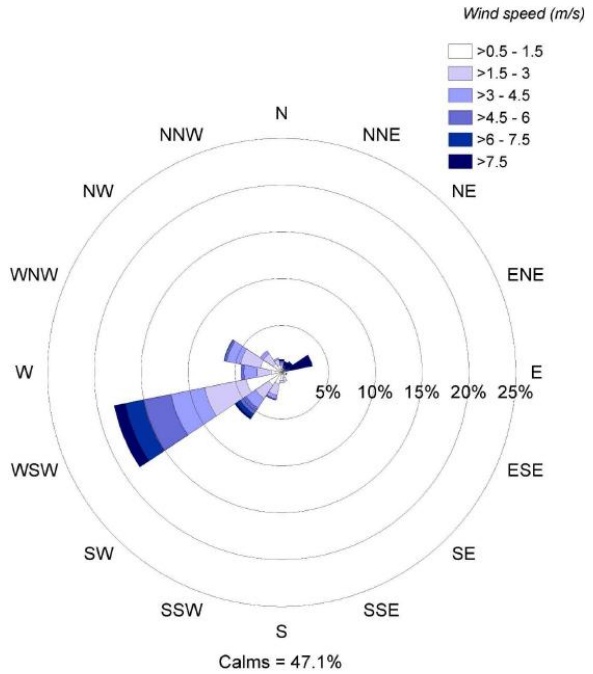

Appendix 6 – Annual Noise Assessment Report

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Annual Compliance Noise Monitoring 2016

Dunmore Quarry

Tabbita Road, Dunmore NSW

Report Number 610.11631-R8

9 September 2016

Boral Property Group
38 Tabbita Road
DUNMORE NSW 2259

Version: Revision 0

Annual Compliance Noise Monitoring 2016

Dunmore Quarry

Tabbita Road, Dunmore NSW

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
610.11631-R8	Revision 0	30 August 2016	Nicholas Vandenberg	Dick Godson	Dick Godson

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TABLES

FIGURES

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) conducted a noise assessment of the operations at Dunmore Quarry during August 2016. The assessment comprised of operator attended noise monitoring at the McParland residence, the Stocker residence and the Dunmore Lakes Estate.

The purpose of the assessment was to determine the quarry noise contribution at Location A (McParland residence), Location K (Stocker residence) and Location O (Dunmore Lakes Estate) in relation to the Development Consent DA 470-11-2003 (DA) and Environment Protection Licence (EPL) limits for the Dunmore Quarry operation.

An explanation of acoustic terminology and descriptors discussed throughout the report is included in **Appendix A**.

2 METHODOLOGY

Noise measurements and assessments in this report have been prepared in accordance with Australian Standard AS 1055-1997 "*Description and Measurement of Environmental Noise*" Part 1, 2 and 3 and with reference to the NSW Industrial Noise Policy (INP) .

All acoustic instrumentation employed throughout the monitoring programme has been designed to comply with the requirements of IEC 61672.1-2004 *"Electroacoustics – Sound Level Metres – Specifications"* and carries current NATA or manufacturer calibration certificates.

The objectives of the noise monitoring assessment were as follows:

- Measure the quarry noise contribution at the McParland, Stocker and Dunmore Lakes Estate residential locations. Noise surveys consisted of operator-attended monitoring.
- Qualify all sources of noise within each of the attended surveys, including estimated contribution or maximum level of each source.
- Assess the noise emissions of Dunmore Quarry in relation to the DA/EPL limits for the site with regard to wind speed and direction during the noise surveys.

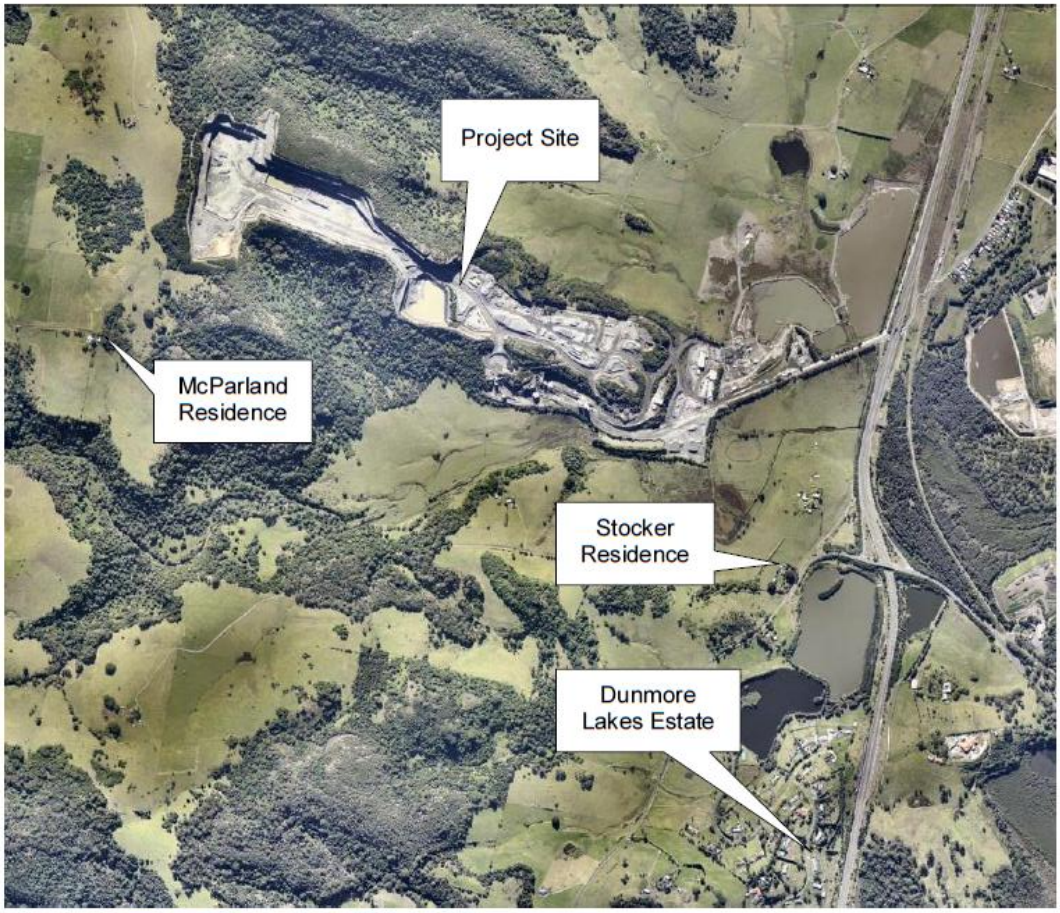
2.1 Monitoring Locations

Operator attended noise measurements were conducted at the locations provided in **Table 1** and depicted in **Figure 1**.

Table 1 Monitoring Locations

Location	Description
A	McParland Residence
K	Stocker Residence
O	Dunmore Lakes Estate

Figure 1 Noise Monitoring Locations



Note: Image courtesy of Nearmap (dated 21 June 2014).

2.2 Operator Attended Noise Monitoring

Operator-attended surveys were conducted at each monitoring location in order to determine the character and contribution of the noise sources, including quarry noise, to the overall ambient noise level. Operator attended noise measurements were conducted using a one-third octave integrating Brüel & Kjær 2270 Type 1 sound level meter (S/N 3008204).

3 OPERATOR ATTENDED NOISE MONITORING

3.1 Compliance Monitoring

Operator attended noise measurements were conducted during the morning shoulder period (6:00 am to 7:00 am) on both 9 August 2016 and 18 August 2016, during the daytime period on 17 August 2016 and during the evening period on 17 August 2016.

A summary of the operator-attended measurements presenting the estimated contribution of quarry noise sources is contained within **Table 2** to **Table 4**.

The tables provide the following information:

- Monitoring location.
- Date and time.
- Wind velocity (m/s) at 1.5 m above the ground.
- Temperature (Temp) in degrees Celsius.
- Estimated Quarry contribution - $L_{Aeq(15minute)}$.
- DA/EPL Limit $L_{Aeq(15minute)}$.

Table 2 Attended Noise Survey Results – Location A - McParland

Period DA/EPL Limit $L_{Aeq(15minute)}$	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
Morning Shoulder 35 dBA	18-08-2016 06:00 7° C 1 m/s NW	59	51	43	32	41	Dist Taffic - <30 to 40 dBA Insects 33 dBA Birds 36 to 59 dBA
		Estimated Quarry $L_{Aeq(15minute)}$ Contribution ~ 32 dBA					**Quarry Audible** Trucks – 31 to 36 dBA Beeper <30
Day 35 dBA	17-08-2016 16:09 20° C, 1 m/s NNW	58	45	37	<30	36	Birds – 40 to 58 dBA Dog 36 to 59 dBA Dist Traffic <30 to 43 dBA Plane – 37 to 42 dBA Chain Saw 33 to 41 dBA
		Estimated Quarry $L_{Aeq(15minute)}$ Contribution - < 30 dBA					**Quarry Not Audible**
Evening 35 dBA	17-08-2016 18:00 18° C, 1 m/s NW	67	52	43	32	41	Insects – 33 to 35 dBA Plane – 35 to 55 dBA Dist Traffic 31 to 36 dBA Dog barking – 36 to 67 dBA
		Estimated Quarry $L_{Aeq(15minute)}$ Contribution - < 30 dBA					**Quarry Not Audible**

Table 3 Attended Noise Survey Results – Location K - Stocker

Period DA/EPL Limit LAeq(15minute)	Date/Start Time/ Weather	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
Morning Shoulder 47 dBA	9-08-2016 06:45 5° C 0.5 m/s NW	63	61	59	56	58	Princes Hwy – 58 to 59 dBA Birds 59 to 62 dBA Local Traffic 58 to 60 dBA **Quarry Audible at times** Truck Rev Tone Bang 55 Faint hum ~47 to 50 dBA[1]
		Estimated Quarry LAeq(15minute) Contribution - <46 dBA					
Day 49 dBA	17-08-2016 17:09 20° C 1m/s NNW	60	55	52	46	49	Local Traffic – 53 to 58 dBA Princes Hwy – 45 to 50 dBA Birds 60 dBA **Quarry Trucks Audible at times** Quarry Trucks - <39 to 43 dBA Faint hum - <36 dBA
		Estimated Quarry LAeq(15minute) Contribution - <40 dBA					
Evening 44 dBA	17-08-2016 19:19 18° C 1 m/s NW	63	57	53	45	50	Traffic – 48 to 51 dBA Local Traffic – 54 to 62 dBA Dog 57 dBA Train Horn – 54 to 55 dBA[2] **Quarry Audible** Trucks faintly Audible - <36 dBA Air breaks 43 dBA Horn – 42 dBA Faint Hum - <36 dBA
		Estimated Quarry LAeq(15minute) Contribution - <39 dBA					

Note 1: Further noise measurements and calculations were performed to confirm the contribution from the quarry.
Note 2: The train horn was not related to trains associated with the quarry.

Table 4 Attended Noise Survey Results – Location O – Dunmore Lakes Estate

Period DA/EPL Limit LAeq(15minute)	Date/Start Time/ Weather Stability Class	Primary Noise Descriptor (dBA re 20 µPa)					Description of Noise Emissions and Typical Maximum Noise Levels (dBA)
		L_{Amax}	L_{A1}	L_{A10}	L_{A90}	L_{Aeq}	
Morning Shoulder 47 dBA	18-08-2016 06:39 7° C, 1 m/s NW	73	66	56	49	55	Swamp Road Traffic – 53 dBA Princes Hwy – 47 to 62 dBA Local Traffic – 67 to72 dBA Birds – 50 to 66 dBA Train Horn – 67 dBA[1] **Quarry Audible at times** Trucks ~ <41 dBA
		Estimated Quarry LAeq(15minute) Contribution - <41 dBA					
Day 49 dBA	17-08-2016 16:49 20° C, 1 m/s NNW	66	61	58	53	56	Traffic 53 to 61 dBA Birds <45 to 53 dBA Helicopter 55 to 66 dBA **Quarry Not Audible**
		Estimated Quarry LAeq(15minute) Contribution - < 43 dBA					
Evening 44 dBA	17-08-2016 19:00 18° C, 1 m/s NW	72	54	50	43	49	Swamp Road Traffic – 53 dBA Pricnes Hwy – 48 to 56 dBA Dog 50 54 dBA Local traffic – 72 dBA Plane 51 to 53 dBA **Quarry Audible Intermittently** Trucks audible in lulls <36 Hum - <40 dBA
		Estimated Quarry LAeq(15minute) Contribution - < 40 dBA					

Note 1: the train horn was not related to trains associated with the quarry.

4 COMPLIANCE ASSESSMENT AND DISCUSSION

A summary of the operator attended noise survey results are provided in **Table 5**.

Table 5 Compliance Noise Assessment - Operations

Location	Estimated Contribution			Consent Conditions			Compliance Achieved		
	Morning Shoulder	Day	Evening	Morning Shoulder	Day	Evening	Morning Shoulder	Day	Evening
McParland	~32	<30	<30	35	35	35	Yes	Yes	Yes
Stocker	<46	<40	<39	47	49	44	Yes	Yes	Yes
Dunmore Lakes	<41	<43	<40	47	49	44	Yes	Yes	Yes

A review of **Table 5** indicates that compliance with the consent conditions was achieved at all locations during the operator attended noise surveys. Further discussion with regard to each monitoring location is provided below.

4.1 Location A – McParland Residence

This location represents receptors located to the west of the Dunmore Quarry. Noise generated from ambient noise sources such as birds and insects as well as noise generated from residents were the dominant noise sources at this location.

Noise contributions from the quarry at the McParland residence were estimated to be:

- ~30 dB $L_{Aeq(15minute)}$ during the morning shoulder period.
- <30 dB $L_{Aeq(15minute)}$ during the daytime period.
- <30 dB $L_{Aeq(15minute)}$ during the evening period.

Quarry operations were only observed to be audible during the morning shoulder period at this location.

4.2 Location K – Stocker Residence

This location represents receptors located to the southeast of Dunmore Quarry. Noise generated from road traffic and birds were the dominant noise source at this location.

The evening period has been identified in previous noise surveys and assessments as the most likely to contain noise enhancing conditions. The Stocker residence is the closest noise sensitive receiver.

Noise contributions from the quarry at the Stocker residence were estimated to be:

- <46 dB $L_{Aeq(15minute)}$ during the morning shoulder period.
- <40 dB $L_{Aeq(15minute)}$ during the daytime period.
- <39 dB $L_{Aeq(15minute)}$ during the evening period.

Quarry operations were audible during all monitoring periods at this location. Quarry operations which contributed to the estimated noise level included truck loading and movement and a low frequency hum. This low frequency hum was observed to be quite prominent during morning shoulder period, however further measurements were conducted on site and at various distances from the quarry.

A measurement of 75 dBA was taken at a distance of approximately 40 meters from the Jaw Crusher, which has been extrapolated to be 45 dBA at the receiver location. However, it has been calculated that there is approximately 6 dB to 8 dB of reduction provided by the earth mound. Therefore it is calculated that the resultant noise level is approximately 37 dBA to 39 dBA.

It should be noted that the noise level at the Stocker Residence is dominated by road traffic noise (particularly during the morning shoulder period), and although audible, the Quarry is not likely to have an impact on the overall noise level at the receiver location.

4.3 Location O – Dunmore Lakes Estate

This location represents receptors located to the east-southeast of Dunmore Quarry. Noise generated from road traffic was the dominant noise source at this residential location.

Noise contributions from the quarry at the Dunmore Lakes residence were estimated to be:

- <41 dB $L_{Aeq(15minute)}$ during the morning shoulder period.
- <43 dB $L_{Aeq(15minute)}$ during the daytime period.
- <40 dB $L_{Aeq(15minute)}$ during the evening period.

Quarry operations were only observed to be audible during the morning shoulder and evening noise monitoring periods. Quarry operations which contributed to the estimated noise level included truck movement and loading noise.

5 CONCLUSION

SLR was engaged by the Boral Property Group to conduct a noise compliance monitoring survey of the operations of the Dunmore Quarry. Operator attended noise measurements were conducted at three (3) locations in order to determine the estimated noise contribution from the Quarry.

The results of noise monitoring indicate that compliance is achieved at all locations during all monitoring periods.

Acoustic Terminology

1 Sound Level or Noise Level

The terms 'sound' and 'noise' are almost interchangeable, except that in common usage 'noise' is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2×10^{-5} Pa.

2 'A' Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an 'A-weighting' filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120	Heavy rock concert	Extremely noisy
110	Grinding on steel	
100	Loud car horn at 3 m	Very noisy
90	Construction site with pneumatic hammering	
80	Kerbside of busy street	Loud
70	Loud radio or television	
60	Department store	Moderate to quiet
50	General Office	
40	Inside private office	Quiet to very quiet
30	Inside bedroom	
20	Recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as 'linear', and the units are expressed as dB(lin) or dB.

3 Sound Power Level

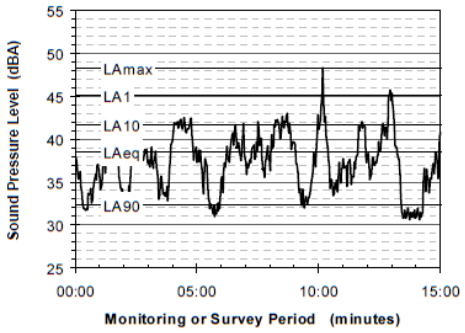
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or Lw, or by the reference unit 10^{-12} W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the 'repeatable minimum' L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or 'average' levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than 'broad band' noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

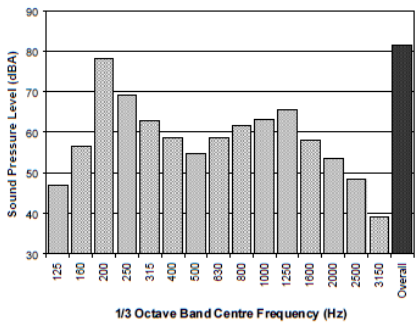
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of 'peak' velocity or 'rms' velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as 'peak particle velocity', or PPV. The latter incorporates 'root mean squared' averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (10^{-9} m/s). Care is required in this regard, as other reference levels may be used by some organizations.

9 Human Perception of Vibration

People are able to 'feel' vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as 'normal' in a car, bus or train is considerably higher than what is perceived as 'normal' in a shop, office or dwelling.

10 Over-Pressure

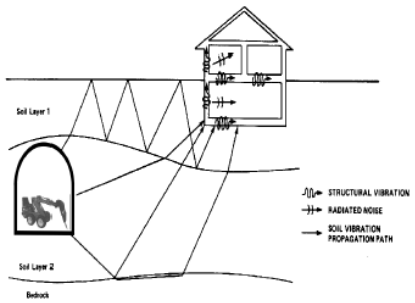
The term 'over-pressure' is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Ground-borne Noise, Structure-borne Noise and Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed 'structure-borne noise', 'ground-borne noise' or 'regenerated noise'. This noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of ground-borne or structure-borne noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and ground-borne noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term 'regenerated noise' is also used in other instances where energy is converted to noise away from the primary source. One example would be a fan blowing air through a discharge grill. The fan is the energy source and primary noise source. Additional noise may be created by the aerodynamic effect of the discharge grill in the airstream. This secondary noise is referred to as regenerated noise