# APPENDIX A

## EXISTING PROJECT APPROVAL 06_0074

# APPENDIX A

# Project Approval

## Section 75J of the *Environmental Planning & Assessment Act 1979*

I, the Minister for Planning approve the project referred to in schedule 1, subject to the conditions set out in schedules 2 to 5.

The reason for these conditions is to:
- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the on-going environmental management of the project.

Frank Sartor MP
**Minister for Planning**

| | | |
|---|---|---|
| Sydney | 2007 | File No. 9040608 |

**SCHEDULE 1**

| | |
|---|---|
| **Project Application:** | 06_0074 |
| **Proponent:** | Boral Resources (NSW) Pty Ltd |
| **Approval Authority:** | Minister for Planning |
| **Land:** | See Appendix 1 |
| **Project:** | Marulan South hard rock quarry and associated infrastructure |

## TABLE OF CONTENTS

**Red type represents March 2009 Modification**
**Blue type represents November 2011 Modification**
**Green type represents October 2012 Modification**

## DEFINITIONS

| | |
|---|---|
| Annual Review | The review required by condition 4 of schedule 5 |
| BCA | Building Code of Australia |
| CCC | Community Consultative Committee |
| Council | Goulburn Mulwaree Council |
| Day | Day is defined as the period from 7.00am to 6.00pm, Monday to Saturday and 8.00am to 6.00pm Sundays and Public Holidays |
| Department | Department of Planning and Infrastructure |
| Director-General | Director-General of the Department (or nominee) |
| DPI | Department of Primary Industries |
| EA | Environmental Assessment for the project titled *Marulan South Quarry Environmental Assessment Report* Volumes 1 and 2 dated October 2006 prepared by ERM |
| EPA | NSW Environment Protection Authority |
| EP&A Act | *Environmental Planning and Assessment Act 1979* |
| EP&A Regulation | *Environmental Planning and Assessment Regulation 2000* |
| EPL | Environment Protection Licence under the *Protection of the Environment Operations Act 1997* |
| Evening | Evening is defined as the period from 6.00pm to 10.00pm |
| Land | Land means the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of this approval |
| Night | Night is defined as the period from 10.00pm to 7.00am Monday to Saturday and 10.00pm to 8.00am Sundays and Public Holidays |
| Noise Bund | Bunds built for noise and visual mitigation purposes and which do not exceed 10 metres in height |
| NOW | NSW Office of Water, within the Department of Primary Industries |
| OEH | Office of Environment and Heritage |
| Project | Development to which the Project Approval applies |
| Proponent | Boral Resources (NSW) Pty Ltd |
| RMS | Roads and Maritime Services |
| Site | Land to which the Project Approval applies (see Appendix 1) |
| Submissions Report | *Marulan South Quarry Submissions Report* dated December 2006 |

## SCHEDULE 2
## ADMINISTRATIVE CONDITIONS

**Obligation to Minimise Harm to the Environment**

1. The Proponent shall implement all practicable measures to prevent or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.

**Terms of Approval**

2. The Proponent shall carry out the project generally in accordance with the:
   (a) EA;
   (b) submissions report;
   (c) modification application 06_0074 – MOD 1 and accompanying Statement of Environmental Effects entitled *Marulan South Quarry Statement of Environmental Effects for a Pre-commencement Exploratory Test Pit* dated 13 November 2008, and letter from Boral Resources Pty Ltd to the Department dated 13 February 2009;
   d) modification application 06_0074 – MOD 2 and the accompanying EA titled *Boral Peppertree Quarry Section 75W Modification Report*, dated June 2011, prepared by ERM Australia, and the responses to issues raised in submissions, including those titled *Peppertree Quarry Submissions Report*, dated 24 August 2011, *Response to OEH Submission*, dated 12 October 2011, and *Response to Armitt Submission*, dated 25 October 2011;
   e) modification application 06_0074 – MOD 3 and the accompanying EA titled *Peppertree Quarry Modification 3 Environmental Assessment*, dated August 2012, prepared by EMGA Mitchell McLennan Pty Limited, and the responses to issues raised in submissions titled *Response to Submissions Peppertree Quarry Modification 3*, dated 3 October 2012; and
   f) conditions of this approval.

   *Note: The general layout of the project is shown in the figure in Appendix 2.*

3. If there is any inconsistency between the above, either the most recent document or the conditions of this approval shall prevail to the extent of the inconsistency.

4. The Proponent shall comply with any reasonable requirement/s of the Director-General arising from the Department's assessment of:
   (a) any reports, plans, programs or correspondence that are submitted in accordance with this approval; and
   (b) the implementation of any actions or measures contained in these reports, plans, programs or correspondence.

4A. The proponent shall be permitted to undertake pre-construction exploratory test pit activities as described in modification application 06_0074 MOD 1.

   Note: The commencement of test pit activities as described in modification application 06_0074 MOD 1 is not subject to the preparation of management plans.

**Limits on Approval**

5. This approval shall lapse at the end of 2038.

6. The Proponent shall not transport more than 3.5 million tonnes of product from the site in a year.

7. All extractive materials and products shall be transported from the site by rail. However, the Proponent may transport some product by road in an emergency with the written approval of the Director-General.

**Structural Adequacy**

8. The Proponent shall ensure that all new buildings and structures on the site are constructed in accordance with the relevant requirements of the BCA.

   *Notes:*
   - *Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for any building works.*
   - *Part 8 of the EP&A Regulation sets out the detailed requirements for the certification of development.*

**Demolition**

9. The Proponent shall ensure that all demolition work on site is carried out in accordance with *AS 2601-2001: The Demolition of Structures,* or its latest version.

**Protection of Public Infrastructure**

10. The Proponent shall:
    (a) repair, or pay all reasonable costs associated with repairing any public infrastructure that is damaged by the project; and
    (b) relocate, or pay all reasonable costs associated with relocating any public infrastructure that needs to be relocated as a result of the project.

**Operation of Plant and Equipment**

11. The Proponent shall ensure that all plant and equipment used at the site is:
    (a) maintained in a proper and efficient condition; and
    (b) operated in a proper and efficient condition.

12. With the approval of the Director-General, the Proponent may prepare and submit any management plan or monitoring program required by this approval on a progressive basis.

## SCHEDULE 3
## ENVIRONMENTAL PERFORMANCE CONDITIONS

### GENERAL EXTRACTION AND PROCESSING PROVISIONS

#### Identification of Boundaries

1. Prior to the commencement of construction, or as otherwise agreed by the Director-General, the Proponent shall:
   (a) engage an independent registered surveyor to survey the boundaries of the approved limit of extraction;
   (b) submit a survey plan of these boundaries to the Director-General; and
   (c) ensure that these boundaries are clearly marked at all times in a permanent manner that allows operating staff and inspecting officers to clearly identify those limits.

*Note: The limit of extraction is shown conceptually on the plan in Appendix 2.*

### NOISE

#### Construction of Bunds

2. In carrying out the construction of the noise bunds, the Proponent shall:
   (a) comply with the construction noise criteria in the *Environmental Noise Control Manual 1994* for the first three months of the construction work; and
   (b) thereafter, comply with the daytime operational noise criteria in condition 4.

#### Construction Noise Management Plan

3. The Proponent shall prepare and implement a Construction Noise Management Plan for the project to the satisfaction of the Director-General. This plan must be submitted to the Director-General for approval prior to the commencement of construction, and include:
   (a) a detailed description of the measures that would be implemented to achieve the construction noise limits in the *Environmental Noise Control Manual 1994* and the operational noise criteria in condition 4*;*
   (b) a community notification protocol for the proposed construction activities;
   (c) a description of the measures that would be implemented where the construction noise limits and/or operational noise limits are unlikely to be achieved or are not being achieved; and
   (d) details of who would be responsible for monitoring, reviewing and implementing the plan.

#### Operational Noise Impact Assessment Criteria

4. The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 1.

| ***Residential Receiver*** | ***Day Shift*** | ***Night Shift*** | | |
|---|---|---|---|---|
| | *Day* | *Evening* | *Night* | |
| | $L_{Aeq(15\ minute)}$ | $L_{Aeq(15\ minute)}$ | $L_{Aeq(15\ minute)}$ | $L_{A1(1\ minute)}$ |
| 2 | 39 | 35 | 35 | 45 |
| 5 | 35 | 35 | 35 | 45 |
| 6 | 35 | 35 | 35 | 45 |
| 16 | 41 | 35 | 35 | 45 |
| Any other noise sensitive location | 35 | 35 | 35 | 45 |

*Table 1: Noise Impact Assessment Criteria*

*Notes:*
- *The identified "Day" noise criteria apply throughout the period of the site's Day Shift (ie 7.00am to 7.00pm) on all days, despite the general definitions of Evening and Night otherwise applying to the approval. The identified "Evening" and "Night" criteria apply only during the period of the site's Night Shift (ie 7.00pm to 7.00am).*
- *Noise generated by the project is to be measured in accordance with the relevant procedures and exemptions (including certain meteorological conditions) of the NSW Industrial Noise Policy.*
- *Residential receiver locations are shown in Appendix 2A.*

#### Land Acquisition Criteria

5. If the noise generated by the project exceeds the criteria in Table 2, the Proponent shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in conditions 6-8 of Schedule 4.

| ***Residential Receiver*** | ***Day*** $L_{Aeq(15\ minute)}$ | ***Evening / Night*** $L_{Aeq(15\ minute)}$ |
|---|---|---|
| 2 | 44 | 44 |
| 5 | 40 | 40 |
| 6 | 40 | 40 |
| 16 | 44 | 44 |

*Table 2: Land Acquisition Criteria*

*Note: The notes under Table 1 apply equally to Table 2.*

**Cumulative Noise Criteria**

6. The Proponent shall take all reasonable and feasible measures to ensure that the noise generated by the project combined with the noise generated by other extractive industries does not exceed the following amenity criteria on any privately owned land, to the satisfaction of the Director-General:
- $L_{Aeq(11\ hour)}$ *50 dB(A) – Day;*
- $L_{Aeq(4\ hour)}$ *45 dB(A) – Evening; and*
- $L_{Aeq(9\ hour)}$ *40 dB(A) – Night.*

**Additional Noise Mitigation Measures**

7. Upon receiving a written request from the owner of residential receiver 3 (except where a negotiated noise agreement is in place) the Proponent shall implement additional noise mitigation measures such as double glazing, insulation, and/or air conditioning at any residence on the land in consultation with the owner. These additional mitigation measures must be reasonable and feasible. If within 3 months of receiving this request from the landowner, the Proponent and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Director-General for resolution.

8. Within 3 months of this approval, the Proponent shall notify the owner of residential receiver 3 that he/she is eligible for additional noise mitigation measures.

**Operating Conditions**

9. The Proponent shall:
   (a) implement best practice noise management, including all reasonable and feasible noise mitigation measures to minimise the noise generated by the project;
   (b) investigate ways to minimise the noise generated by the project;
   (c) operate a comprehensive noise management system that uses a combination of predictive meteorological forecasting and noise monitoring data to guide the day to day planning of quarrying operations and the implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this approval;
   (d) minimise noise impacts during adverse weather conditions; and
   (e) report on these investigations and the implementation and effectiveness of these measures in the Annual Review,

   to the satisfaction of the Director-General.

**Noise Management Plan**

10. The Proponent shall prepare and implement a Noise Management Plan for the project to the satisfaction of the Director-General. This plan must be prepared in consultation with EPA and submitted to the Director-General for approval by the end of March 2012, and must:
   (a) describe the measures that would be implemented to ensure compliance with the relevant conditions of this approval;
   (b) describe the noise management system;
   (c) include a noise monitoring program that:
      - supports the noise management system;
      - provides information to evaluate the performance of the project;
      - includes a protocol for determining exceedances of relevant conditions of this approval; and
      - provides for the use of real-time and/or supplementary attended monitoring measures, if directed by the Director-General;
   (d) include a community notification protocol for the proposed construction activities; and

(e) detail who would be responsible for monitoring, reviewing and implementing the plan.

**Hours of Operation**

11. The Proponent shall comply with the hours of operation in Table 3.

| *Activity* | *Day* | *Time* |
|---|---|---|
| Construction works | Monday-Friday | 7.00am to 6.00pm |
| | Saturday | 8.00am to 1.00pm |
| | Sunday and public holidays | None |
| Topsoil/overburden removal/emplacement | Any day | 7.00am to 7.00pm |
| Blasting | Monday-Saturday | 9.00am to 5.00pm |
| | Sunday and public holidays | None |
| In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit) | Any day | 7.00am to 7.00pm |
| Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance) | Any day | 24 hours |

*Table 3 – Hours of Operation*

**BLASTING AND VIBRATION**

**Airblast Overpressure Criteria**

12. The Proponent shall ensure that the airblast overpressure level from blasting at the project does not exceed the criteria in Table 4 at any residence on privately-owned land.

| *Airblast overpressure level (dB(Lin Peak))* | *Allowable exceedance* |
|---|---|
| 115 | 5% of the total number of blasts over a period of 12 months |
| 120 | 0% |

*Table 4: Airblast Overpressure Impact Assessment Criteria*

**Ground Vibration Criteria**

13. The Proponent shall ensure that the ground vibration level from blasting at the project does not exceed the criteria in Table 5 at any residence or sensitive receiver on privately-owned land.

| *Peak particle velocity (mm/s)* | *Allowable exceedance* |
|---|---|
| 5 | 5% of the total number of blasts over a period of 12 months |
| 10 | 0% |

*Table 5: Ground Vibration Impact Assessment Criteria for Residences on Privately-owned Land*

**Operating Conditions**

14. The Proponent shall implement best blasting practice to:
(a) ensure that no flyrock leaves the site;
(b) protect the safety of people, property, and livestock; and
(c) minimise the dust and fume emissions from blasting on the site,
to the satisfaction of the Director-General.

**Public Notice**

15. The Proponent shall:
    (a) notify the landowner/occupier of any residence within 2 kilometres of the quarry pit who registers an interest in being notified about the blasting schedule on site;
    (b) operate a blasting hotline, or alternative system agreed to by the Director-General, to enable the public to get up-to-date information on blasting operations at the project; and
    (c) keep the public informed about this hotline (or any alternative system),

    to the satisfaction of the Director-General.

**Monitoring**

16. The Proponent shall prepare and implement a Blast Monitoring Program for the project to the satisfaction of the Director-General. This program must:
    (a) be submitted to the Director-General for approval prior to the commencement of construction;
    (b) be prepared in consultation with the EPA; and
    (c) monitor the performance of the project against the relevant blasting criteria.

**AIR QUALITY**

**Air Quality Impact Assessment Criteria**

17. The Proponent shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the project do not exceed the criteria listed in Tables 6, 7 and 8 at any residence on privately owned land, or on more than 25 percent of any privately owned land.

*Table 6: Long term impact assessment criteria for particulate matter*

| Pollutant | Averaging period | [d] Criterion |
|---|---|---|
| Total suspended particulate (TSP) matter | Annual | [a] 90 µg/$m^3$ |
| Particulate matter < 10 µm ($PM_{10}$) | Annual | [a] 30 µg/$m^3$ |

*Table 7: Short term impact assessment criterion for particulate matter*

| Pollutant | Averaging period | [d] Criterion |
|---|---|---|
| Particulate matter < 10 µm ($PM_{10}$) | 24 hour | [a] 50 µg/$m^3$ |

*Table 8: Long term impact assessment criteria for deposited dust*

| Pollutant | Averaging period | Maximum increase[2] in deposited dust level | Maximum total[1] deposited dust level |
|---|---|---|---|
| [c] Deposited dust | Annual | [b] 2 g/$m^2$/month | [a] 4 g/$m^2$/month |

*Notes to Tables 6-8*

*[a] Total impact (i.e. incremental increase in concentrations due to the project plus background concentrations due to all other sources);*

*[b] Incremental impact (i.e. incremental increase in concentrations due to the project on its own);*

*[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and*

*[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Director-General.*

**Land Acquisition Criteria**

18. If particulate matter emissions generated by the project exceed the criteria in Tables 9, 10, and 11 at any residence on privately-owned land, or on more than 25 percent of any privately owned land, then upon written request for acquisition from the landowner, the Proponent shall acquire the land in accordance with the procedures in conditions 6-7 of schedule 4.

*Table 9: Long term land acquisition criteria for particulate matter*

| Pollutant | Averaging period | [d] Criterion |
|---|---|---|
| Total suspended particulate (TSP) matter | Annual | [a] 90 µg/$m^3$ |
| Particulate matter < 10 µm ($PM_{10}$) | Annual | [a] 30 µg/$m^3$ |

*Table 10: Short term land acquisition criteria for particulate matter*

| Pollutant | Averaging period | [da] Criterion |
|---|---|---|
| Particulate matter < 10 µm ($PM_{10}$) | 24 hour | [a] 150 µg/m$^3$ |
| Particulate matter < 10 µm ($PM_{10}$) | 24 hour | [b] 50 µg/m$^3$ |

*Table 11: Long term land acquisition criteria for deposited dust*

| Pollutant | Averaging period | Maximum increase[2] in deposited dust level | Maximum total[1] deposited dust level |
|---|---|---|---|
| [c] Deposited dust | Annual | [b] 2 g/m$^2$/month | [a] 4 g/m$^2$/month |

*Notes to Tables 9-11*

*[a] Total impact (i.e. incremental increase in concentrations due to the project plus background concentrations due to all other sources);*

*[b] Incremental impact (i.e. incremental increase in concentrations due to the project on its own);*

*[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and*

*[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents or any other activity agreed by the Director-General.*

### Operating Conditions

19. The Proponent shall:
    (a) implement best management practice on site, including all reasonable and feasible measures to minimise the off-site odour, fume and dust emissions generated by the project;
    (b) minimise any visible air pollution generated by the project;
    (c) minimise the surface disturbance of the site generated by the project; and
    (d) operate a comprehensive air quality management system that uses a combination of predictive meteorological forecasting and air quality monitoring data to guide the day to day planning of quarrying operations and the implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of this approval;

    to the satisfaction of the Director-General.

### Air Quality Management Plan

20. The Proponent shall prepare and implement a detailed Air Quality Management Plan for the project to the satisfaction of the Director-General. This plan must:
    (a) be prepared in consultation with EPA and submitted to the Director-General by the end of March 2012;
    (b) describe the measures that would need to be implemented to ensure compliance with the relevant conditions of this approval;
    (c) include a program for the implementation of the measures referred to in (b) above; and
    (d) include an air quality monitoring program that:
    - uses a combination of high volume samplers and dust deposition gauges to evaluate the performance of the project;
    - supports the air quality management system;
    - provides information to evaluate the performance of the project;
    - includes a protocol for determining exceedances of relevant conditions of this approval; and
    - provides for the use of real-time monitoring measures, if directed by the Director-General.

## METEOROLOGICAL MONITORING

21. For the life of the project, the Proponent shall ensure that there is a meteorological station in the vicinity of the site that:
    (a) complies with the requirements in the *Approved Methods for Sampling of Air Pollutants in New South Wales* guideline; and
    (b) is capable of continuous real-time measurement of temperature lapse rate in accordance with the *NSW Industrial Noise Policy.*

## SURFACE AND GROUND WATER

### Water Supply

22. Prior to the commencement of construction, the Proponent shall obtain the necessary approvals for the project under the *Water Act 1912*.

*Note: The Water Management Act 2000 may apply to the project. The Proponent shall consult with the NOW on the relevant approvals at the time the application is made.*

**Discharges**

23. Except as may be expressly provided for by an EPL, the Proponent shall not discharge any dirty water from the quarry or ancillary operational areas.

23A. The Proponent shall prepare an onsite wastewater report for the proposed effluent management system consistent with the requirements of *Sydney Catchment Authority – "Developments in Sydney's Drinking Water Catchment" – Water Quality Information Requirements, 2011.* The effluent management system must be designed and constructed to be in accordance with this onsite wastewater report and its design must be approved by Council prior to construction.

**Tangarang Creek Environmental Flow**

24. The proponent shall provide an environmental flow to Tangarang Creek equivalent to 10% of average daily flows. Details of the management of these environmental flows shall be included in the Site Water Balance for the project (see below).

**Sediment Dams**

25. The Proponent shall ensure that:
   (d) critical structures such as "dirty water" dams are designed, constructed and maintained to a accommodate a 1 in 100 year ARI 24-hour event; and
   (e) other dams and water management structures are designed, constructed and maintained to accommodate a 1 in 20 year ARI 24-hour event.

**Management and Monitoring**

26. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. This plan must:
   (a) be submitted to the Director-General for approval prior to the commencement of construction;
   (b) be prepared in consultation with the NOW, EPA and Sydney Catchment Authority; and
   (c) include a:
      - Site Water Balance;
      - Erosion and Sediment Control Plan;
      - Surface Water Monitoring Program;
      - Ground Water Monitoring Program; and
      - Surface and Ground Water Response Plan to address any potential adverse impacts associated with the project.

**Site Water Balance**

27. The Site Water Balance shall
   (a) include details of all water extracted (including make up water), dewatered, transferred, used and/or discharged by the project; and
   (b) describe measures to minimise water use by the project.

**Erosion and Sediment Control**

28. The Erosion and Sediment Control Plan shall:
   (a) be consistent with the requirements of *Managing Urban Stormwater: Soils and Construction, Volume 1, 4$^{th}$ Edition, 2004* (Landcom);
   (b) identify activities that could cause soil erosion and generate sediment;
   (c) describe measures to minimise soil erosion and the potential for the transport of sediment to downstream waters;
   (d) describe the location, function, and capacity of erosion and sediment control structures; and
   (e) describe what measures would be implemented to maintain (and if necessary decommission) the structures over time.

**Surface Water Monitoring**

29. The Surface Water Monitoring Program shall include:
   (a) detailed baseline data on surface water flows and quality in Tangarang Creek and Barbers Creek;
   (b) surface water impact assessment criteria;
   (c) a program to monitor surface water flows and quality;
   (d) a protocol for the investigation of identified exceedances of the surface water impact assessment criteria; and
   (e) a program to monitor the effectiveness of the Erosion and Sediment Control Plan.

**Ground Water Monitoring Program**

30. The Ground Water Monitoring Program shall include:
    (a) detailed baseline data on ground water levels, flows, and quality, based on statistical analysis;
    (b) groundwater impact assessment criteria for monitoring bores;
    (c) a program to monitor regional ground water levels and quality; and
    (d) a protocol for the investigation of identified exceedances of the ground water impact assessment criteria.

**TRAFFIC AND TRANSPORT**

31. The Proponent shall prepare and implement a construction traffic management plan for the project to the satisfaction of the RMS and Council.

**ABORIGINAL HERITAGE**

32. The Proponent shall prepare and implement an Aboriginal Heritage Management Plan for the project to the satisfaction of the Director-General. This plan must:
    (f) be submitted to the Director-General for approval prior to the commencement of construction;
    (g) be prepared in consultation with the OEH and relevant Aboriginal communities; and
    (h) include a:
        - description of the measures that would be implemented for the mapping, and salvage or relocation of the archaeological relics in the Tangarang Creek Dam 1 area;
        - description of the measures that would be implemented if any new Aboriginal objects or relics are discovered during the project; and
        - protocol for the ongoing consultation and involvement of the Aboriginal communities in the conservation and management of Aboriginal cultural heritage on the site.

32A If historical archaeological relics are unexpectedly discovered during works, all works must cease and a suitably qualified and experienced historical archaeologist be brought in to assess the find. Depending on the nature of the discovery, additional assessment and recording may be required prior to the recommencement of excavation in the affected area. The Heritage Council (or its Delegate) must be notified of this discovery in writing in accordance with section 146 of the *Heritage Act, 1977.*

**FLORA AND FAUNA**

33. The Proponent shall:
    (a) rehabilitate the site in a manner that is generally consistent with the conceptual rehabilitation principles in Chapter 2.8 of the EA; and
    (b) implement the Habitat Management Area in a manner that is generally consistent with the documents listed in condition 2 of schedule 3 (and shown conceptually in Appendix 3), including the establishment, conservation and maintenance of at least 13.5 hectares of vegetation species characteristic of Box Gum Woodland,

    to the satisfaction of the Director-General.

**Threatened Species Protection**

33A. The Proponent shall:
    (a) prior to clearing of vegetation and site preparation on the site of the Western Overburden Emplacement and extension, clearly and securely mark out the proposed boundary of the emplacement and extension;
    (b) avoid disturbance of *Box Gum Woodland* Endangered Ecological Community and other native vegetation adjacent to the site of the Western Overburden Emplacement and extension;
    (c) only undertake clearing of vegetation on the site of the Western Overburden Emplacement and extension following a recent fauna survey undertaken by a suitably qualified expert who has been approved by the Director-General; and
    (d) seek to avoid clearing of native vegetation on the site of the Western Overburden Emplacement and extension during the period August to November of any year.

**Landscape and Rehabilitation Management Plan**

34. The Proponent shall prepare and implement a Landscape and Rehabilitation Management Plan for the project to the satisfaction of the Director-General. This plan must:
    (e) be submitted to the Director-General for approval prior to the commencement of construction;
    (f) be prepared in consultation with the OEH and Council;
    (g) describe in general the short, medium, and long-term measures that would be implemented to:
        - rehabilitate the site;
        - implement the Habitat Management Area;
        - manage the remnant vegetation and habitat on the site; and
        - landscape the site (including the bunds and overburden emplacement areas) to mitigate any visual impacts of the project;

(h) describe in detail the measures that would be implemented over the next 5 years to rehabilitate and manage the landscape on the site;
(i) describe how the performance of these measures would be monitored over time; and
(j) set completion criteria for the rehabilitation of the site.

**Rehabilitation Bond**

35. Within 3 months of the first Independent Environmental Audit the Proponent shall lodge a rehabilitation bond for the project with the Director-General. The sum of the bond shall be calculated at $2.50/m$^2$ for the total area to be disturbed in each 5 year period, or as otherwise directed by the Director-General.

*Notes:*
- *If the rehabilitation is completed to the satisfaction of the Director-General, the Director-General will release the rehabilitation bond.*
- *If the rehabilitation is not completed to the satisfaction of the Director-General, the Director-General will call in all or part of the rehabilitation bond, and arrange for the satisfactory completion of the relevant works.*

36. Within 3 months of subsequent audits, the Proponent shall review, and if necessary revise, the sum of the bond to the satisfaction of the Director-General. This review must consider:
(a) the effects of inflation;
(b) any changes to the total area of disturbance; and
(c) the performance of the rehabilitation against the completion criteria of the Rehabilitation and Landscape Management Plan.

**VISUAL IMPACT**

**Visual Amenity and Lighting**

37. The Proponent shall:
(a) *minimise the visual impacts, and particularly the off-site lighting impacts, of the project;*
(b) *revegetate overburden emplacements, emplacement extensions and bunds as soon as practicable;*
(c) *take all practicable measures to further mitigate off-site lighting impacts from the project; and*
(d) *ensure that all external lighting associated with the project complies with* Australian Standard AS4282 (INT) 1995 - Control of Obtrusive Effects of Outdoor Lighting*,*
*to the satisfaction of the Director-General.*

*38.* *(Deleted)*

39. *(Deleted)*

**Advertising**

40. The Proponent shall not erect or display any advertising structure(s) or signs on the site without the written approval of the Director-General.

*Note – This does not include business identification, traffic management and safety or environmental signs.*

**WASTE MANAGEMENT**

41. The Proponent shall:
(a) monitor the amount of waste generated by the project;
(b) investigate ways to minimise waste generated by the project;
(c) implement reasonable and feasible measures to minimise waste generated by the project; and
(d) report on waste management and minimisation in the Annual Review.
to the satisfaction of the Director-General.

42. The Proponent shall ensure that all waste generated or stored on site is assessed, classified and managed in accordance with the EPA's *Environmental Guidelines: Assessment Classification and Management of Liquid and Non-Liquid Wastes*.

**EMERGENCY AND HAZARDS MANAGEMENT**

**Dangerous Goods**

43. The Proponent shall ensure that the storage, handling, and transport of dangerous goods are conducted in accordance with the relevant *Australian Standards*, particularly AS1940 and AS1596, and the *Dangerous Goods Code*.

### Safety

44. The Proponent shall secure the project to ensure public safety to the satisfaction of the Director-General.

### Bushfire Management

45. The Proponent shall:
    (a) ensure that the project is suitably equipped to respond to any fires on-site; and
    (b) assist the rural fire service and emergency services as much as possible if there is a fire on-site.

## PRODUCTION DATA

46. The Proponent shall:
    (a) provide annual production data to the DPI using the standard form for that purpose; and
    (b) include a copy of this data in the Annual Review.

## QUARRY EXIT STRATEGY

47. The Proponent shall prepare and implement a Quarry Exit Strategy for the project to the satisfaction of the Director-General. This strategy must:
    (a) be submitted to the Director-General for approval at least 5 years prior to the cessation of the project;
    (b) be prepared in consultation with the relevant agencies;
    (c) define the objectives and criteria for quarry closure;
    (d) investigate options for the future use of the site, including any final void/s;
    (e) describe the measures that would be implemented to minimise or manage the ongoing environmental effects of the project; and
    (f) describe how the performance of these measures would be monitored over time.

## SCHEDULE 4
## ADDITIONAL PROCEDURES

### NOTIFICATION OF LANDOWNERS

1. If the results of monitoring required in Schedule 3 identify that impacts generated by the project are greater than the relevant impact assessment criteria, then the Proponent shall notify the Director-General and the affected landowners and/or existing or future tenants (including tenants of quarry owned properties) accordingly, and provide quarterly monitoring results to each of these parties until the results show that the project is complying with the relevant criteria.

### INDEPENDENT REVIEW

2. If a landowner (excluding quarry owned properties) considers that the operations of the quarry are exceeding the impact assessment criteria in Schedule 3, then he/she may ask the Proponent in writing for an independent review of the impacts of the project on his/her land.

   If the Director-General is satisfied that an independent review is warranted, then within 2 months of the Director-General's decision, the Proponent shall:
   (a) commission a suitably qualified, experienced and independent expert, whose appointment has been approved by the Director-General, to:
      - consult with the landowner to determine his/her concerns;
      - conduct monitoring to determine whether the project is complying with the relevant impact assessment criteria in schedule 3; and
      - if the project is not complying with these criteria then:
         - o determine if the more than one quarry/mine is responsible for the exceedance, and if so the relative share of each quarry/mine regarding the impact on the land;
         - o identify the measures that could be implemented to ensure compliance with the relevant criteria; and
   (b) give the Director-General and landowner a copy of the independent review.

3. If the independent review determines that the quarrying operations are complying with the relevant criteria in Schedule 3, then the Proponent may discontinue the independent review with the approval of the Director-General.

4. If the independent review determines that the quarrying operations are not complying with the relevant criteria in Schedule 3, and that the quarry is primarily responsible for this non-compliance, then the Proponent shall:
   (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent expert, and conduct further monitoring until the project complies with the relevant criteria; or
   (b) secure a written agreement with the landowner to allow exceedances of the relevant impact assessment criteria,
   to the satisfaction of the Director-General.

   If the independent review determines that the project is not complying with the relevant acquisition criteria, and that the project is primarily responsible for this non-compliance, then upon receiving a written request from the landowner, the Proponent shall acquire all or part of the landowner's land in accordance with the procedures in condition 6-7 below.

5. If the independent review determines that the relevant criteria are being exceeded, but that more than one quarry/mine is responsible for this exceedance, then together with the relevant quarry/mine/s, the Proponent shall:
   (a) implement all reasonable and feasible mitigation measures, in consultation with the landowner and appointed independent expert, and conduct further monitoring until there is compliance with the relevant criteria; or
   (b) secure a written agreement with the landowner and other relevant mine/s to allow exceedances of the relevant impact assessment criteria,
   to the satisfaction of the Director-General.

   If the independent review determines that the project is not complying with the relevant acquisition criteria in schedule 3, but that more than one mine is responsible for this non-compliance, then upon receiving a written request from the landowner, the Proponent shall acquire all or part of the landowner's land on as equitable a basis as possible with the relevant quarries/mine/s, in accordance with the procedures in conditions 6-7 below.

### LAND ACQUISITION

6. Within 3 months of receiving a written request from a landowner with acquisition rights, the Proponent shall make a binding written offer to the landowner based on:

(i) the current market value of the landowner's interest in the property at the date of this written request, as if the land was unaffected by the project the subject of the project application, having regard to the:
- existing and permissible use of the land, in accordance with the applicable planning instruments at the date of the written request; and
- presence of improvements on the land and/or any approved building or structure which has been physically commenced at the date of the landowner's written request, and is due to be completed subsequent to that date, but excluding any improvements that have resulted from the implementation of the 'additional noise mitigation measures' in condition 7 of Schedule 3;

(j) the reasonable costs associated with:
- relocating within the Goulburn Mulwaree local government area, or to any other local government area determined by the Director-General; and
- obtaining legal advice and expert advice for determining the acquisition price of the land, and the terms upon which it is required; and

(k) reasonable compensation for any disturbance caused by the land acquisition process.

However, if at the end of this period, the Proponent and landowner cannot agree on the acquisition price of the land, and/or the terms upon which the land is to be acquired, then either party may refer the matter to the Director-General for resolution.

Upon receiving such a request, the Director-General will request the President of the NSW Division of the Australian Property Institute to appoint a qualified independent valuer to:
- consider submissions from both parties;
- determine a fair and reasonable acquisition price for the land and/or the terms upon which the land is to be acquired, having regard to the matters referred to in paragraphs (a)-(c) above;
- prepare a detailed report setting out the reasons for any determination; and
- provide a copy of the report to both parties.

Within 14 days of receiving the independent valuer's report, the Proponent shall make a binding written offer to the landowner to purchase the land at a price not less than the independent valuer's determination.

However, if either party disputes the independent valuer's determination, then within 14 days of receiving the independent valuer's report, they may refer the matter to the Director-General for review. Any request for a review must be accompanied by a detailed report setting out the reasons why the party disputes the independent valuer's determination. Following consultation with the independent valuer and both parties, the Director-General will determine a fair and reasonable acquisition price for the land, having regard to the matters referred to in paragraphs (a)-(c) above, the independent valuer's report, the detailed report of the party that disputes the independent valuer's determination and any other relevant submissions.

Within 14 days of this determination, the Proponent shall make a binding written offer to the landowner to purchase the land at a price not less than the Director-General's determination.

If the landowner refuses to accept the Proponent's binding written offer under this condition within 6 months of the offer being made, then the Proponent's obligations to acquire the land shall cease, unless the Director-General determines otherwise.

7. The Proponent shall pay all reasonable costs associated with the land acquisition process described in condition 6 above, including the costs associated with obtaining Council approval for any plan of subdivision (where permissible), and registration of this plan at the Office of the Registrar-General.

8. *(deleted)*

## SCHEDULE 5
## ENVIRONMENTAL MANAGEMENT AND MONITORING CONDITIONS

### ENVIRONMENTAL MANAGEMENT STRATEGY

1. The Proponent shall prepare and implement an Environmental Management Strategy for the project to the satisfaction of the Director-General. This strategy must be submitted to the Director-General for approval prior to the commencement of construction, and:
   (a) provide the strategic context for environmental management of the project;
   (b) identify the statutory requirements that apply to the project;
   (c) describe in general how the environmental performance of the project would be monitored and managed;
   (d) describe the procedures that would be implemented to:
      - keep the local community and relevant agencies informed about the construction, operation and environmental performance of the project;
      - receive, handle, respond to, and record complaints;
      - resolve any disputes that may arise during the life of the project;
      - respond to any non-compliance;
      - manage cumulative impacts; and
      - respond to emergencies; and
   (e) describe the role, responsibility, authority, and accountability of the key personnel involved in the environmental management of the project.

### ENVIRONMENTAL MONITORING PROGRAM

2. The Proponent shall prepare an Environmental Monitoring Program for the project to the satisfaction of the Director-General. This program must be submitted to the Director-General prior to the commencement of construction, and consolidate the various monitoring requirements in Schedule 3 of this approval into a single document.

### INCIDENT REPORTING

3. Within 7 days of detecting an exceedance of the goals/limits/performance criteria in this approval or an incident causing (or threatening to cause) material harm to the environment, the Proponent shall report the exceedance/incident to the Department and any relevant agencies. This report must:
   (a) describe the date, time, and nature of the exceedance/incident;
   (b) identify the cause (or likely cause ) of the exceedance/incident;
   (c) describe what action has been taken to date; and
   (d) describe the proposed measures to address the exceedance/incident.

### ANNUAL REVIEW

4. By the end of March each year, the Proponent shall prepare and submit a review of the environmental performance of the project to the satisfaction of the Director-General. This review must:
   (a) describe the development that was carried out in the previous calendar year, and the development that is proposed to be carried out over the next year;
   (b) include a comprehensive review of the monitoring results and complaints records of the project over the previous calendar year, which includes a comparison of these results against the
      - the relevant statutory requirements, limits or performance measures/criteria;
      - the monitoring results of previous years; and
      - the relevant predictions in the EA;
   (c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
   (d) identify any trends in the monitoring data over the life of the project;
   (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and
   (f) describe what measures will be implemented over the next year to improve the environmental performance of the project.

### INDEPENDENT ENVIRONMENTAL AUDIT

5. Within 3 years of the date of the commencement of construction, and every 5 years thereafter, unless the Director-General directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must:
   (a) be conducted by a suitably qualified, experienced, and independent person(s) whose appointment has been approved by the Director-General;
   (b) include consultation with the relevant agencies;
   (c) assess the environmental performance of the project, and its effects on the surrounding environment;
   (d) assess whether the project is complying with the relevant standards, performance measures and statutory requirements;

(e) review the adequacy of any strategy/plan/program required under this approval; and, if necessary,
(f) recommend measures or actions to improve the environmental performance of the project, and/or any strategy/plan/program required under this approval.

6. Within 1 month of completion of each Independent Environmental Audit, the Proponent shall submit a copy of the audit report to the Director-General and relevant agencies, with a response to any of the recommendations in the audit report.

REVISION OF STRATEGIES, PLANS AND PROGRAMS

7. Within 3 months of:
- the submission of an incident report under condition 3 above;
- the submission of an Annual Review under condition 4 above;
- the submission of an audit report under condition 5 above; or
- any modification to the conditions of this approval, (unless the conditions require otherwise),

the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Director-General.

*Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.*

**COMMUNITY CONSULTATIVE COMMITTEE**

8. Prior to the commencement of construction, the Proponent shall establish a Community Consultative Committee (CCC) for the project. The CCC shall:
(a) be comprised of:
- 2 representatives from the Proponent, including the person responsible for environmental management at the quarry;
- 1 representative from Council (if available); and
- at least 3 representatives from the local community,

whose appointment has been approved by the Director-General;
(b) be chaired by an independent chairperson, whose appointment has been approved by the Director-General;
(c) meet at least twice a year;
(d) review the Proponent's performance with respect to environmental management and community relations;
(e) undertake regular inspections of the quarry operations;
(f) review community concerns or complaints about the quarry operations, and the Proponent's complaints handling procedures; and
(g) provide advice to:
- the Proponent on improved environmental management and community relations, including the provision of information to the community and the identification of community initiatives to which the Proponent could contribute;
- the Department regarding the conditions of this approval; and
- the general community on the performance of the quarry with respect to environmental management and community relations.

*Notes*
- *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval.*
- *The membership of the CCC should be reviewed on a regular basis (every 3 years).*
- *If possible, an alternate member should be appointed for each of the representatives from the local community.*

9. At its own expense, the Proponent shall,:
(a) ensure that 2 of its representatives attend CCC meetings;
(b) provide the CCC with regular information on the environmental performance and management of the project;
(c) provide meeting facilities for the CCC;
(d) arrange site inspections for the CCC, if necessary;
(e) take minutes of the CCC meetings;
(f) make these minutes available to the public;
(g) respond to any advice or recommendations the CCC may have in relation to the environmental management or community relations; and
(h) forward a copy of the minutes of each CCC meeting, including a response to any recommendations from the CCC, to the Director-General within a month of the CCC meeting.

## ACCESS TO INFORMATION

10. By 31 January 2012, the Proponent shall:
    (a) make copies of the following publicly available on its website:
        - the documents referred to in condition 2 of schedule 2;
        - all current statutory approvals for the project;
        - all approved strategies, plans and programs required under the conditions of this approval;
        - the monitoring results of the project, reported in accordance with the specifications in any conditions of this approval, or any approved plans and programs;
        - a complaints register, updated on a monthly basis;
        - minutes of CCC meetings;
        - the annual reviews of the project;
        - any independent environmental audit of the project, and the Proponent's response to the recommendations in any audit;
        - any other matter required by the Director-General; and
        - keep this information up-to-date,

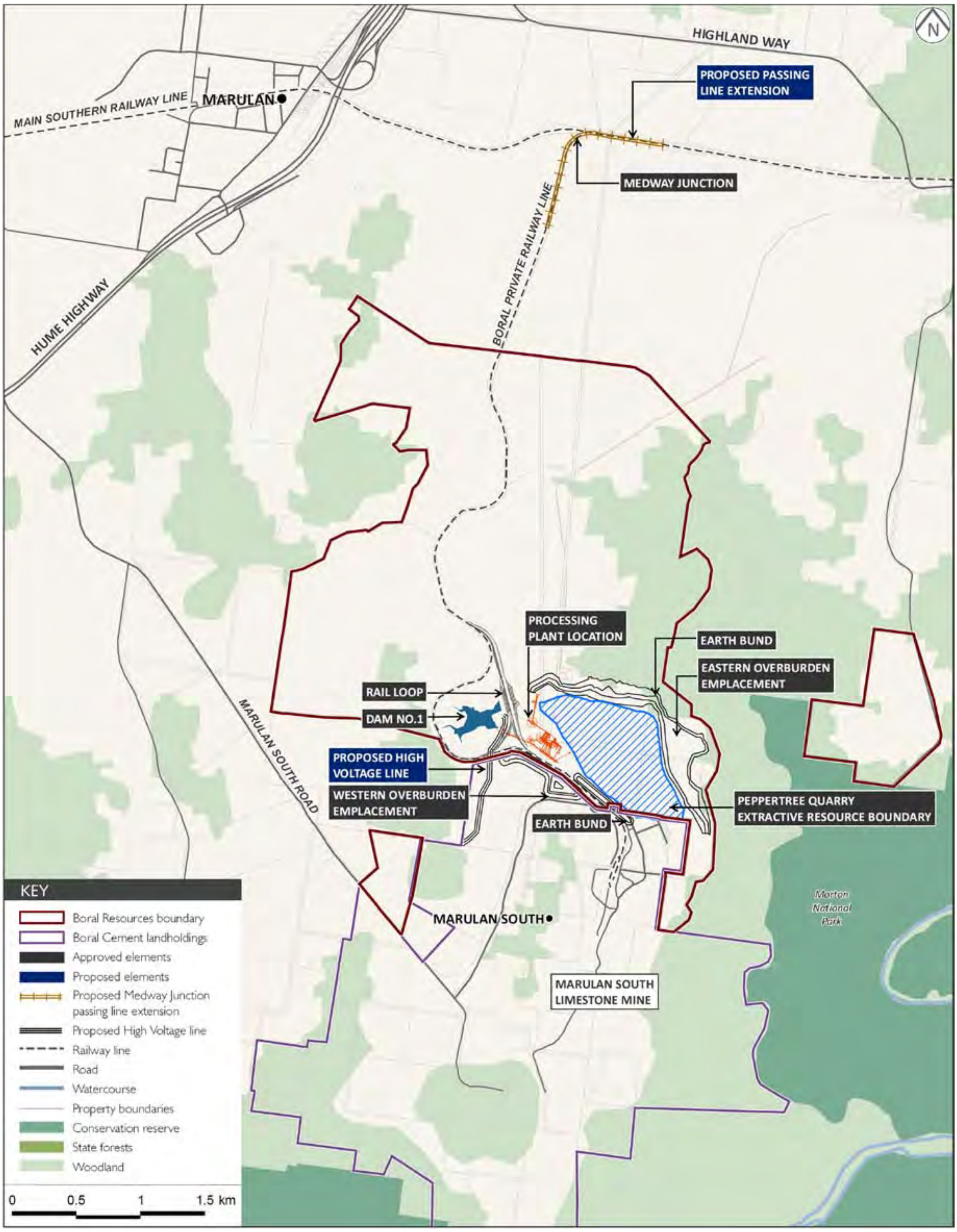
    to the satisfaction of the Director-General.

13. *(deleted)*

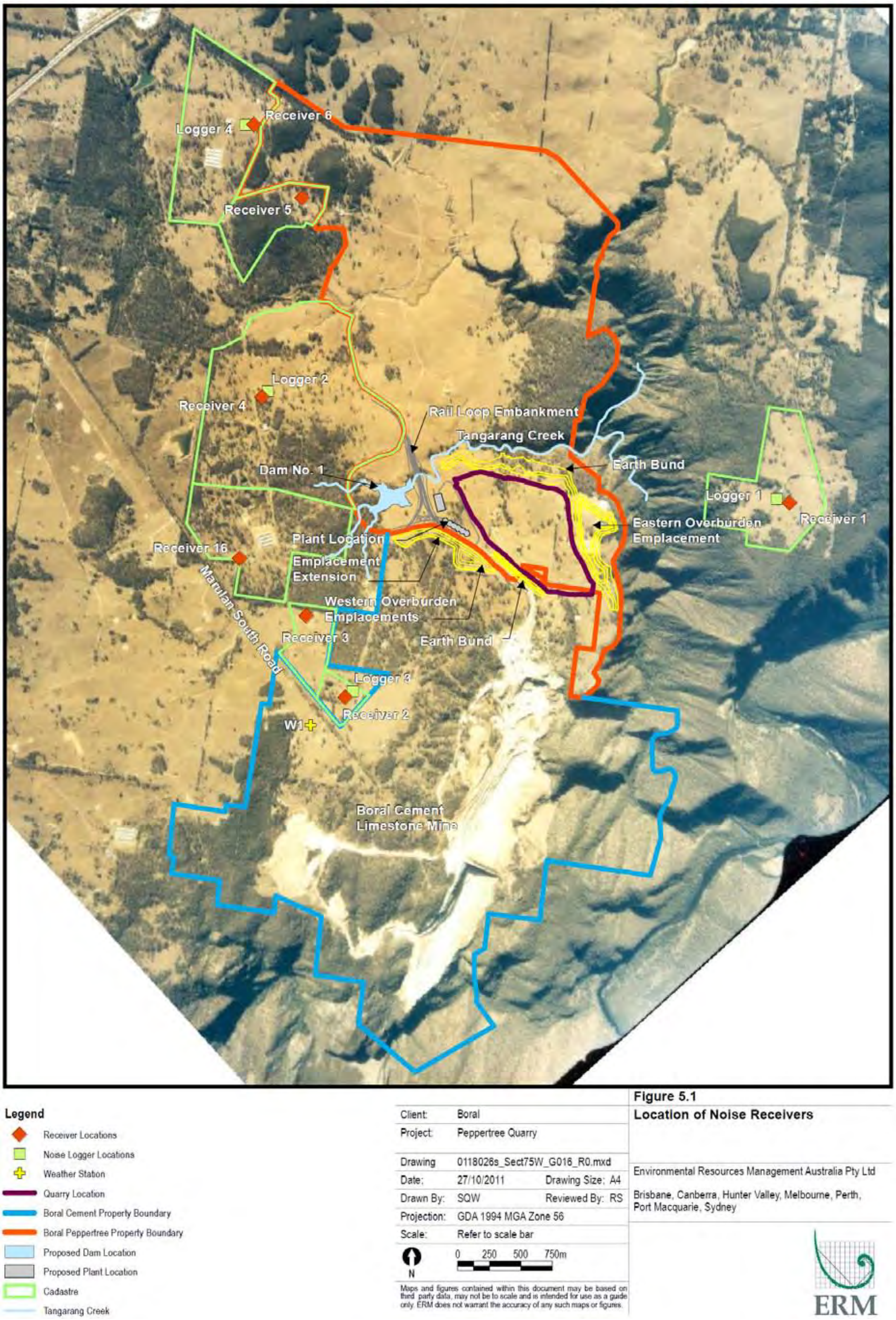
## APPENDIX 1
## SCHEDULE OF LAND

| *Lot* | *DP* |
|---|---|
| 23 | 867667 |
| 5 | 203290 |
| 95 | 750029 |
| 24 | 867667 |
| 109 | 750029 |
| 1 | 371167 |
| 1-6 | 261615 |
| 1 | 557562 |
| 143 | 750029 |
| 12 | 570616 |
| 2 | 557562 |
| 21 | 657523 |
| 100 | 1064794 |
| 4 | 106569 |
| 1-9 | 216767 |
| 11 | 570616 |
| 5 | 111641 |
| 22 | 867667 |
| 1 | 1124189 |
| 2 | 106569 |

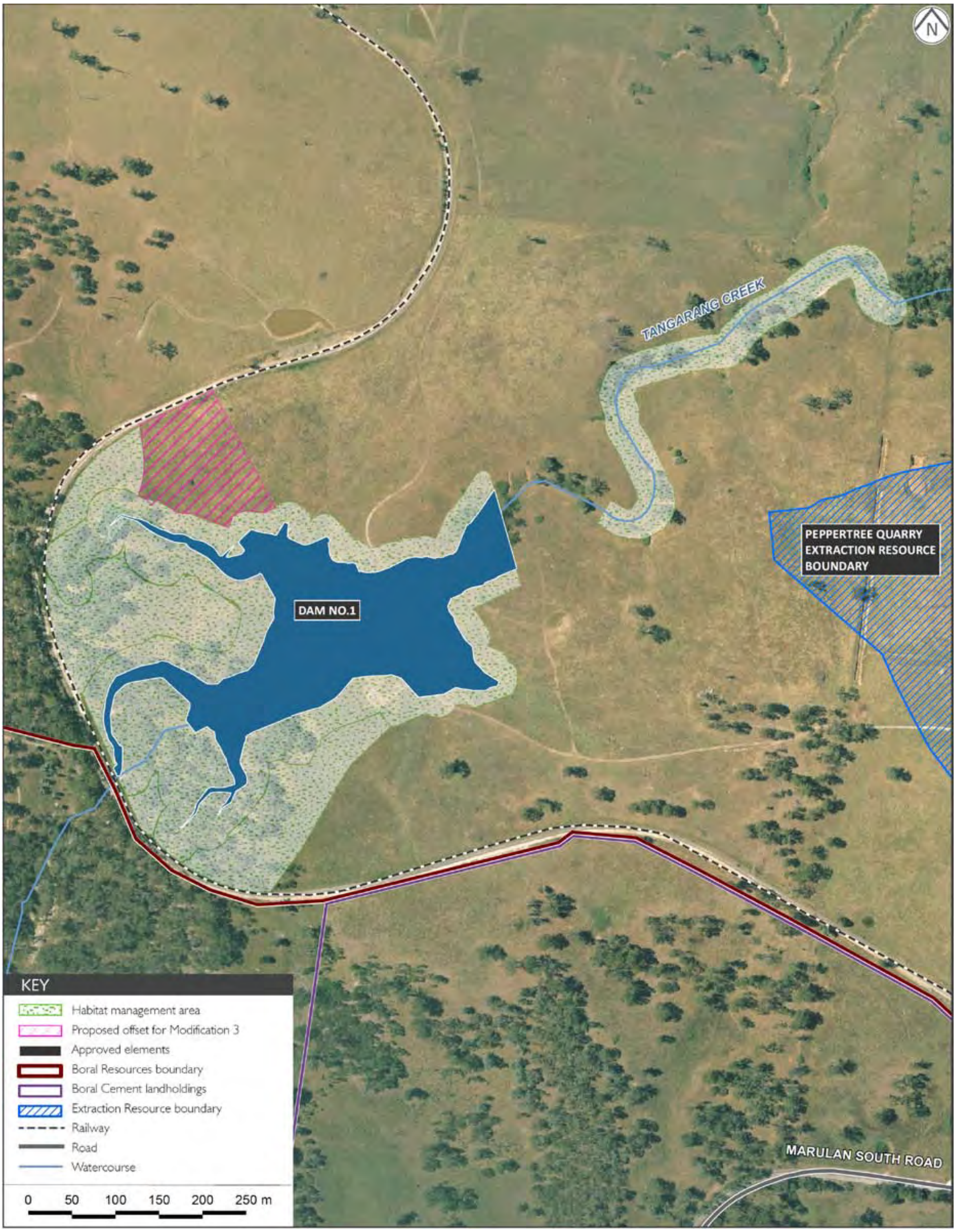
# APPENDIX 2
# PROJECT SITE



# APPENDIX 2A
# NOISE RECEIVER LOCATION PLAN



## APPENDIX 3
## HABITAT MANAGEMENT AREA



# APPENDIX B

NOISE IMPACT ASSESSMENT

# APPENDIX B

ACOUSTICS AND AIR

# NOISE IMPACT ASSESSMENT

## PEPPERTREE QUARRY MOD 4

**REPORT NO.** 14250
**VERSION** D

FEBRUARY 2016

**PREPARED FOR**

ELEMENT ENVIRONMENT
ON BEHALF OF BORAL RESOURCES (NSW) PTY LTD

WILKINSON MURRAY

# DOCUMENT CONTROL

| Version | Status | Date | Prepared By | Reviewed By |
|---|---|---|---|---|
| A | Draft | 24 August 2015 | John Wassermann | George Jenner |
| B | Draft | 14 September 2015 | John Wassermann | George Jenner |
| C | Final | 9 February 2016 | John Wassermann | Roman Haverkamp |
| D | Final | 23 March 2016 | John Wassermann | - |

**Note**



**Quality Assurance**

We are committed to and have implemented AS/NZS ISO 9001:2008 "Quality Management Systems – Requirements". This management system has been externally certified and Licence No. QEC 13457 has been issued.

**AAAC**

This firm is a member firm of the Association of Australian Acoustical Consultants and the work here reported has been carried out in accordance with the terms of that membership.

**Celebrating 50 Years in 2012**

Wilkinson Murray is an independent firm established in 1962, originally as Carr & Wilkinson. In 1976 Barry Murray joined founding partner Roger Wilkinson and the firm adopted the name which remains today. From a successful operation in Australia, Wilkinson Murray expanded its reach into Asia by opening a Hong Kong office early in 2006. 2010 saw the introduction of our Queensland office and 2011 the introduction of our Orange office to service a growing client base in these regions. From these offices, Wilkinson Murray services the entire Asia-Pacific region.

Wilkinson Murray Pty Limited · ABN 39 139 833 060
Level 4, 272 Pacific Highway, Crows Nest NSW 2065, Australia • Offices in Orange, Qld & Hong Kong
t +61 2 9437 4611 • f +61 2 9437 4393 • e acoustics@wilkinsonmurray.com.au • w www.wilkinsonmurray.com.au

# TABLE OF CONTENTS

# GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

**Maximum Noise Level ($L_{Amax}$) –** The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

**$L_{A1}$ –** The $L_{A1}$ level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the $L_{A1}$ level for 99% of the time.

**$L_{A10}$ –** The $L_{A10}$ level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the $L_{A10}$ level for 90% of the time. The $L_{A10}$ is a common noise descriptor for environmental noise and road traffic noise.

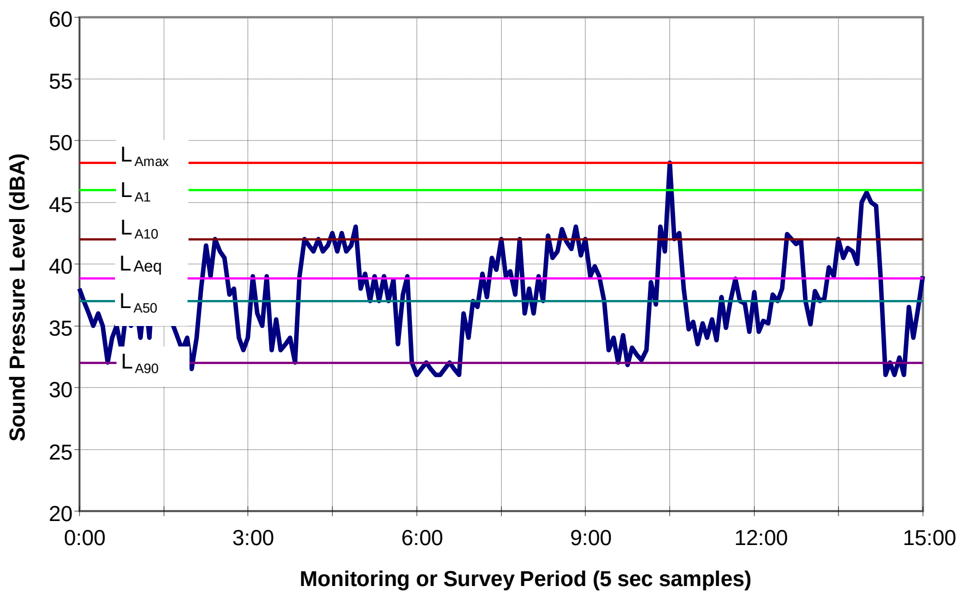
**$L_{A90}$ –** The $L_{A90}$ level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the $L_{A90}$ level for 10% of the time. This measure is commonly referred to as the background noise level.

**$L_{Aeq}$ –** The equivalent continuous sound level ($L_{Aeq}$) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

**ABL –** The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level ($L_{A90}$) for each period.

**RBL –** The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

**Typical Graph of Sound Pressure Level vs Time**



# EXECUTIVE SUMMARY

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry located in Marulan South.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to provide for the following (hereafter referred to as the Project):

- Establish an additional overburden emplacement area to the south of the existing approved eastern overburden emplacement area which would operate in accordance with the Project Approval, ie. 7.00am to 7.00pm;
- Extend the operating hours for in-pit works (currently approved from 7.00am to 7.00pm) by six hours. The new operating hours for in-pit works would be from 5.00am to 11.00pm, therefore occurring in the evening and night time periods.

To assess the potential noise impacts associated with the proposed modifications to the Peppertree Quarry operations, this report simply compared the predicted noise emissions from the existing and proposed operations with the operational noise impact assessment criteria in the Project Approval.

The assessment has found that:

- The predicted noise level for dayshift activities associated with the proposed southern overburden emplacement comply with the operational noise impact assessment criteria in the Project Approval at all locations for both calm and worst-case meteorological conditions;
- The predicted noise level for nightshift activities including the proposed in-pit operations comply with the operational noise impact assessment criteria in the Project Approval at all locations for both calm and worst-case meteorological;
- As the land acquisition criteria in the Project Approval are higher than the operational noise impact assessment criteria, the predicted noise levels associated with the proposed modifications, do not exceed the land acquisition criteria at any residence;
- Maximum noise levels from the modified Peppertree Quarry operations have been analysed and it is expected that compliance of the sleep disturbance criteria in the Project Approval ($L_{A1,\ 1minute}$) would be achieved at all locations.
- Cumulative industrial noise levels as required to be considered by the Project Approval have been estimated at the closest residential receivers and it is expected that the amenity criteria would be met.

Relative to the existing activities, the proposed modifications to the Peppertree Quarry operations are unlikely to contribute to any significant change in existing operational or cumulative noise levels at identified sensitive receivers. This is supported by the noise impact assessment which predicts that there would be no exceedances of the operational noise impact assessment criteria stipulated by the Project Approval at any identified sensitive receiver as a result of operational activities associated with the modified Peppertree Quarry operations. A low frequency noise assessment has been conducted which identified compliance with the appropriate EPA noise criteria, however the assessment indicated that there is potential risk for low frequency noise from the site.

Given this, to ensure compliance with appropriate noise criteria it is proposed that quarterly compliance monitoring currently identified in the Noise Management Plan be strengthened to include additional noise monitoring locations and a more detailed low frequency noise assessment and reporting regime. The additional monitoring locations are proposed to be R17 and R4.

# 1 INTRODUCTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Peppertree Quarry (the Quarry), a hard rock quarry located in Marulan South, New South Wales.

Boral is seeking to modify the current Project Approval (PA 06_0074) under Section 75W of the Environmental Planning and Assessment Act 1979 (EP&A Act), to provide for the following (hereafter referred to as the Project):

- Extend daily in-pit operating hours at the Quarry by 6 hours; and
- Develop a new overburden emplacement area.

The modification proposed above will constitute Modification 4 to the current Project Approval.

Wilkinson Murray Pty Limited (WMPL) has prepared this report for Element Environment on behalf of Boral. It presents an assessment of the potential noise impacts associated with the Project.

To assess the potential noise impacts associated with the Project, this report simply compared the Project with noise criteria developed from the *Industrial Noise Policy* and limits in the Project Approval.

The noise assessment within this document has been conducted in accordance with the *NSW Industrial Noise Policy (INP)* (EPA, 2000).

Transportation noise (rail and traffic) and blasting has not been conducted in this report as no modification is being proposed to existing transportation or blasting regimes.

# 2 EXISTING ENVIRONMENT & QUARRY OPERATIONS

## 2.1 Site Description and Existing Environment

The Quarry is located in Marulan South, 10 kilometres (km) southeast of Marulan, 35 km east of Goulburn and approximately 175 km south-west of Sydney, within the Goulburn Mulwaree Local Government Area (LGA) in the Southern Tablelands of NSW (Figure 2-1). Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine with the Hume Highway approximately 9 km to the northwest (Figure 2-2). Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 6 km to the north (**Figure 2-2**).

The Quarry is located on Boral owned land approximately 650 hectares (ha) in size, which includes the Quarry site, approximately 70ha in size, additional granodiorite resources to the south and surrounding land (**Figure 2-3** and **Figure 2-4**). The site is zoned RU1 - Primary Production zone under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009 (**Figure 2-5**). Mining and extractive industries are permissible in this zone with consent.

The Quarry is bordered to the south by the Limestone Mine, to the east by Morton National Park and by rural properties to the north and west. Surrounding land uses include mining, grazing, rural properties including an agricultural lime manufacturing facility, fireworks storage facility, turkey farm and rural residential. The main access for these properties is via Marulan South Road. Rural residential properties are also located to the northeast of the Quarry along Long Point Road. These properties are separated from the Quarry by the deep Barbers Creek gorge.

The site of the former village of Marulan South is located between the Quarry and the Limestone Mine on Boral owned land. The village was established principally to service the Limestone Mine but has been uninhabited since the late 1990's. The majority of the village's infrastructure has been removed and only a village hall and former bowling club remains. The bowling club has been converted into administration offices for the Limestone Mine.

Figure 2-2**Error! Reference source not found.** shows the land ownership around the eppertree Quarry, along with the noise-sensitive receiver locations. Receivers prefixed with 'R' are residential locations that are assessed in this report. There are 17 residential locations assessed. Receivers prefixed by 'B' are owned by Boral or 'C' are commercial receivers. C1 which is owned by Aglime, C2 is a commercial premise with a proposed residence (PR) and C3 is Foti Fireworks.

## 2.2 Approved Project

### 2.2.1 Quarry Activities and Infrastructure

The approved quarrying activities are for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1-2 million tonnes per annum (Mtpa) and a maximum rate of 3.5 Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 mm) and railway ballast (28-50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from Boral's adjacent Limestone Mine or Penrose Quarry to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities. The location of infrastructure at the Quarry is shown on **Figure 3-1**.

Work to establish the Quarry commenced in July 2011. Production commenced early in 2014 following a lengthy commissioning and proving phase. The Quarry has approval to operate until the end of 2038.

### 2.2.2 Transport of Product

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E. The Quarry has approval to transport up to 3.5 Mtpa of product from the site. At full production the Quarry will operate up to four trains per day which will transport product north to the Sydney market and other customers. In addition, the Limestone Mine currently operates up to six trains per day transporting product north to Berrima and Maldon and east to Port Kembla.

Trains to the Quarry and the Limestone Mine access Boral's private rail line from the Main Southern Railway at the Medway Junction (Figure 2-2). The rail line is mostly single track with a 1 km length of triple line track used for shunting and train loading. A rail loop has been constructed at the Quarry for separation of rail movements on the rail line between the two Boral sites. Rail loading facilities were also established on the rail loop adjacent to the Quarry's processing plant.

Loading of product from the Quarry onto trains and train movements occur 24-hours, 7 days a week. This enables train trips on the Main Southern Railway to be scheduled away from peak commuter times.

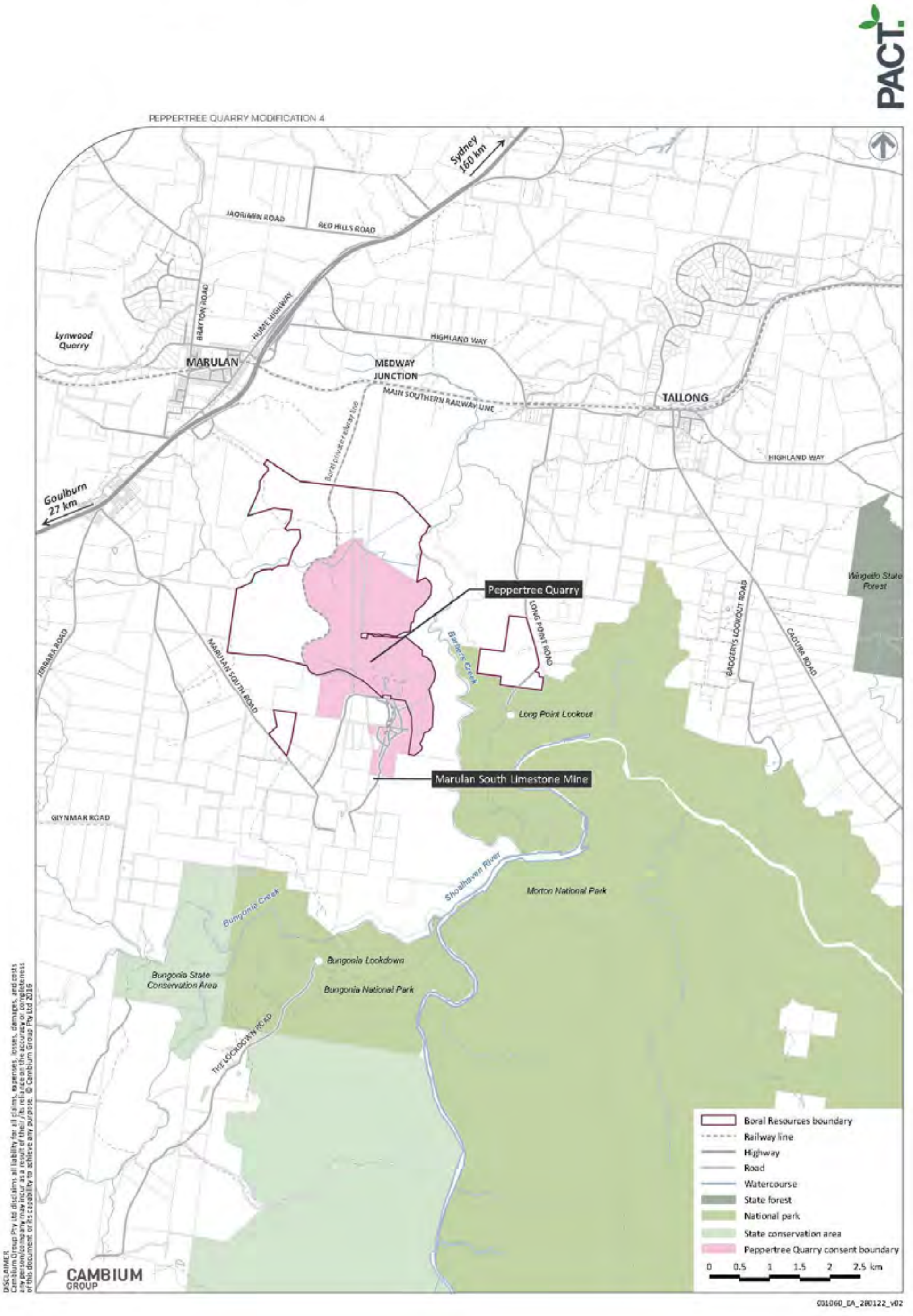
### 2.2.3 Operating Hours and Workforce

The Quarry operates 24-hours, 7 days a week with in-pit activities restricted to the hours of 7.00am to 7.00pm. Approved operating hours are outlined in detail in Table 2-1.

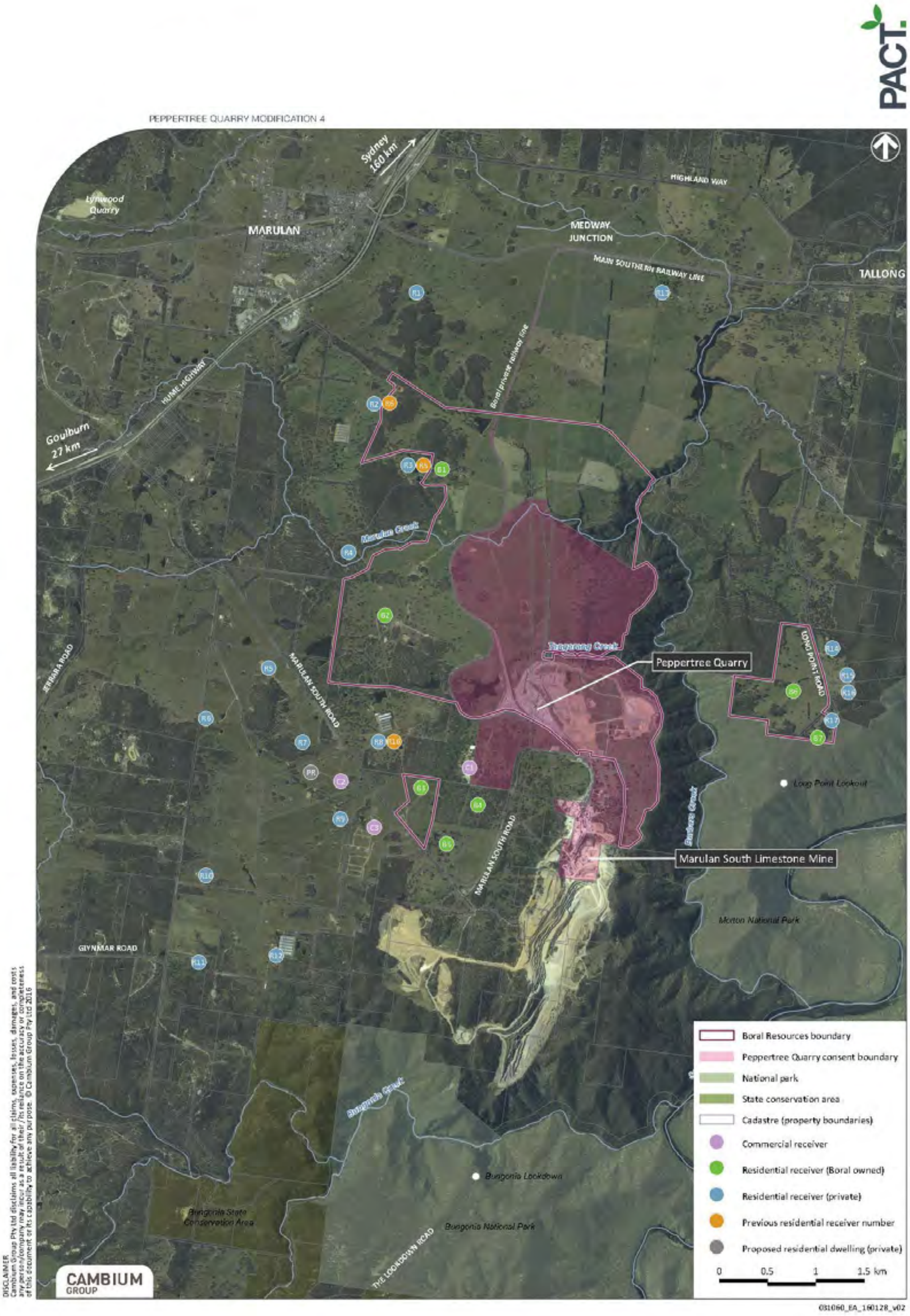
**Table 2-1 Approved Operating Hours**

| Activity | Day | Time |
|---|---|---|
| Construction works | Monday-Friday<br>Saturday<br>Sunday & public holidays | 7.00am to 6.00pm<br>8.00am to 1.00pm<br>None |
| Topsoil / overburden removal / emplacement | Any day | 7.00am to 7.00pm |
| Blasting | Monday-Saturday<br>Sunday & public holidays | 9.00am to 5.00pm<br>None |
| In-pit activities (including drilling, extraction, processing, and transfer of material out of the pit) | Any day | 7.00am to 7.00pm |
| Out-of-pit activities (including processing, stockpiling, train loading and distribution, and maintenance) | Any day | 24 hours |

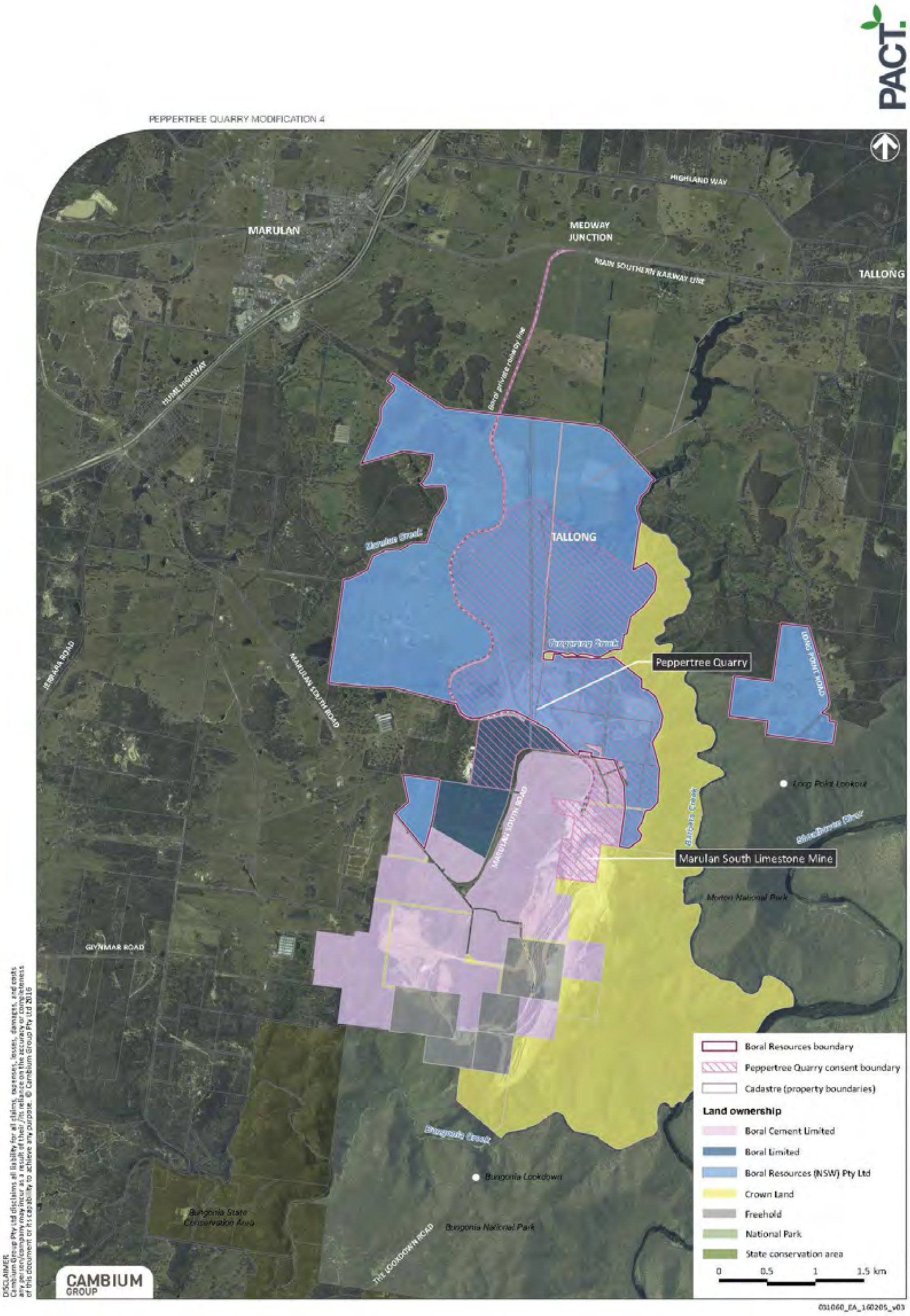
**Figure 2-1 Region Context**



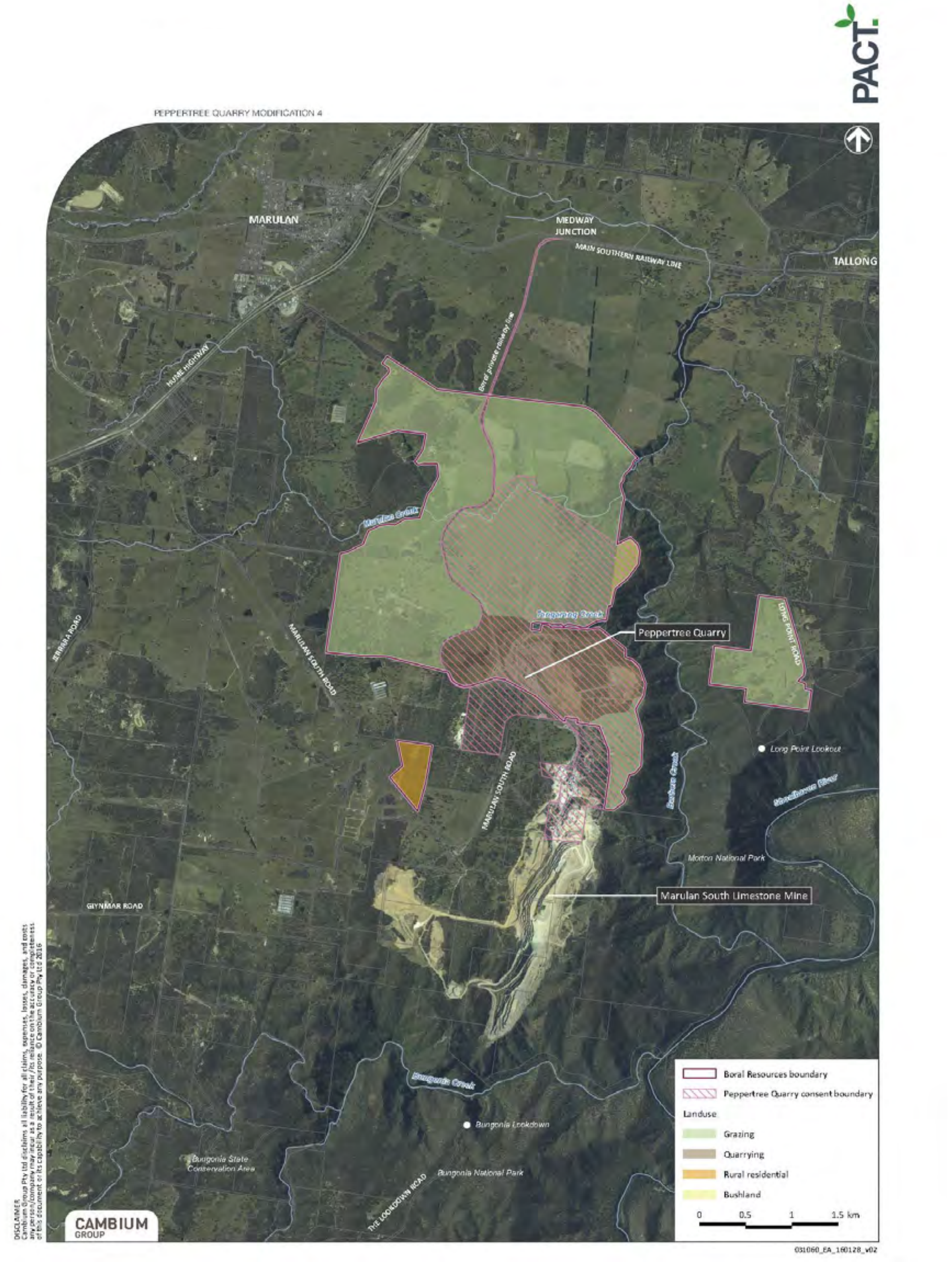
## Figure 2-2 Local Context



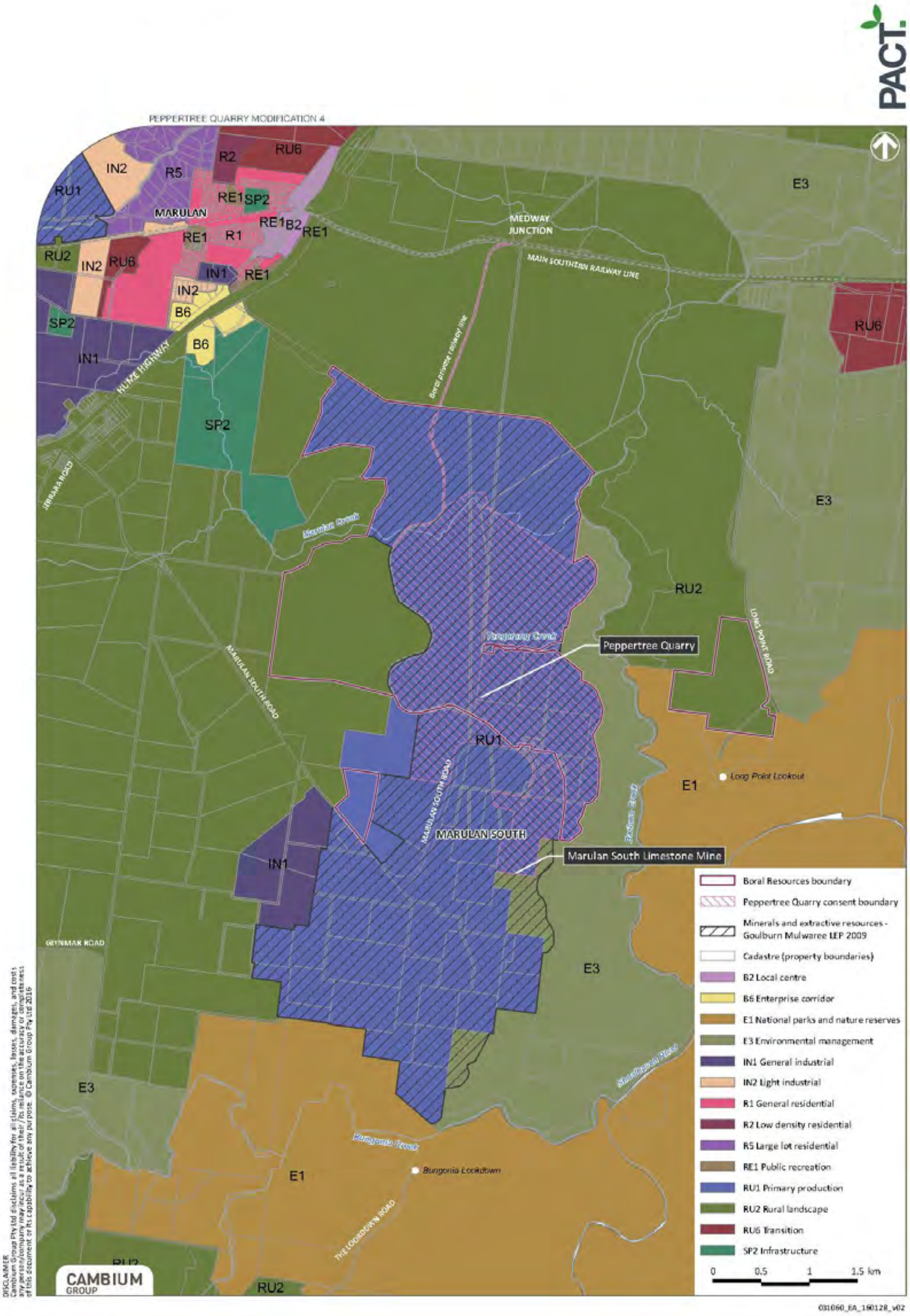
## Figure 2-3 Land Ownership



## Figure 2-4 Landuse



## Figure 2-5 Local Zoning



# 3 PROPOSED MODIFICATIONS

## 3.1 Description of the Proposed Modifications

Boral is seeking to modify the current Project Approval to:

- Extend in-pit operating hours at the Quarry by 6 hours; and
- Develop a new overburden emplacement area.

### 3.1.1 Extension of in-pit Operating Hours

Peppertree Quarry currently has approval to operate in-pit activities for 12 hours per day between 7.00am and 7.00pm. In-pit activities include:

- Drilling and blasting;
- Extraction;
- Delivering blast rock to the mobile crusher;
- Crushing of rock; and
- Conveying crushed rock out of the pit.

Boral is seeking to extend these in-pit operating hours by 6 hours per day in order to account for scalping of overburden material in early phases of pit development and meet annual production volumes up to the approved limit of 3.5 million tonnes per annum. Boral are proposing to extend the approved 7.00am to 7.00pm in-pit operating hours to 5.00am to 11.00pm.

Blasting will however continue within the current approved blasting hours of 9.00am and 5.00pm Monday to Saturday.

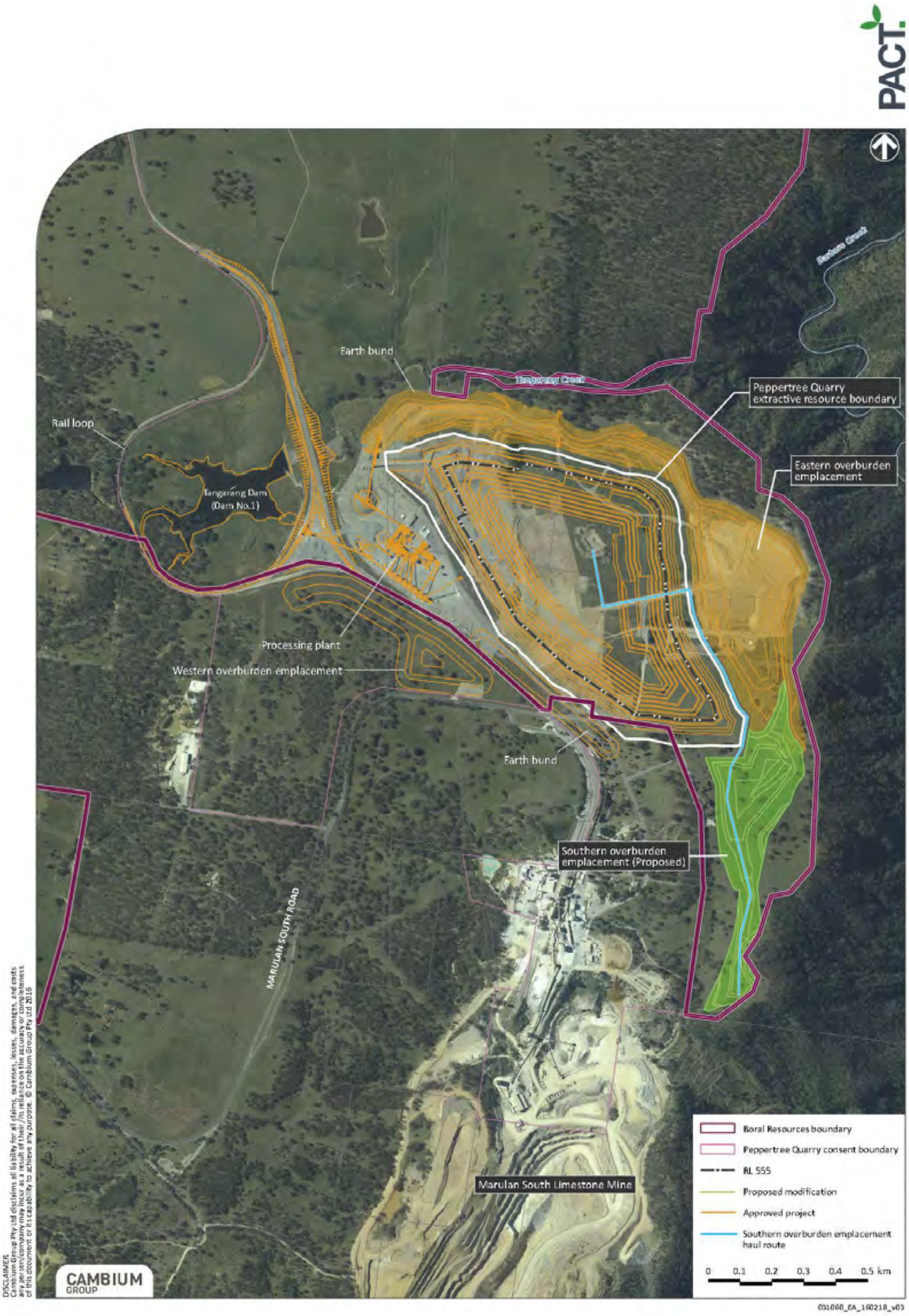
### 3.1.2 New Southern Overburden Emplacement

Overburden emplacement at the Quarry is currently approved within noise bunds located along the northern and eastern boundaries of the site, an emplacement area to the east of the approved quarry pit and a western emplacement area and noise bund to the west of the Quarry across Boral's private railway line. Remaining overburden was proposed to be emplaced within the south pit of Boral's adjoining Limestone Mine.

The noise bunds were completed during construction of the Quarry, and the eastern overburden emplacement area will reach capacity in early 2016. Mine planning for the Limestone Mine has ruled out emplacement within the south pit. The Limestone Mine, under its forthcoming development application, is seeking to hold 5 million $m^3$ (approximately 13 Mt) of overburden for the Quarry, however, this will not be approved until late 2016. As an interim measure, Boral is seeking to place approximately 1 million $m^3$ of overburden within a new overburden emplacement to the south of the approved 30 year quarry pit (refer to **Figure 3-1**). Overburden stripped from the pit will be transported by trucks along the most direct haul route possible (refer to **Figure 3-1**). This new overburden emplacement area will be needed in early 2016 and will take approximately 12 months to establish.

The proposed new overburden emplacement will be located within the south-eastern extent of the future hard rock (granodiorite) resource, which extends south from the existing Quarry pit, to the northern end of the Limestone Mine's north pit. A significant granodiorite resource also exists on Boral's lands to the north of the existing Quarry pit, extending northwards from Tangarang Creek. The proposed southern overburden emplacement will not sterilise resource as Boral will relocate this southern emplacement in the future if the southern granodiorite resource needs to be accessed. Although the southern overburden emplacement may be relocated in the future, this is unlikely to be required for at least the next 25 years. The proposed emplacement will therefore be landscaped and rehabilitated in accordance with the existing Peppertree Quarry Landscape and Rehabilitation Management Plan.

## Figure 3-1 The Project



# 4 EXISTING PROJECT APPROVAL

The noise-sensitive receptors identified in the Appendix 2A of the Project Approval are presented in Figure 2-2 and the noise conditions from Schedule 3 of the Project Approval are presented below:

### Operational Noise Impact Assessment Criteria

*4. The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 1.*

*Table 1: Noise Impact Assessment Criteria*

| ***Residential Receiver*** | ***Day Shift*** | ***Night Shift*** | | |
|---|---|---|---|---|
| | ***Day*** | ***Evening*** | ***Night*** | |
| | $L_{Aeq,15min}$ | $L_{Aeq,15min}$ | $L_{Aeq,15min}$ | $L_{A1,1min}$ |
| *2* | *39* | *35* | *35* | *45* |
| *5* | *35* | *35* | *35* | *45* |
| *6* | *35* | *35* | *35* | *45* |
| *16* | *41* | *35* | *35* | *45* |
| *Any other noise-sensitive location* | *35* | *35* | *35* | *45* |

*Notes:*
- *The identified "Day" noise criteria apply throughout the period of the site's Day Shift (ie 7am to 7pm) on all days, despite the general definitions of Evening and Night otherwise applying to the approval. The identified "Evening" and "Night" criteria apply only during the period of the site's Night Shift (ie 7pm to 7am)*
- *Noise generated by the project is to be measured in accordance with the relevant procedures and exemptions (including certain meteorological conditions) of the NSW Industrial Noise Policy.*
- *Residential receiver locations are shown in Appendix 2A.*

### Land Acquisition Criteria

*5. If the noise generated by the project exceeds the criteria in Table 2, the Proponent shall, upon receiving a written request for acquisition from the landowner, acquire the land in accordance with the procedures in Conditions 6-8 of Schedule 4.*

*Table 2: Land Acquisition Criteria*

| ***Residential Receiver*** | ***Day*** $L_{Aeq,15min}$ | ***Evening / Night*** $L_{Aeq,15min}$ |
|---|---|---|
| *2* | *44* | *44* |
| *5* | *40* | *40* |
| *6* | *40* | *40* |
| *16* | *44* | *44* |

*Notes: The notes under Table 1 apply equally for Table 2.*

### Cumulative Noise Criteria

*6. The Proponent shall take all reasonable and feasible measures to ensure that the noise generated by the project combined with the noise generated by other extractive industries does not exceed the following amenity criteria on any privately owned land, to the satisfaction of the Director-General:*

- *$L_{Aeq,11hour}$ 50dB(A) – Day;*
- *$L_{Aeq,4hour}$ 45dB(A) – Evening; and*
- *$L_{Aeq,9hour}$ 40dB(A) – Night.*

### Identification of Sensitive Receivers

Seven sensitive receivers are identified in the Project Approval. Since then, four of these receivers have been acquired by Boral.

For the purposes of this Modification 4 noise assessment, and to ensure consistency in sensitive receiver numbering with the adjacent Marulan South Limestone Mine Continued Operations Project, additional sensitive receivers have been identified and a new receiver numbering system has been adopted, including 17 Residential Receivers (R1 – R17), three Commercial Receivers (C1 – C3) and seven Boral Owned Receivers (B1 – B7).

The receiver numbers in the Project Approval and corresponding receiver numbers adopted in this report are summarised in Table 4-1.

**Table 4-1 Receiver Numbers in the Project Approval with Corresponding Receiver Numbers Adopted in this Report**

| Receiver Nos. from Project Approval | Receiver Nos. in this Report | Comment |
|---|---|---|
| 1 | B6 | Acquired by Boral |
| 2 | B5 | Acquired by Boral |
| 3 | B3 | Acquired by Boral |
| 4 | B2 | Acquired by Boral |
| 5 | R3 | - |
| 6 | R2 | - |
| 16 | R8 | - |

Any other residential receptors that do not have a noise performance condition assigned under Condition 4 of the Schedule 3 of the Project Approval would be interpreted as "any other sensitive location". Hence any additional receptors would have a noise performance limit of 35dBA $L_{Aeq,15minutes}$ and 45dBA $L_{A1,1minutes}$.

It should be noted that, Boral owned receivers do not have noise limits as they are not classified as sensitive receivers under the *INP* because Boral purchased the properties as a noise mitigation strategy. There are no noise limits for commercial properties in this Approval.

Note the proposed residential dwelling (PR) does not actually exist at this time. As a conservative measure potential impacts at this potential future dwelling have been considered on the basis of the modelled levels at the existing receivers located substantially closer to the modification where impacts would be higher.

## 4.1 Summary of Criteria

The operational noise impact assessment criteria for all the receivers are presented in Table 4-2.

**Table 4-2 Operational Noise Impact Assessment Criteria**

| Receiver | $L_{Aeq,15min}$ | | |
|---|---|---|---|
| | Daytime | Evening | Night |
| R1 | 35 | 35 | 35 |
| R2 | 35 | 35 | 35 |
| R3 | 35 | 35 | 35 |
| R4 | 35 | 35 | 35 |
| R5 | 35 | 35 | 35 |
| R6 | 35 | 35 | 35 |
| R7 | 35 | 35 | 35 |
| R8 | 41 | 35 | 35 |
| R9 | 35 | 35 | 35 |
| R10 | 35 | 35 | 35 |
| R11 | 35 | 35 | 35 |
| R12 | 35 | 35 | 35 |
| R13 | 35 | 35 | 35 |
| R14 | 35 | 35 | 35 |
| R15 | 35 | 35 | 35 |
| R16 | 35 | 35 | 35 |
| R17 | 35 | 35 | 35 |

The maximum operational noise impact assessment criteria or sleep disturbance criteria are presented in Table 4-3. These $L_{A1,1min}$ noise levels are assessed at the exterior of a bedroom window.

**Table 4-3 $L_{A1,1min}$, Operational Noise Impact Assessment Criteria**

| Receiver | $L_{A1,1min}$ Night |
|---|---|
| R1 | 45 |
| R2 | 45 |
| R3 | 45 |
| R4 | 45 |
| R5 | 45 |
| R6 | 45 |
| R7 | 45 |
| R8 | 45 |
| R9 | 45 |
| R10 | 45 |
| R11 | 45 |
| R12 | 45 |
| R13 | 45 |
| R14 | 45 |
| R15 | 45 |
| R16 | 45 |
| R17 | 45 |

With regard to land acquisition noise criteria there are three receivers that remain with a land acquisition criteria.

The land acquisition criteria within the Project Approval for those receivers that remain after Boral acquisitions are presented in Table 4-4.

**Table 4-4 Land Acquisition Criteria, $L_{Aeq,15min}$**

| Receiver | Intrusive Criteria | | |
|---|---|---|---|
| | Daytime | Evening | Night |
| R2 | 40 | 40 | 40 |
| R3 | 40 | 40 | 40 |
| R8 | 44 | 44 | 44 |

It should be noted that "Day" noise criteria apply throughout the period of the site's day shift (ie. 7.00am to 7.00pm) on all days, despite the general definitions of evening and night otherwise applying to the approval. The identified "Evening" and "Night" criteria apply during the period of the site's night shift (ie. 7.00pm to 7.00am).

To be consistent with the Project Approval the operational time periods from here on are referred to as "Day Shift" (7.00am to 7.00pm) and "Night Shift" (7.00pm to 7.00am) activities. For simplicity of the assessment, night shift uses the lowest criterion between evening and night time.

## 4.2 Noise Compliance Monitoring

Environmental Resource Management Australia Pty Ltd (ERM) completes noise compliance monitoring for Peppertree Quarry. The conclusions from compliance monitoring are:

- Day shift site noise levels associated with the quarry comply with the relevant $L_{Aeq,15minute}$ operational noise impact assessment criteria contained in Boral's planning Approval;
- Night shift site noise levels associated with the quarry comply with the relevant $L_{Aeq,15minute}$ and $L_{A1,\ 1minute}$ operational noise impact assessment criteria contained in Boral's planning Approval;
- The compliance noise monitoring considered Industrial Noise Policy modifying factor corrections for tonality, low frequency or impulsive noise. No modifying factors have been considered; and
- Daytime, evening and night time noise level contributions ($L_{Aeq,\ period}$) are below the cumulative amenity criteria applicable to the area.

# 5 NOISE MODELLING PROCEDURE

Operational noise levels at nearby receivers have been calculated using the Environmental Noise Model (ENM) a proprietary computer program from RTA Technology Pty Ltd. ENM accounts for the effects of distance, shielding, ground effects, air absorption and meteorological effects. This modelling software is recommended by the *INP* and has been previously accepted by the EPA for use in environmental noise assessments. The assessment models the total noise at each receiver from the operation of the Project. Total predicted operational noise levels are then compared with the operational noise criteria presented in Table 4-2.

Typical quarrying activities involve the stripping of overburden and the extraction of hard rock using open-cut drill and blast techniques. Overburden is transported by trucks to the overburden emplacement areas, where it is spread and shaped by dozer. Overburden emplacement occurs in the active eastern overburden emplacement to the east and thereafter within the new southern overburden emplacement to the southeast of the extraction area (quarry pit).

Quarried material is processed on-site using various crushers and screens to obtain the desired product. Material is initially crushed in a primary mobile crusher located within the pit, which is currently fed by an excavator, front end loaders and trucks. In the future, in-pit works will be truck less with blasted rock fed directly into the primary mobile crusher by excavator. After passing through the primary crusher, the crushed material is taken from the pit along a series of conveyors to the first set of screens located to the northwest of the pit and material is stockpiled in a surge pile. Material in the surge pile is reclaimed and conveyed to the main processing area where it undergoes further crushing and screening. Product material is stored in the various storage bins prior to being dispatched off-site by trains.

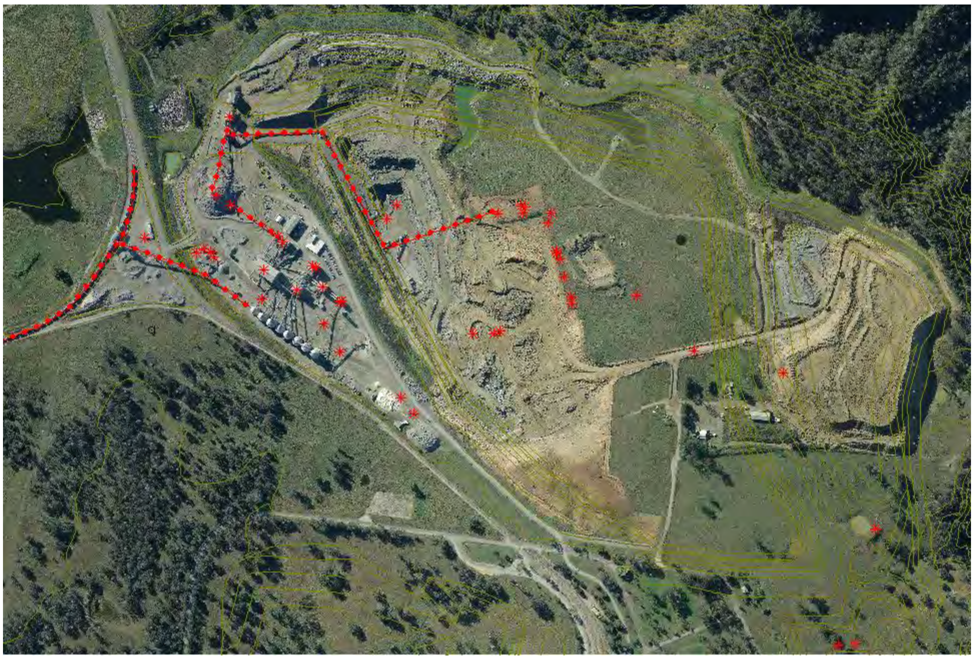
To account for the proposed increase of in-pit operational hours, the activities associated with in-pit works including operation of the in-pit crusher and extraction equipment are assumed to operate from 5.00am to 11.00pm. Overburden stripping and emplacement at the new southern overburden emplacement will be the same as the current approved operations from 7.00am to 7.00pm. All other processing operations at the Peppertree Quarry are assumed to occur in accordance with the current approved operations 24-hours per day / 7 days per week.

For the purposes of undertaking a worst-case assessment of the Project, operational scenarios were developed to represent the potential worst-case noise levels at the surrounding sensitive receptors.

The following operational scenarios have been modelled:

- Typical approved day shift activities of the Peppertree Quarry (Secondary / Tertiary Processing, rail loading and product transportation/ In-pit extraction and processing operations) with the proposed overburden hauling and emplacement activities associated with the new southern overburden emplacement (as presented in Table 5-1). Figure 5-1 shows the locations of the noise sources for the typical approved day shift activities and the proposed overburden hauling and emplacement activities associated with the new southern overburden emplacement. It should be noted that the Mobile Crusher would be operating at RL 555 with the Excavator and articulated trucks operating at RL 570.

**Figure 5-1 Indicative Modelling Scenario for the Modified Day Shift Activities (7am-7pm)**



- Typical approved night shift operations of the Peppertree Quarry and proposed in-pit operations (as presented in Table 5-1) between 5.00am and 11.00pm. Figure 5-2 shows the locations of the noise sources for the typical approved evening / night time operations of the Peppertree Quarry with the proposed in-pit operations. It should be noted that the Mobile Crusher would be operating at RL 555 with the Excavator and articulated trucks operating at RL 570. At the commencement of the proposed in-pit operations the southern overburden emplacement was assumed to have just started.

**Figure 5-2 Indicative Modelling Scenario for the Modified Night Shift (5am-11pm)**

These scenarios were based on the assumption that all plant and equipment operates simultaneously. In practice, such an operating scenario would be unlikely to occur and the results of the modelling are typically conservative. The noise modelling scenario are summarised in Table 5-1.

**Table 5-1 Operational Scenario**

| Operation | Day Shift 7am-7pm | Night Shift 7pm-7am |
|---|---|---|
| In-pit extraction and processing operations | ✓ | 5am-7am & 7pm-11pm |
| Overburden operations (southern overburden emplacement) | ✓ | ✗ |
| Secondary & Tertiary processing | ✓ | ✓ |
| Rail loading & product transportation | ✓ | ✓ |

The typical number of plant and equipment modelled are presented below:

**Southern overburden emplacement**

- 1x Dozer
- 1x Grader
- 2x Excavator (65 tonnes)
- 8x Trucks (40 tonnes articulated)
- 1x Watercart (30,000 litres Articulated)

**Secondary / Tertiary Processing, rail loading and product transportation**

- Primary Screening Plant
- Grizzly Screen
- Secondary Crushing & Screening
- Tertiary Crushing & Screening
- Numerous conveyors and transfer points
- Rocks falling on Stockpile
- Tunnel reclaim
- Train moving slowly through loading facility
- Loading Rail wagons
- Enclosed Rail storage bins loading
- 2x FELs
- 3x Road Trucks

**In-pit extraction and processing operations**

- 1x in-pit Mobile Crusher operating at RL 555;
- 1x Excavator (65 tonne) + 2x Trucks (40 tonne Articulated) all operating at RL 570
- 2x Drill Rigs
- 1x Watercart (10,000 litre)

Presently, two trucks are used in the pit to haul blast rock from the blast face to the crusher. In future, there will be no trucks and a front end loader will replace the trucks. To assess worst-case noise impacts the two trucks hauling blast rock from the blast face to the crusher was modelled.

An inventory of sound power levels of plant, equipment and operations are presented in Table 5-2. The sound power levels are based on a combination of measured noise levels, data from previous environmental assessments of the Peppertree Quarry and Wilkinson Murray's database.

**Table 5-2 Equipment Sound Power Levels**

| Fleet Item | Typical Plant Description | Location | Sound Power Level $L_{Aeq}$ (dBA) | Reference |
|---|---|---|---|---|
| Haul Trucks | Articulated Truck | In-pit | 110 | Site noise measurements |
| | Articulated Truck | Overburden emplacement | 110 | Site noise measurements |
| Primary Screening Plant | | Processing area | 104 | Site noise measurements |
| Grizzly Screen | | Processing area | 104 | Site noise measurements |
| Secondary Crushing & Screening | | Processing area | 104 | Site noise measurements |
| Tertiary Crushing & Screening | | Processing area | 104 | Site noise measurements |
| Conveyor (Pit to Stockpile) | | Processing area | 80dBA per m | Peppertree Mod2 |
| Rocks falling on Stockpile | | Processing area | 103 | Site noise measurements |
| Tunnel reclaim | | Processing area | 93 | Site noise measurements |
| Train moving slowly through loading facility | | Rail loading & product transportation | 103 | Site noise measurements |
| Conveyor (others) | | Processing area | 75dBA per m | Peppertree Mod2 |
| Conveyor transfer points | | Processing area | 92 | Site noise measurements |
| Drill | | In-pit | 115 | Wilkinson Murray database |
| In-pit Mobile Crusher | | In-pit | 114 | Site noise measurements |

| Fleet Item | Typical Plant Description | Location | Sound Power Level $L_{Aeq}$ (dBA) | Reference |
|---|---|---|---|---|
| Road Trucks | | Processing area | 102 | Wilkinson Murray database |
| Dozer | D10 / D11 | Overburden emplacement | 112 | Peppertree Mod2 |
| Enclosed Rail storage bins loading | | Rail loading & product transportation | 94 | Peppertree Mod2 |
| Excavators | Komatsu 850 | In-pit | 106 | Peppertree Mod2 |
| Loaders | Komatsu WA800 | Processing Area | 114 | Peppertree Mod2 |
| | CAT 988 | In-pit | 111 | Peppertree Mod2 |
| Grader | CAT 140H | Haul roads | 108 | Wilkinson Murray database |
| Watercarts | | Haul roads | 110 | Wilkinson Murray database |

The following noise management measures included in the noise modelling for the approved Peppertree Quarry operations were incorporated into the noise model:

- Noise mitigation of the in-pit primary crusher;
- Enclosure of the secondary and tertiary processing plant;
- Enclosure of the rail loading facility;
- Enclosure of overhead bins for rail loading;
- Haul truck noise reduction; and
- Dozer noise reduction.

Noise barriers located to the south of the processing plant and pit, as shown in Figure 3-1.

## 5.1 Meteorological Conditions

Meteorological conditions can enhance noise levels particularly under down wind conditions and temperature inversions conditions where the air is colder on the ground than in the air. The *INP* typically recommends worst-case meteorological default values for inversion strength and wind speed, namely:

- 3°/100 m (degrees Celsius / 100 metres) temperature inversion strength; and
- 3 m/s wind blowing in the direction from source to receiver.

For this assessment however, to be more accurate with our noise predictions, a site-specific noise validation study was conducted in order to determine the appropriate meteorological conditions to model for the noise assessment. The study measured noise levels in the area from Marulan South Limestone mine and compared it with the predicted noise scenarios. The results of the noise study are presented in Appendix A.

The typical worst-case meteorological conditions that enhance noise levels, such as source to receiver winds and temperature inversion conditions that were adopted for the assessment of noise emissions from the modified Peppertree Quarry operations include:

- Day shift emissions would generally be assessed using isothermal, still meteorological conditions. Easterly winds occur for a significant period of time at the site, therefore to account for the wind, it is proposed to assess the impact of noise under a $1^{o}$/100 m temperature inversion; and
- Night shift operations would generally be assessed using a $2^{o}$/100 m temperature inversion. The temperature inversion conditions would occur for more than 30% of the time for all seasons.

# 6 NOISE IMPACT ASSESSMENT

## 6.1 Operational Noise Assessment

Predicted noise levels for the identified operational scenarios have been calculated using the assumptions presented above and are presented in Table 6-1 and Table 6-2.

### Table 6-1 Noise Predictions – Day Shift

| Receiver | Predicted Noise levels, $L_{Aeq,15min}$ | | Operational Noise Limit $L_{Aeq,15min}$ |
|---|---|---|---|
| | Calm | Worst-Case Meteorological Conditions | Day Shift |
| R1 | 22 | 28 | 35 |
| R2 | 27 | 31 | 35 |
| R3 | 29 | 34 | 35 |
| R4 | 28 | 34 | 35 |
| R5 | 28 | 35 | 35 |
| R6 | 26 | 31 | 35 |
| R7 | 30 | 35 | 35 |
| R8 | 34 | 38 | 41 |
| R9 | 29 | 34 | 35 |
| R10 | 25 | 31 | 35 |
| R11 | 22 | 27 | 35 |
| R12 | 24 | 30 | 35 |
| R13 | 22 | 29 | 35 |
| R14 | 33 | 34 | 35 |
| R15 | 32 | 33 | 35 |
| R16 | 32 | 33 | 35 |
| R17 | 33 | 34 | 35 |

The predicted noise levels for approved day shift activities, including the proposed southern overburden emplacement comply with the operational noise impact assessment criteria in the Project Approval at all locations for both calm and worst-case meteorological conditions.

**Table 6-2 Noise Predictions – Night Shift**

| Receiver | Predicted Noise levels, $L_{Aeq,15min}$ | | Operational Noise Limit $L_{Aeq,15min}$ |
|---|---|---|---|
| | Calm | Worst-Case Meteorological Conditions | Night Shift |
| R1 | 16 | 25 | 35 |
| R2 | 22 | 28 | 35 |
| R3 | 24 | 31 | 35 |
| R4 | 22 | 33 | 35 |
| R5 | 23 | 33 | 35 |
| R6 | 19 | 29 | 35 |
| R7 | 25 | 33 | 35 |
| R8 | 29 | 35 | 35 |
| R9 | 21 | 28 | 35 |
| R10 | 16 | 25 | 35 |
| R11 | 10 | 21 | 35 |
| R12 | 12 | 21 | 35 |
| R13 | 16 | 26 | 35 |
| R14 | 27 | 28 | 35 |
| R15 | 26 | 28 | 35 |
| R16 | 26 | 28 | 35 |
| R17 | 27 | 28 | 35 |

The predicted noise levels for approved night shift operations including the proposed in-pit operations (5.00am to 11.00pm) comply with the operational noise impact assessment criteria in the Project Approval at all locations for both calm and worst-case meteorological conditions. Predictions under calm meteorological are well below the criteria.

The sensitive receiver located closest to the quarry and that is most likely to be impacted by the proposed modifications is R8. Worst-case noise predictions indicate that both day shift and night shift operational noise criteria are met. The proposed night shift in-pit operations increased the operational noise level by less than 0.5dB.

Predicted noise contour maps for the worst-case scenario meteorological condition are presented in Appendix B.

## 6.2 Sleep Disturbance Assessment

At a distance from a quarry operation, instantaneous changes in noise level are typically small as the noise experienced by the receiver is due to many low-level noise sources.

Night-time operator-attended noise measurement results have been examined to determine the mean difference between the intrusive $L_{Aeq,15min}$ and the corresponding $L_{A1,1min}$ noise levels. The results of night-time noise measurements for the compliance monitoring for Peppertree Quarry in 2014 (ERM, 2014) are summarised in Table 6-3 including the measured (quarry-contributed) intrusive $L_{Aeq,15min}$ and the $L_{A1,1min}$ noise levels.

**Table 6-3 Measured Night-time $L_{Aeq,15min}$ and $L_{A1,1min}$ Noise Levels**

| Receiver | Measured $L_{Aeq,15min}$ | Measured $L_{A1,1min}$ | Difference |
|---|---|---|---|
| R2 | 29 | 35 | 6 |
| | 25 | 33 | 8 |
| R5 | 28 | 37 | 9 |
| | 30 | 38 | 8 |
| R8 | 29 | 37 | 8 |
| | 23 | 33 | 10 |
| B5 | 26 | 35 | 9 |
| | 25 | 34 | 9 |
| Average | | | 8 |

The night-time operator-attended noise measurement results show a mean difference of 8 dBA between the (quarry-contributed) intrusive $L_{Aeq,15min}$ and the $L_{A1,1min}$ noise levels and are therefore consistent with similar quarrying operations.

Therefore from measured noise levels the maximum $L_{A1,1min}$ noise level at any receiver would be typically less than 8dBA above the $L_{Aeq,15min}$ level, leading to a worst-case $L_{A1,1min}$ of 43dBA at any receiver. This complies with the sleep disturbance criteria.

## 6.3 Land Acquisitions Noise Criteria

As the land acquisition criteria in the Project Approval are higher than the operational noise impact assessment criteria, the predicted daytime and night time noise levels associated with the proposed modifications, do not exceed the land acquisition criteria at any residence.

## 6.4 Cumulative Assessment

The cumulative assessment requires predictions of noise over the entire daytime, evening or night time period.

The $L_{Aeq,period}$ predicted noise levels at the residential receivers from the modified Peppertree Quarry operations are presented in Table 6-4. By itself, the noise from the Peppertree Quarry complies with the amenity criteria at all receivers, but must be considered as part of the overall noise environment.

**Table 6-4 $L_{Aeq,period}$ Predicted Noise Levels – Modified Peppertree Quarry Operations**

| Receiver | Day | Evening | Night |
|---|---|---|---|
| R1 | 25 | 22 | 22 |
| R2 | 28 | 25 | 25 |
| R3 | 31 | 28 | 28 |
| R4 | 31 | 30 | 30 |
| R5 | 32 | 30 | 30 |
| R6 | 28 | 26 | 26 |
| R7 | 32 | 30 | 30 |
| R8 | 35 | 32 | 32 |
| R9 | 31 | 25 | 25 |
| R10 | 28 | 22 | 22 |
| R11 | 24 | 18 | 18 |
| R12 | 27 | 18 | 18 |
| R13 | 26 | 23 | 23 |
| R14 | 31 | 25 | 25 |
| R15 | 30 | 25 | 25 |
| R16 | 30 | 25 | 25 |
| R17 | 31 | 25 | 25 |

The other major industrial noise source in the vicinity of Peppertree Quarry is the Marulan South Limestone Mine. The $L_{Aeq,period}$ noise levels for Marulan South Limestone Mine estimated from indicative noise modelling are presented in Table 6-5.

**Table 6-5 $L_{Aeq,period}$ Predicted Noise Levels – Marulan South Lime Stone Mine**

| Receiver | Day | Evening | Night |
|---|---|---|---|
| R1 | 17 | 23 | 23 |
| R2 | 23 | 26 | 26 |
| R3 | 28 | 32 | 32 |
| R4 | 24 | 30 | 30 |
| R5 | 27 | 34 | 34 |
| R6 | 26 | 33 | 33 |
| R7 | 30 | 36 | 36 |
| R8 | 29 | 37 | 37 |
| R9 | 32 | 38 | 38 |
| R10 | 29 | 35 | 35 |

| Receiver | Day | Evening | Night |
|---|---|---|---|
| R11 | 28 | 35 | 35 |
| R12 | 30 | 38 | 38 |
| R13 | 26 | 28 | 28 |
| R14 | 30 | 32 | 32 |
| R15 | 31 | 32 | 32 |
| R16 | 31 | 32 | 32 |
| R17 | 28 | 30 | 30 |

Combining the $L_{Aeq,day}$, $L_{Aeq,evening}$ and $L_{Aeq,night}$ noise levels in Table 6-4 (Modified Peppertree Quarry operations) and Table 6-5 (Marulan South Limestone Mine) would result in cumulative noise levels (See Table 6-6) below the amenity criteria for industrial noise during the daytime, evening and night time periods of 50 $L_{Aeq,day}$ / 45 $L_{Aeq,evening}$ / 40 $L_{Aeq,night}$. Therefore, the assessment of cumulative noise impacts associated with the modified Peppertree Quarry operations has predicted no exceedances of the amenity criteria in the Project Approval at any sensitive receiver.

**Table 6-6 Combined $L_{Aeq,period}$ Predicted Noise Levels**

| Receiver | Day | Evening | Night |
|---|---|---|---|
| | Amenity Criteria 50 $L_{Aeq,day}$ | Amenity Criteria 45 $L_{Aeq,evening}$ | Amenity Criteria 40 $L_{Aeq,night}$ |
| R1 | 26 | 26 | 26 |
| R2 | 29 | 29 | 29 |
| R3 | 33 | 33 | 33 |
| R4 | 32 | 33 | 33 |
| R5 | 33 | 35 | 35 |
| R6 | 30 | 34 | 34 |
| R7 | 34 | 37 | 37 |
| R8 | 36 | 38 | 38 |
| R9 | 35 | 38 | 38 |
| R10 | 32 | 35 | 35 |
| R11 | 29 | 35 | 35 |
| R12 | 32 | 38 | 38 |
| R13 | 29 | 29 | 29 |
| R14 | 34 | 33 | 33 |
| R15 | 34 | 33 | 33 |
| R16 | 34 | 33 | 33 |
| R17 | 33 | 31 | 31 |

# 7 LOW FREQUENCY NOISE IMPACTS

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level.

The *INP* recommends correction factors to be applied to the source noise level at the receiver before comparison with the criteria to account for the additional annoyance caused by these modifying factors.

For this project there is the possibility that low frequency noise might be audible. The *INP* recommends for low frequency noise that an assessment be conducted of the difference between C- and A-weighting levels and if a greater than 15dB difference exits, a correction of +5dB be applied.

At the most-affected receiver (R8) a difference between C-weighting and A-weighting levels of 15dB was calculated. This would indicate compliance with the EPA criterion; however, would also indicate due to the closeness to the criterion, that it would appear to be possible for quarry noise sources to exceed the (dBC-dBA) difference.

Given this, Boral is committed to ameliorating any low frequency noise issues if they arise for the site consistent with the most recent low frequency noise assessment processes available. To ensure compliance with appropriate noise criteria it is proposed that quarterly compliance monitoring currently identified in the Noise Management Plan be strengthened to include additional noise monitoring locations and a more detailed low frequency noise assessment and reporting regime.

# 8 CONCLUSION

This report details predicted operational noise emissions from the proposed modifications to the Peppertree Quarry. The Project essentially seeks to:

- Establish an additional overburden emplacement area to the south of the existing approved eastern overburden emplacement area which would operate in accordance with the Project Approval, ie. 7.00am to 7.00pm;
- Extend the operating hours for in-pit works (currently approved from 7.00am to 7.00pm) by 6 hours. The new operating hours for in-pit works would be from 5.00am to 11.00pm, therefore occurring in the evening and night time periods.

To assess the potential noise impacts associated with the proposed modifications to the Peppertree Quarry operations, this report simply compared the predicted noise emissions form the existing and proposed operations with the operational noise impact assessment criteria in the Project Approval.

The assessment has found that:

- The predicted noise level for day shift activities associated with the proposed southern overburden emplacement comply with the operational noise impact assessment criteria in the Project Approval at all locations for both calm and worst-case meteorological conditions;
- The predicted noise level for proposed in-pit operations during the night shift comply with the operational noise impact assessment criteria in the Project Approval at all locations for both calm and worst-case meteorology;
- As the land acquisition criteria in the Project Approval are higher than the operational noise impact assessment criteria, the predicted daytime and night time noise levels associated with the proposed modifications, do not exceed the land acquisition criteria at any residence;
- Maximum noise levels from the modified Peppertree Quarry operations have been analysed and it is expected that compliance of the sleep disturbance criteria in the Project Approval ($L_{A1,\ 1minute}$) would be achieved at all locations.
- Cumulative industrial noise levels as required to be considered by the Project Approval have been estimated at the closest residential receivers and it is expected that the amenity criteria would be met.

Relative to the existing operations, the proposed modifications to the Peppertree Quarry operations are unlikely to contribute to any significant change in existing operational or cumulative noise levels at identified sensitive receivers. This is supported by this noise impact assessment which predicts that there would be no exceedances of the operational noise impact assessment criteria stipulated by the Project Approval at any identified sensitive receiver as a result of operational activities associated with the modified Peppertree Quarry operations. A low frequency noise assessment has been conducted which identified compliance with the appropriate EPA noise criteria, however the assessment indicated that there is potential risk for low frequency noise from the site.

Given this, to ensure compliance with appropriate noise criteria it is proposed that quarterly compliance monitoring currently identified in the Noise Management Plan be strengthened to include additional noise monitoring locations and a more detailed low frequency noise assessment and reporting regime. The additional monitoring locations are proposed to be R17 and R4.

# 9 REFERENCES


- Environment Protection Authority (2000) *NSW Industrial Noise Policy (INP)*
- Office of Environment and Heritage (2011) *Application Notes – NSW Industrial Noise Policy*. Website: http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm
  Accessed 5 October 2011
- Leventhall, G, (2003) A review of Published Research on Low Frequency Noise and its Effects, Report for Department for Environment, Food and Rural Affairs (UK)
- Leventhall, G, (2004) Low Frequency Noise and Annoyance, Noise & Health 6:23, 59-72
- Moorhouse A, Waddington D, Adams, M (2005), Proposed criteria for the assessment of low frequency noise disturbance, Prepared for DEFRA
- Moorhouse A, Waddington D, Adams, M (2005), Procedure for the assessment of low frequency noise complaints, Prepared for DEFRA.
- ERM (2014), Peppertree Quarry Noise Compliance Monitoring, Monitoring period October 2014.

# APPENDIX A

## METEOROLOGICAL DATA ANALYSIS

Operational noise levels at nearby receivers have been calculated using the Environmental Noise Model (ENM) a proprietary computer program from RTA Technology Pty Ltd. ENM accounts for the effects of:

- distance;
- shielding;
- ground effects;
- air absorption; and
- meteorological effects.

This modelling software is recommended by the *INP* and has been previously accepted by the EPA for use in environmental noise assessments. The assessment models the total noise at each receiver from the operation of the Project.

Meteorological conditions can enhance noise levels particularly under down wind conditions and temperature inversions conditions where the air is colder on the ground than in the air. The *INP* typically recommends worst-case meteorological default values for inversion strength and wind speed, namely:

- 3°/100 m temperature inversion strength; and
- 3 m/s wind blowing in the direction from source to receiver.

For this assessment however to be more accurate with our noise predictions, a site-specific noise validation study was conducted in order to determine the appropriate meteorological conditions to model for the noise assessment. The study measured noise levels in the area from Marulan South Limestone mine and compared it with the predicted noise scenarios. The measured noise level from the Marulan Limestone mine was considered the reference source to the study.

In order to validate the noise model, a survey of noise was carried out at receiver location B5 from 19 March to 2 April 2015. Noise measurements were done using the BarnOwl® noise measurement system which is a directional noise monitor. The BarnOwl® allows discrimination of separate noise sources coming from different directions. In this way, the noise level of the mine could be separated from the overall ambient noise level during the measurement period.

Separately to the noise measurement, Boral have provided the meteorological conditions which occurred on site during the same period, including periods of rain, wind speed and direction, and atmospheric stability which allows estimation of the currents and strength of temperature inversions.

Boral have also provided a schedule of operations that occurred during the noise survey.

Combining this data, it was possible to model the approximate operations and noise propagation due to specific meteorological conditions for every hour of the measurement period.

**Analysis of Model Validation Results & Meteorological Environment for Noise Assessment Process**

In order to determine the appropriate meteorological conditions to model for the noise assessment, the BarnOwl® measurements were analysed and compared to various prediction scenarios.

One method of prediction is to analyse meteorological data from the site, calculate noise for the full set of meteorological data, and determine the noise level predicted to be exceeded for 10% of the time – this is called the 10th percentile noise level.

A year of meteorological data has been analysed to make predictions for the operational scenario that occurred during the measurement period at the BarnOwl® location. The results are shown in Table A-1 for Spring meteorology. The first column contains the measured 10th percentile levels based on the maximum and minimum BarnOwl® measured levels, and excluding all results where the wind was higher than 3 m/s. The 10th percentile predictions are up to 7dB higher than the measured levels. The result of higher levels in daytime than at night is unexpected and does not correlate with the measurements or experience.

The table also shows the levels predicted under isothermal conditions, and with temperature inversions of 1°/100 m and 2°/100 m. This is estimated from the range of predicted levels for the scenarios given (shown in parentheses) and the frequency of activities that led to the range. This correlates well with the measurements.

**Table A-1 Comparison of Measured and Predicted Noise Levels, $L_{Aeq}$ – dB(A)**

| Period | Measured | Predicted for Spring Based on 1 year of meteorology 10th Percentile Noise Levels | Predicted, 1°/100 m Temperature Inversion | Predicted, 2°/100 m Temperature Inversion | Predicted – Isothermal |
|---|---|---|---|---|---|
| Day | 39-41 | 49 | 40 (37-41) | 42 (39-43) | 38 (35-39) |
| Evening | 39-40 | 46 | 40 (37-41) | 42 (39-43) | 38 (35-39) |
| Night | 41 | 44 | 40 (37-41) | 42 (39-43) | 38 (35-39) |

Two sets of charts are presented below. The first set shows the measured noise levels and meteorological data, along with noise levels predicted using the meteorology recorded at Marulan for the time plotted, as well as the operational scenario of the time.

The second set of charts show the measured noise levels and meteorological data, and predicted noise from the worst-case operational scenario assuming a constant 2°/100 m temperature inversion.

The information shown in the charts is as follows:

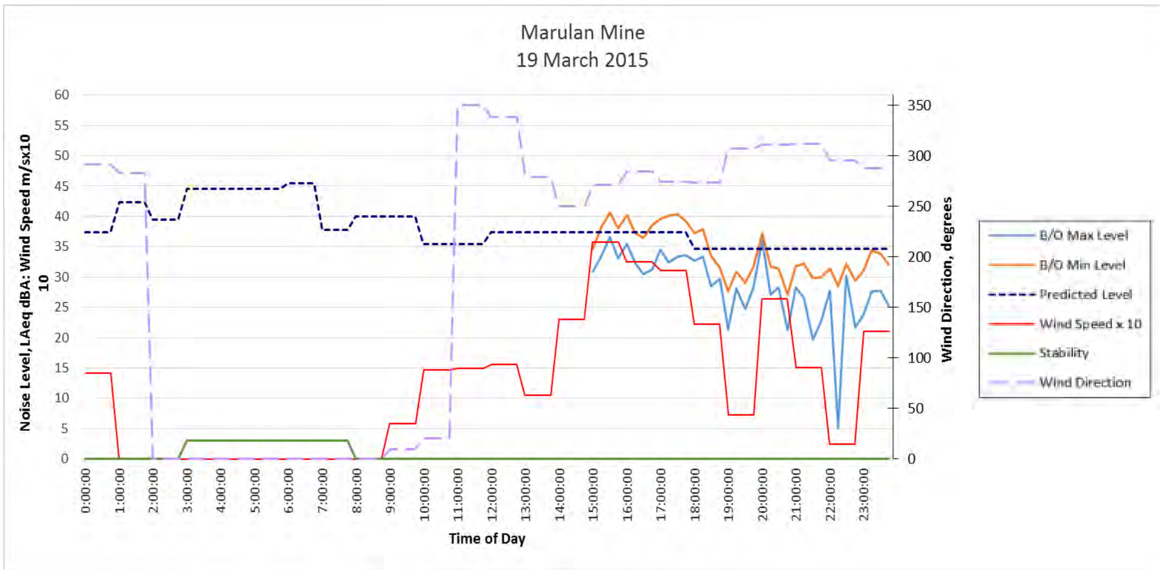
- The maximum and minimum noise levels measured by the BarnOwl® – this represents mine noise levels. These are shown as the light blue (minimum) and brown (maximum) traces on the charts. When these lines show the same noise level, it indicates a high level of certainty that the recorded noise was from the mine. When the traces show different noise levels, for example, at the beginning of the trace at 5.00pm on 19 March, it indicates some uncertainty as to the level of the mine which is expected to be within the range of minimum to maximum. The uncertainty is caused either by the presence of wind or other causes of high ambient noise level which make it difficult for the BarnOwl® to extract the directional information of the mine noise.

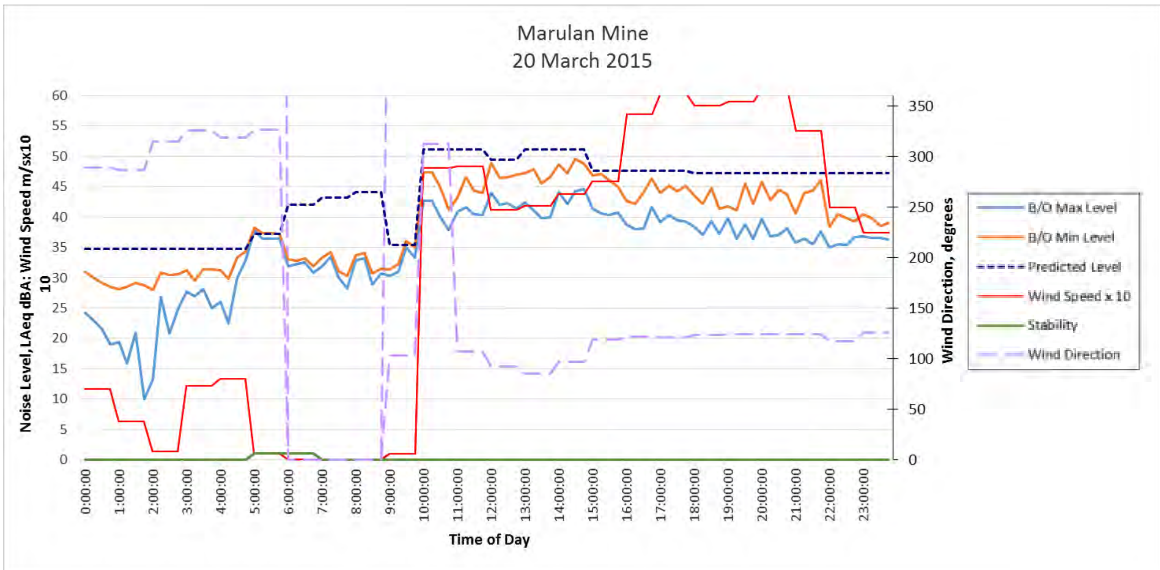
- The red trace shows the wind scaled up by a factor of 10. For example, at 5.00pm on 19 March the wind speed is approximately 3.5 m/s which shows on the left hand scale as 35.
- Wind direction, shown as the purple dashed line, is shown against the right hand scale.
- The predicted noise level is shown as the dark blue dashed line. The prediction was done using ENM and assuming the wind speed, wind direction and temperature inversion that occurred at the same time.
- Pasquill Stability Class is shown as the implied temperature inversion, according to the method of the *INP* Appendix E. For example, a Pasquill Stability of F class is shown as a 3°/100 m temperature inversion. This is the green solid line and is referenced to the left vertical axis.

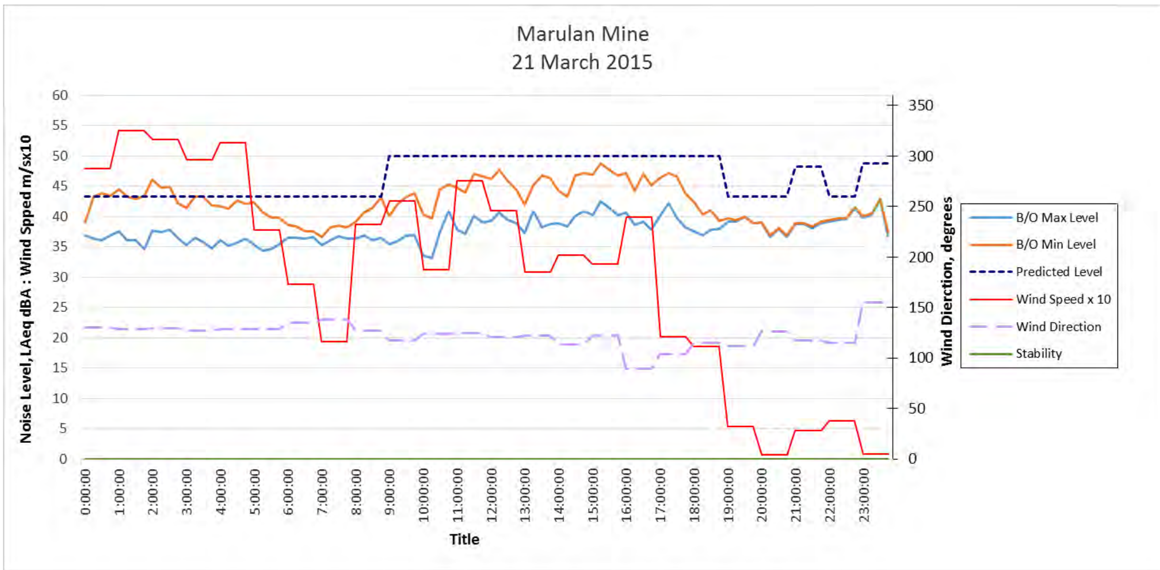
Given these results, the following ENM modelling meteorological parameters are used to predict noise during typical worst-case meteorological conditions that enhance noise levels, such as source to receiver winds and temperature inversion conditions, for the assessment of noise emission from continuing operation of the mine:

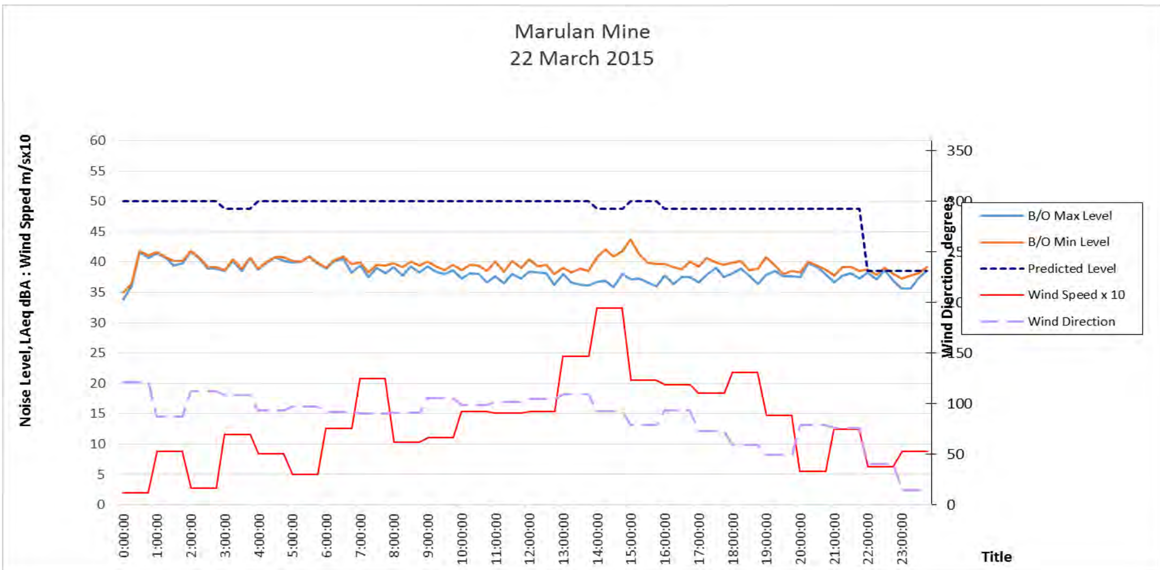
- <u>Calm/Isothermal Meteorological Conditions for Daytime Emissions</u> – No wind; no temperature inversions; 70% relative humidity; and 20° degrees Celsius.
- <u>Adverse Meteorological Conditions for Daytime Emissions</u> – During the measurement period, easterly winds occurred increasing noise at the measurement location. To account for daytime noise enhancing meteorological conditions, operations would be assessed with no wind; with a 1°/100 m temperature inversion; 70% relative humidity; and 20° degrees Celsius. As shown in Table A-1, this correlates well with the measurements conducted by BarnOwl®.
- <u>Calm/Isothermal Meteorological Conditions for Evening and Night Time Emissions</u> – No wind; no temperature inversions; 90% relative humidity; and 10° degrees Celsius.
- <u>Adverse Meteorological Conditions for Evening and Night Time Emissions</u> – To account for evening and night time noise enhancing meteorological conditions, operations would be assessed with no wind; with a 2°/100 m temperature inversion; 90% relative humidity; and 10° degrees Celsius. The temperature inversion condition of a 2°/100 m would occur for more than 30% of the time for all seasons. As shown in Table A-1, this correlates well with the measurements conducted by BarnOwl®.

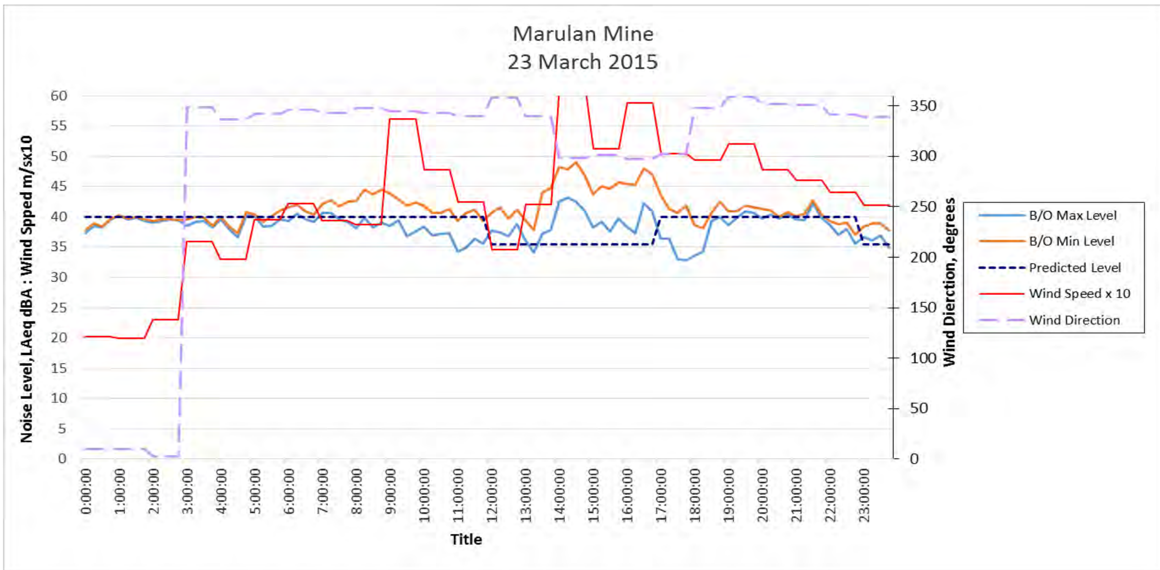
**Measured Noise Levels Compared to Predicted Noise Levels Actual Meteorological Conditions**

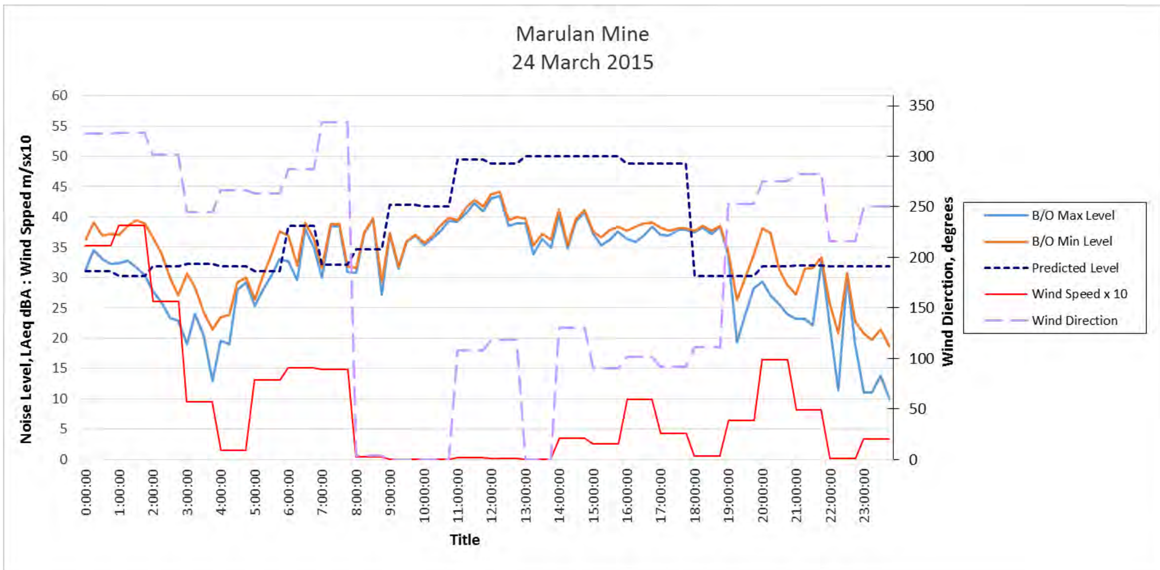


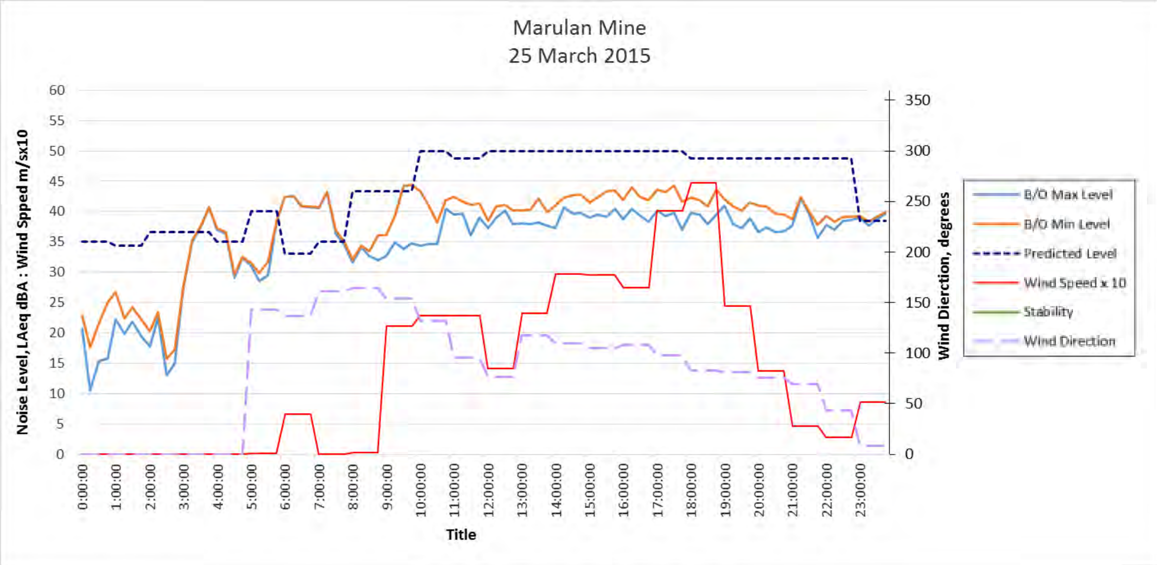



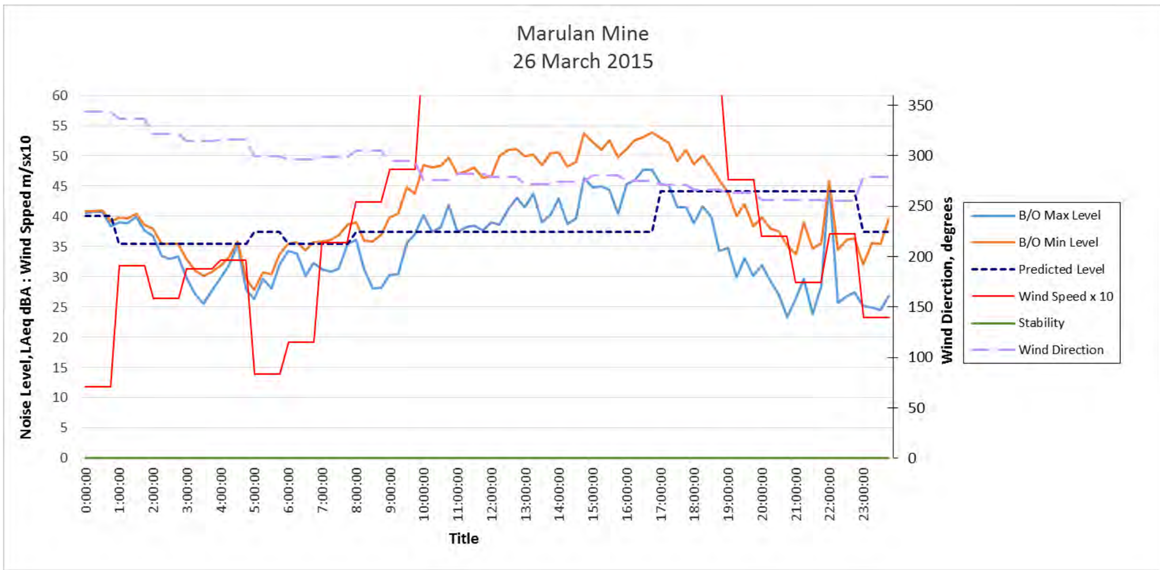

Marulan Mine
21 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Wind Direction
Stability

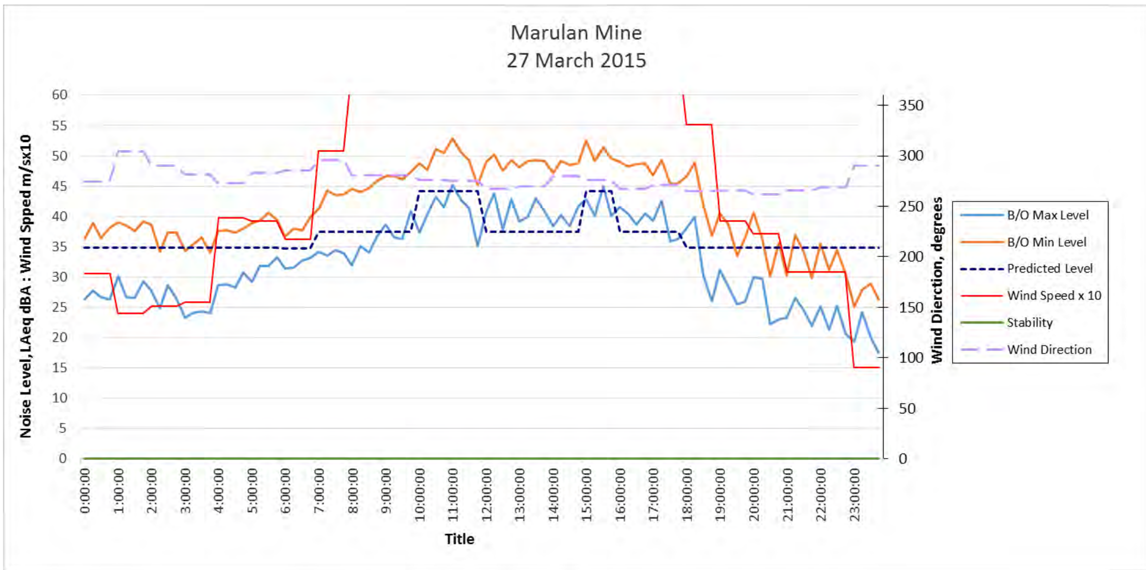

Marulan Mine
22 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Wind Direction

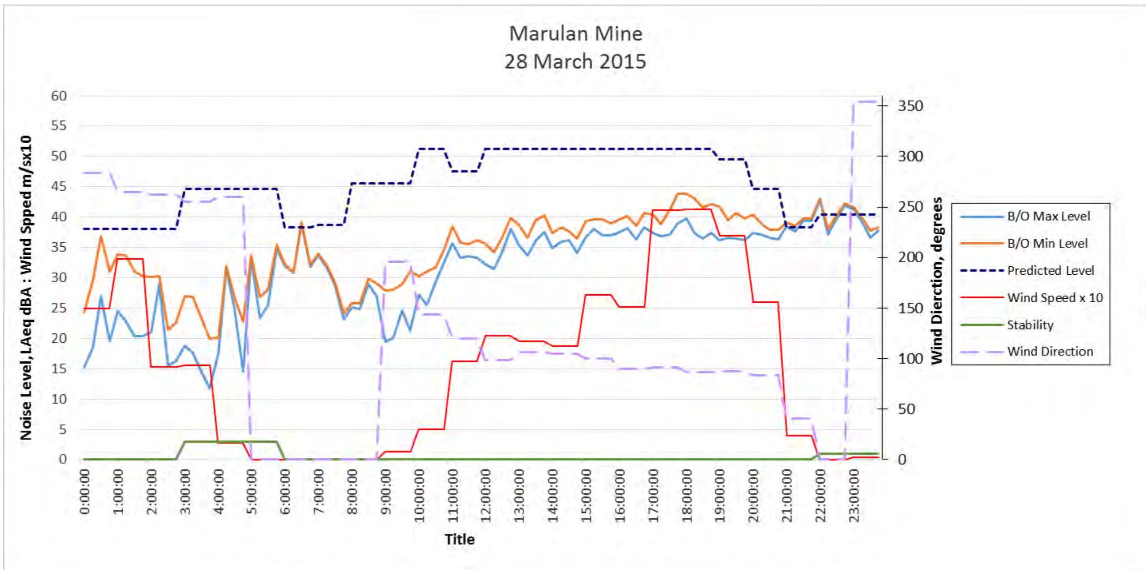

Marulan Mine
23 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Wind Direction

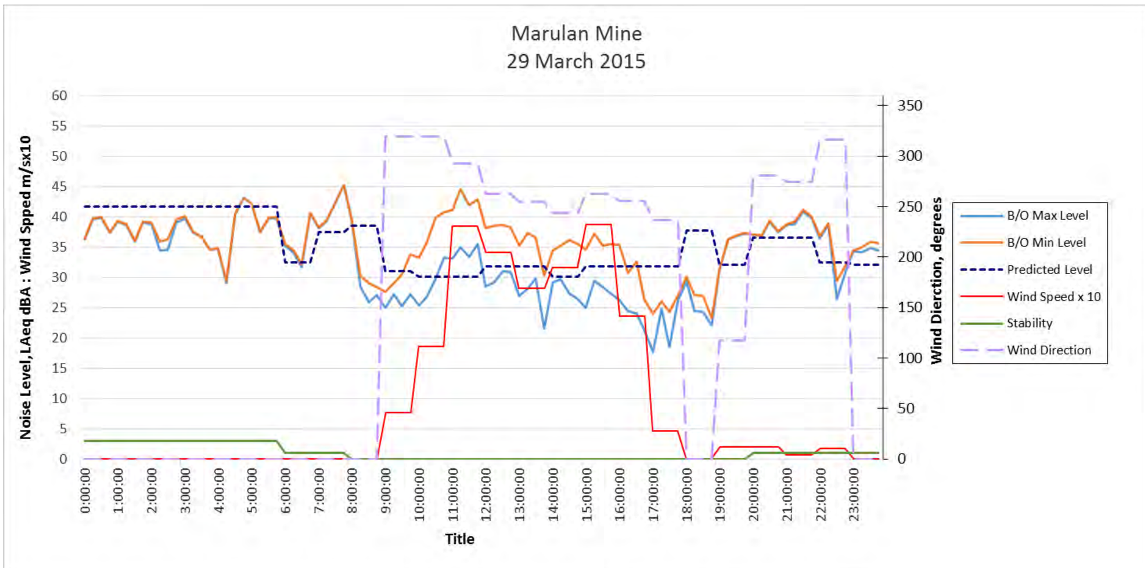

Marulan Mine
24 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Wind Direction

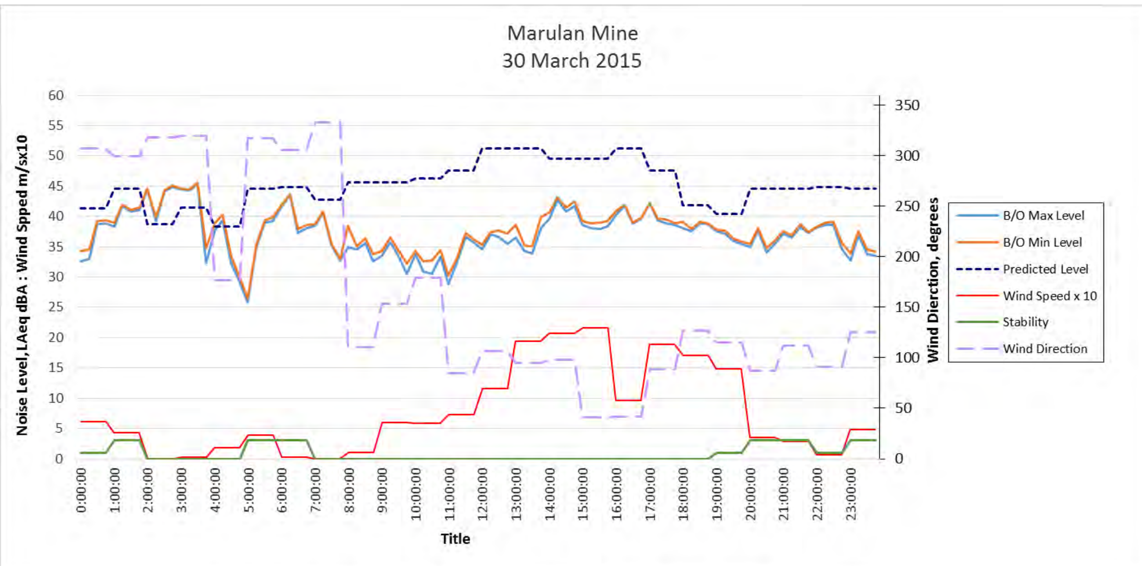

Marulan Mine
25 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

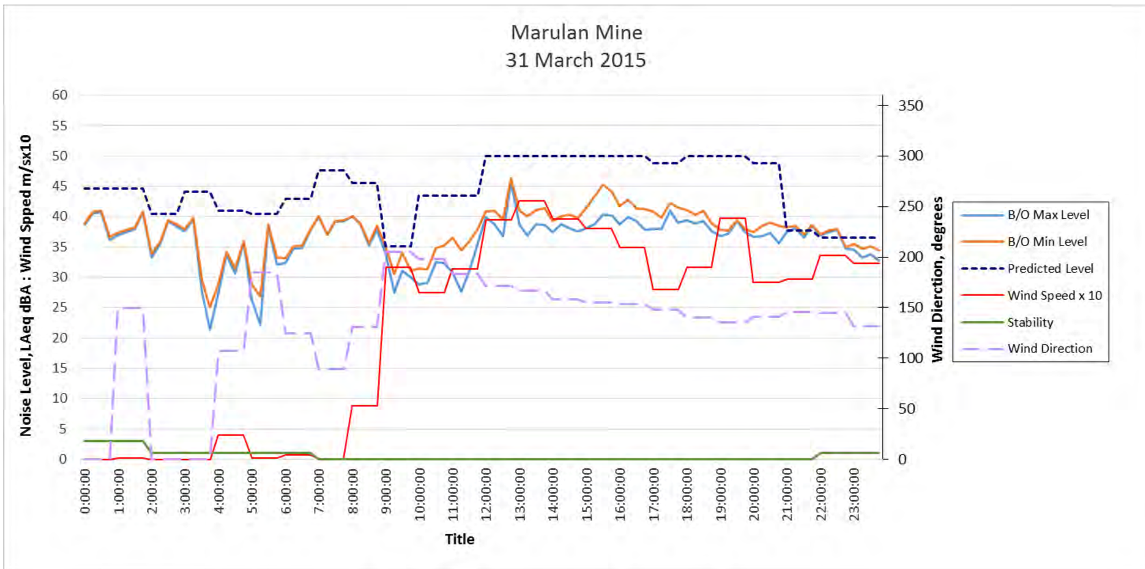

Marulan Mine
26 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

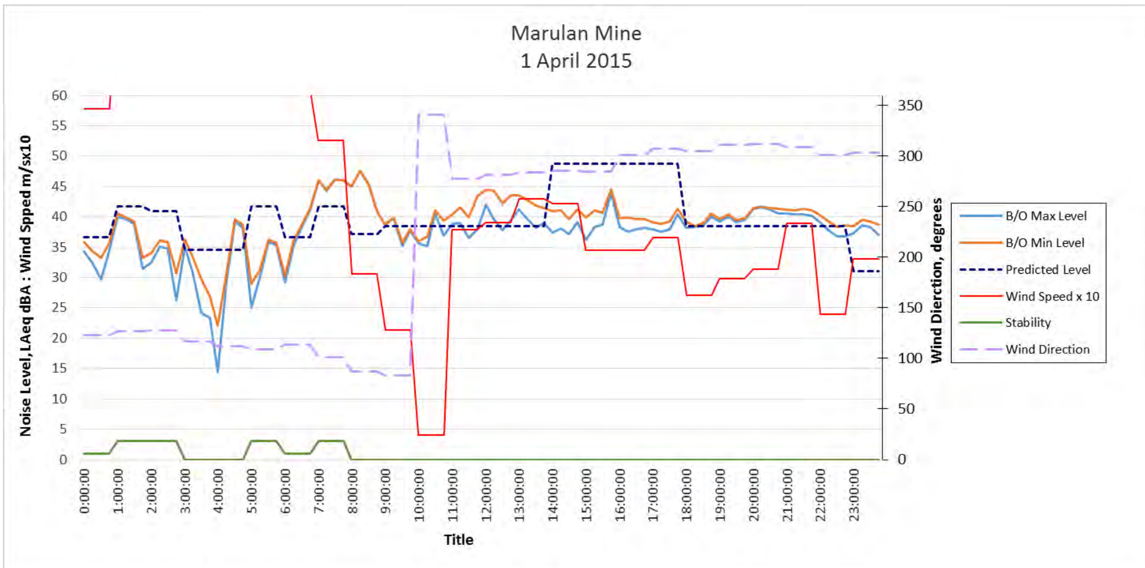

Marulan Mine
27 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction


Marulan Mine
28 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

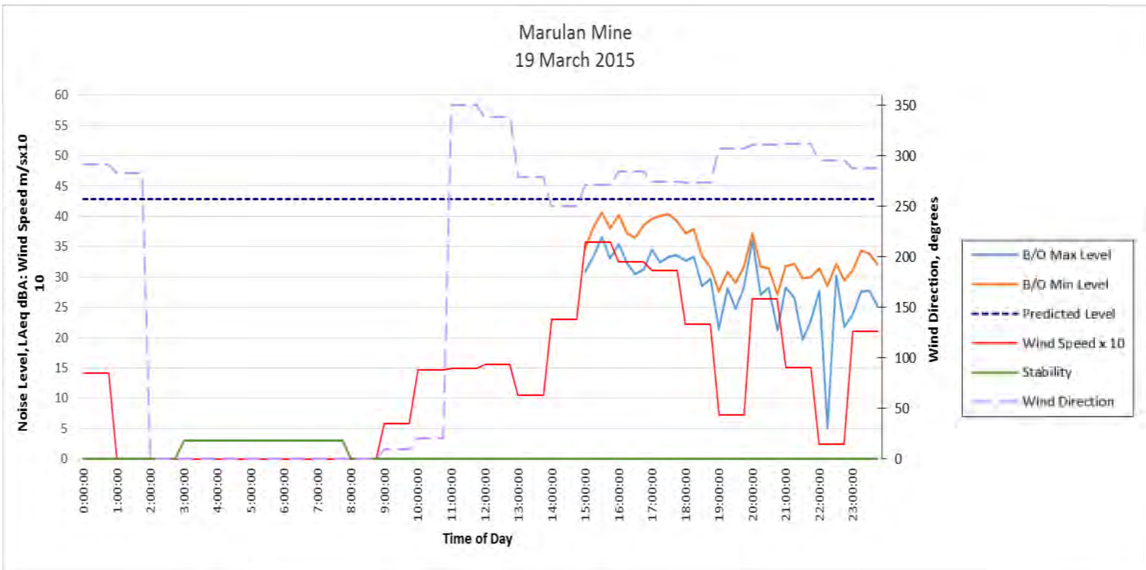

Marulan Mine
29 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

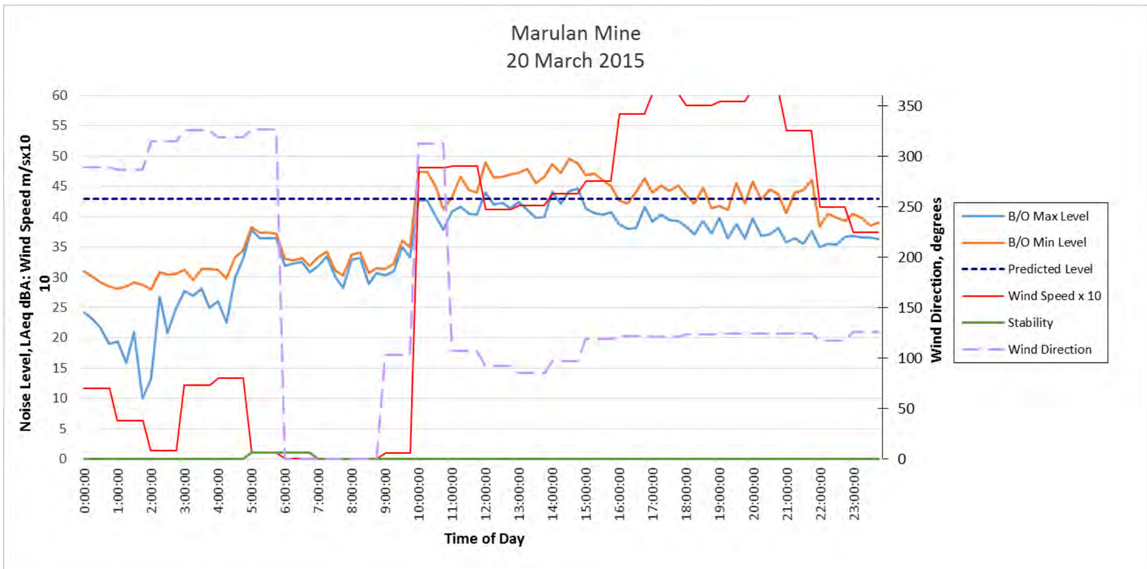

Marulan Mine
30 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

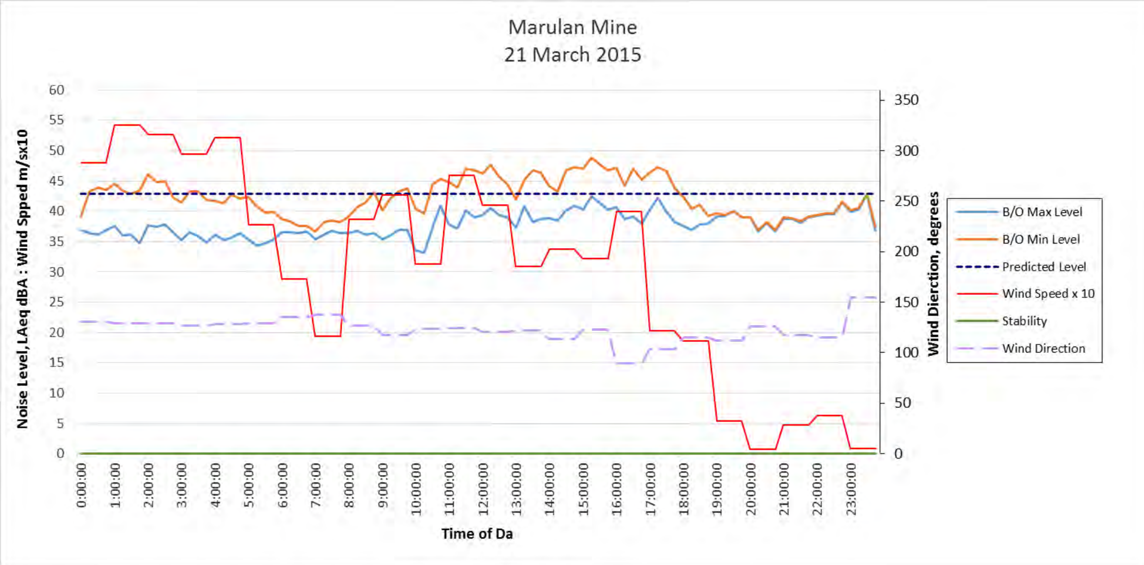

Marulan Mine
31 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

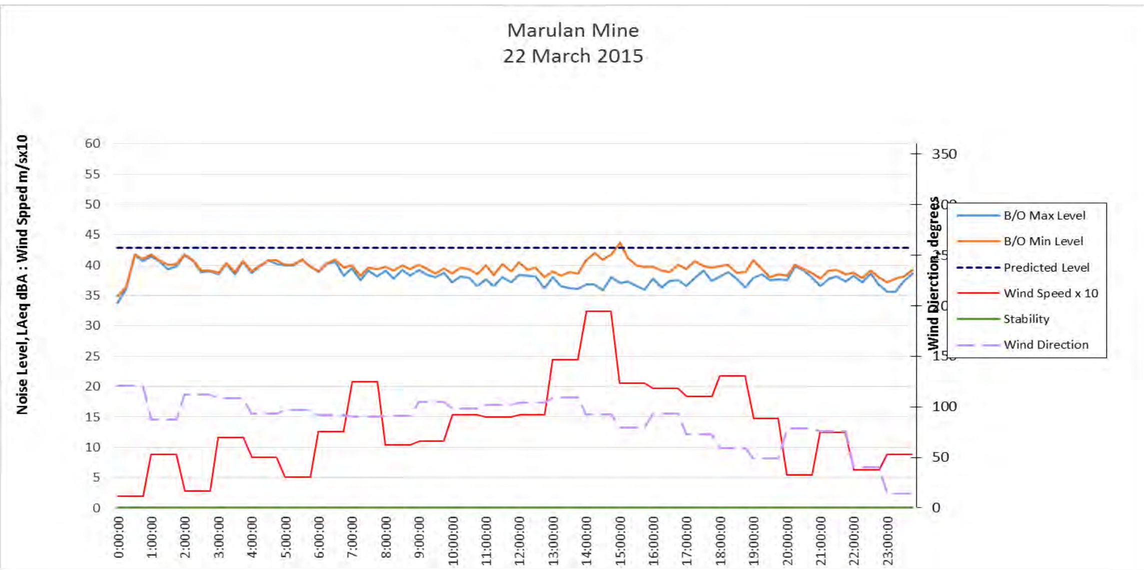

Marulan Mine
1 April 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Title
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

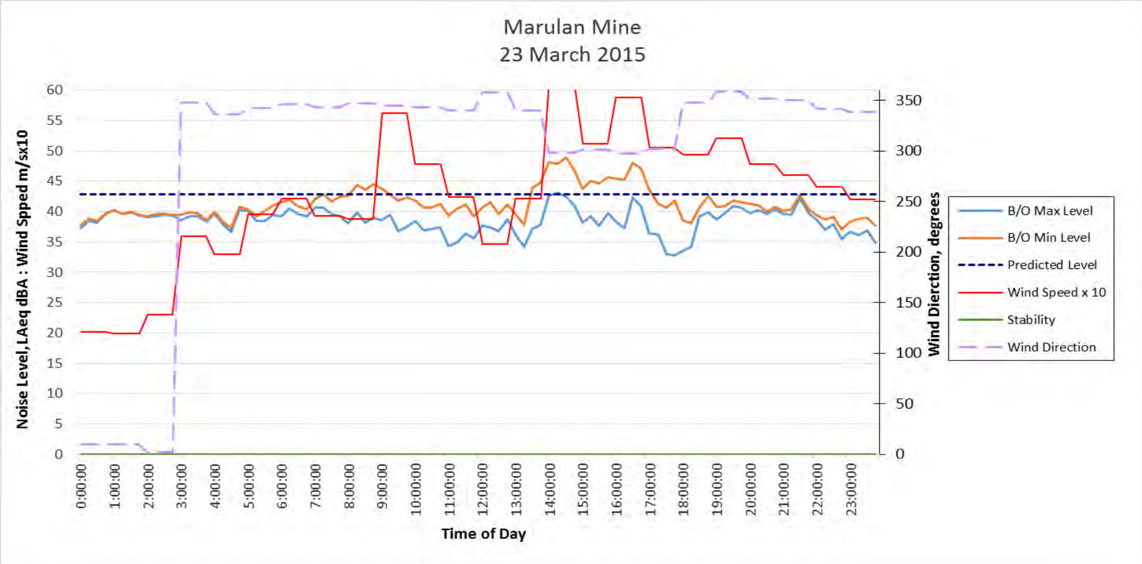
## Measured Noise Levels Compared to Predicted Levels based on 2 Degree / 100m Temperature Inversion

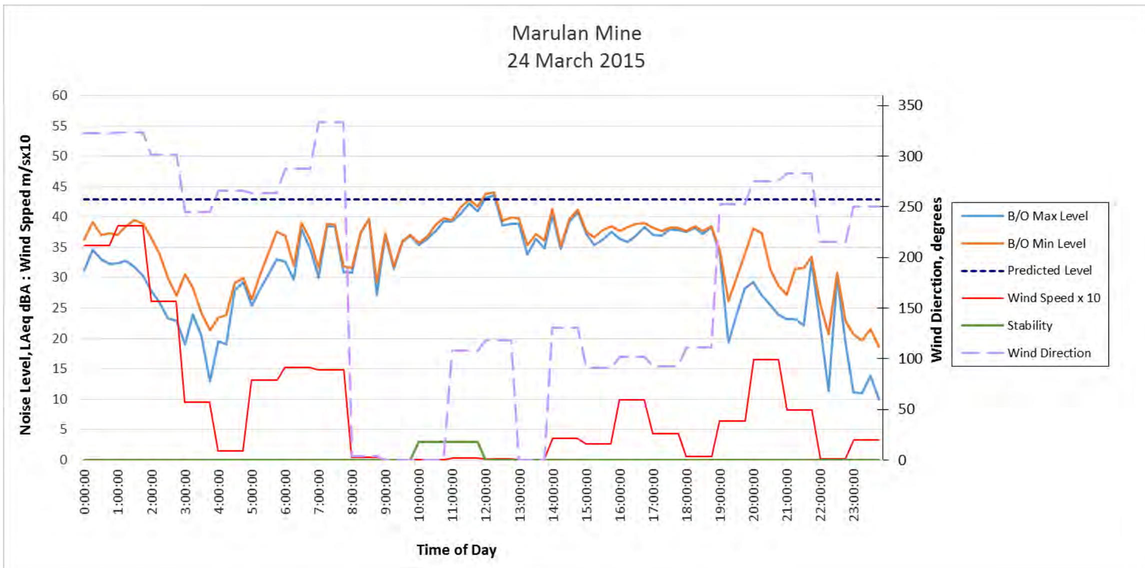


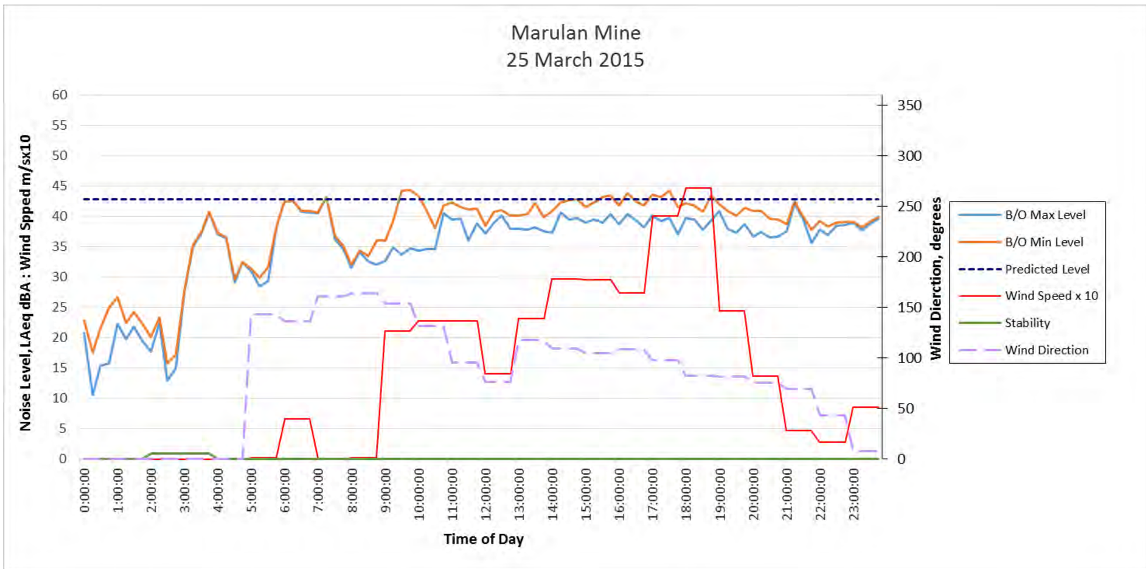



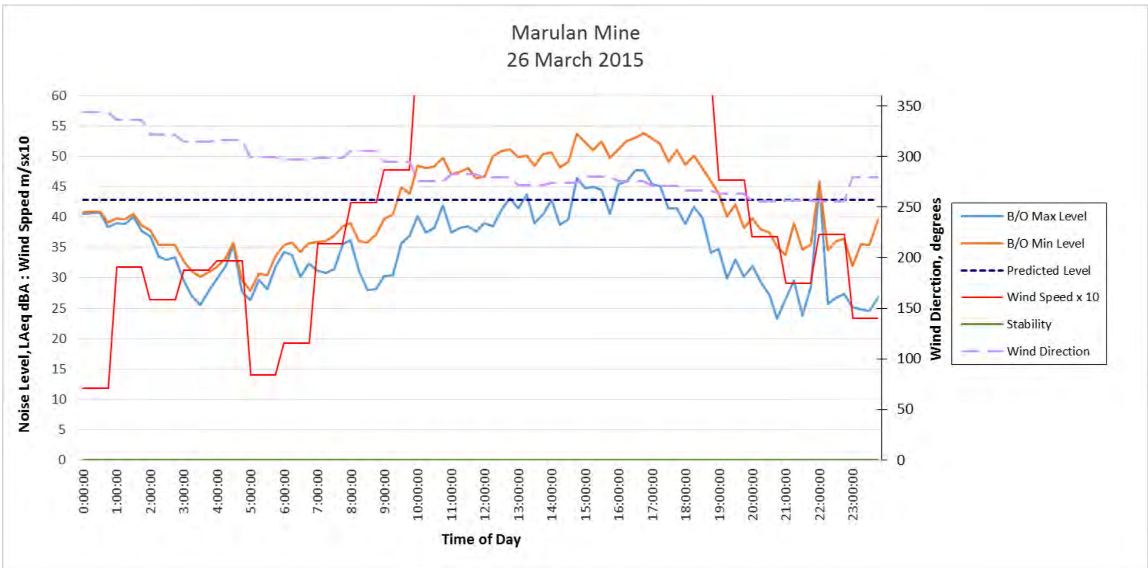

Marulan Mine
21 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Da
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction


Marulan Mine
22 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

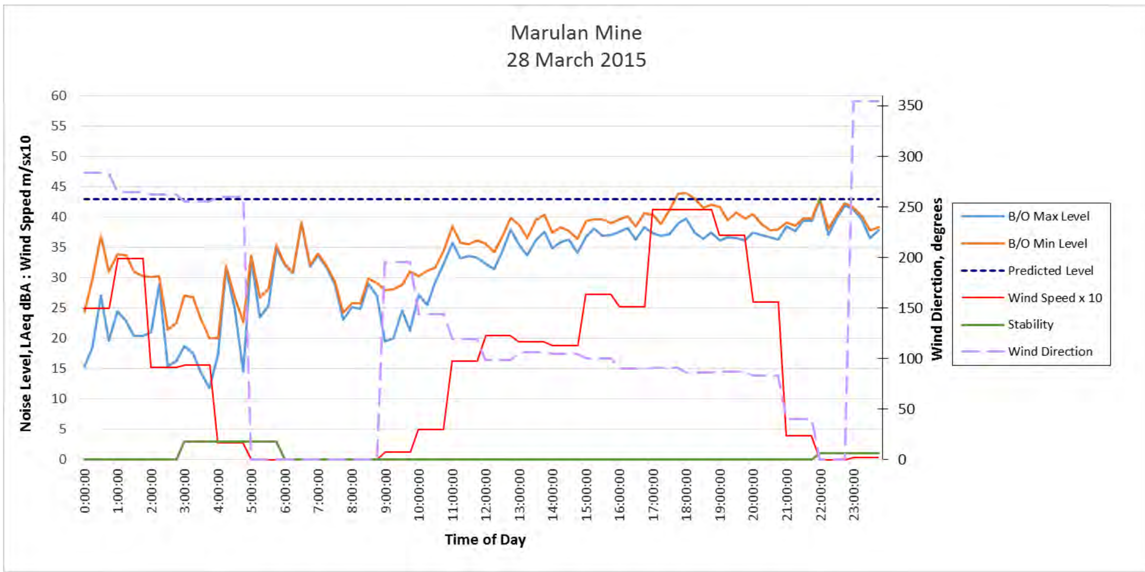

Marulan Mine
23 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

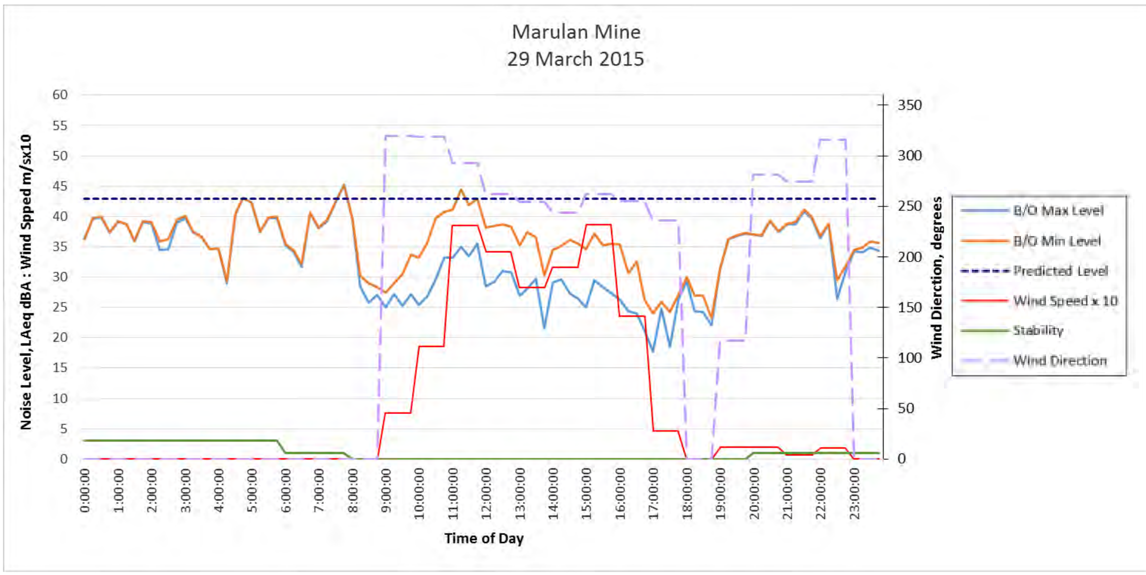

Marulan Mine
24 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

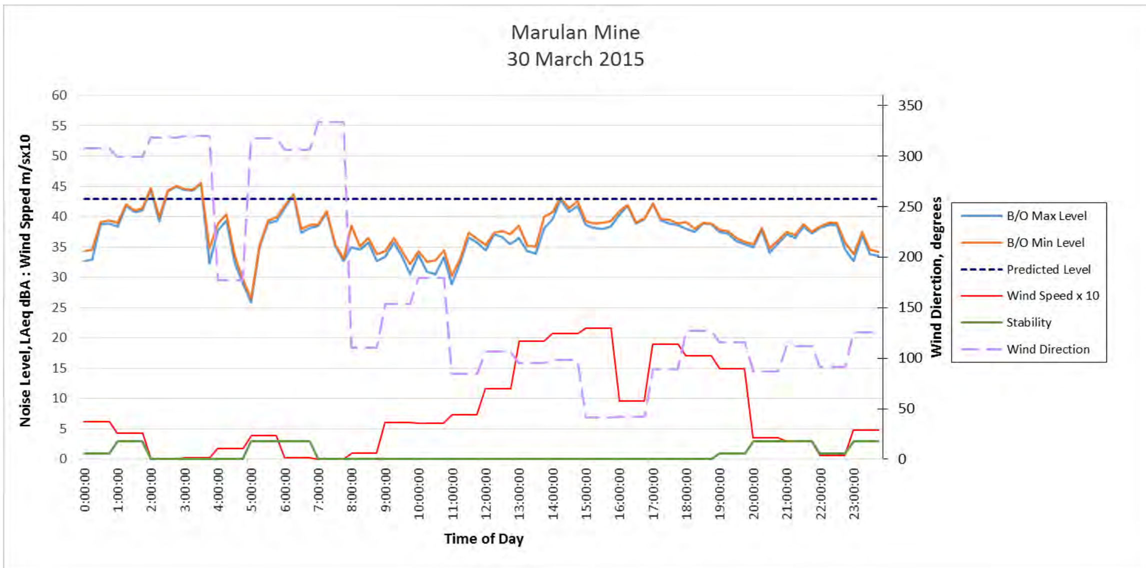

Marulan Mine
25 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

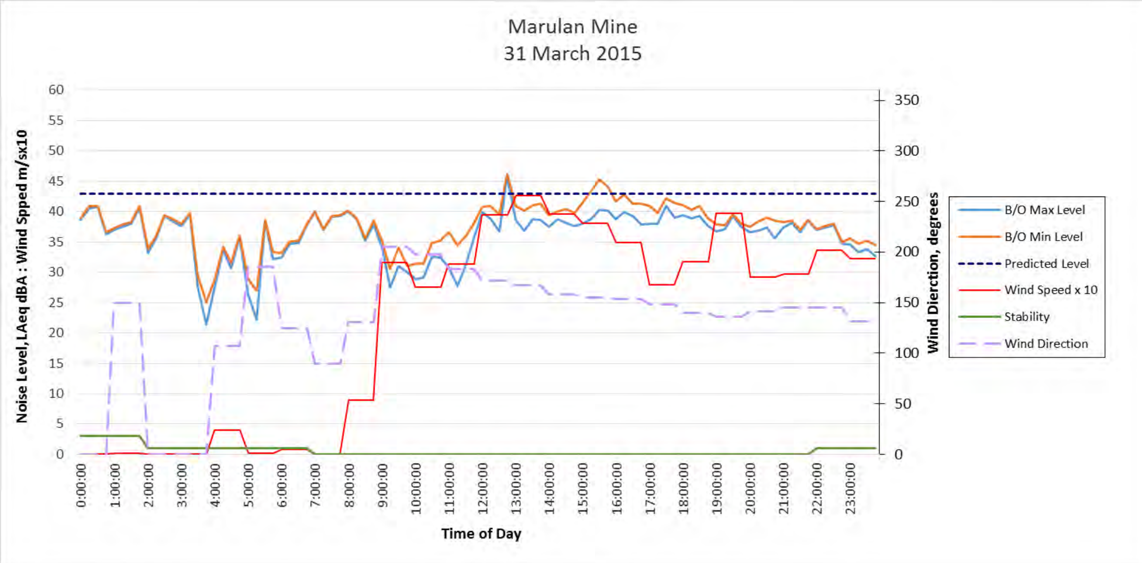

Marulan Mine
26 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

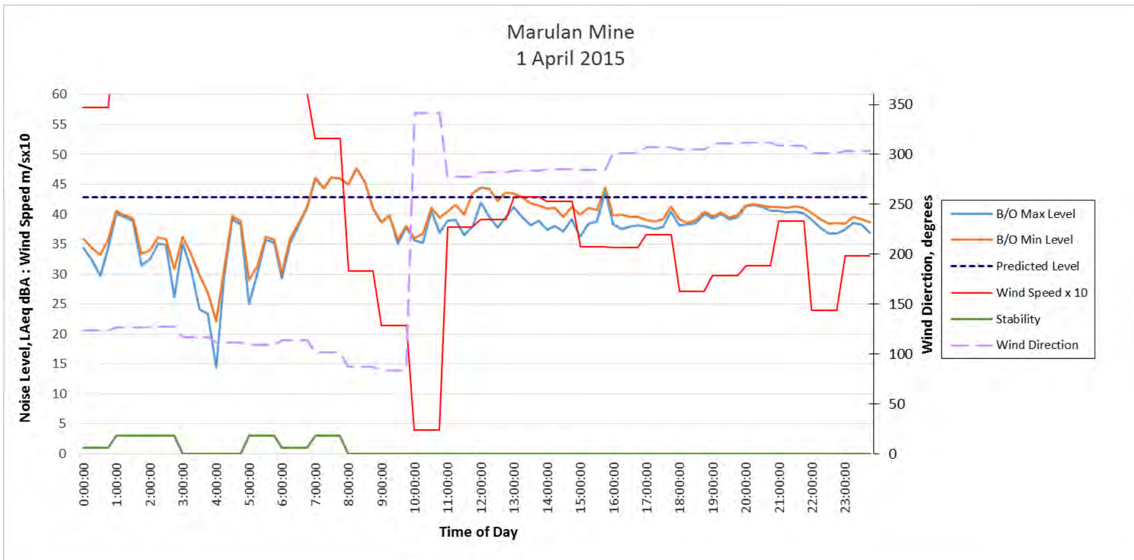

Marulan Mine
27 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction


Marulan Mine
28 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction


Marulan Mine
29 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction


Marulan Mine
30 March 2015
Noise Level,LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

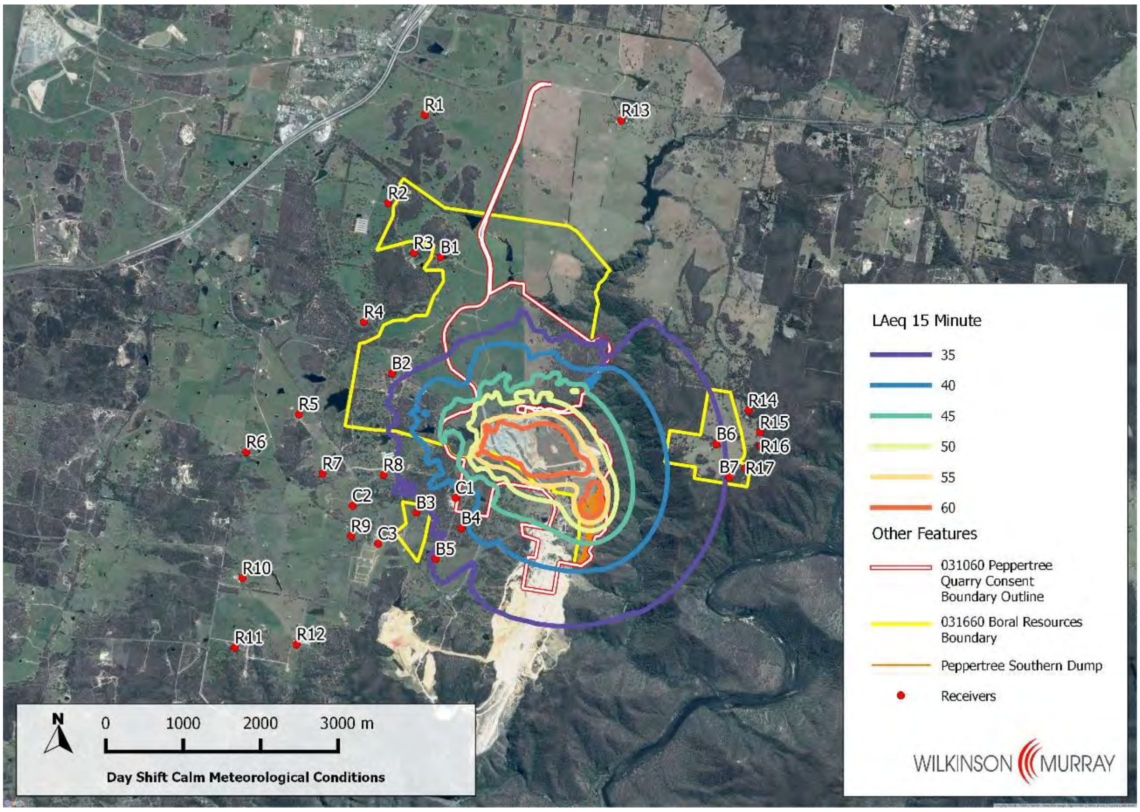

Marulan Mine
31 March 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

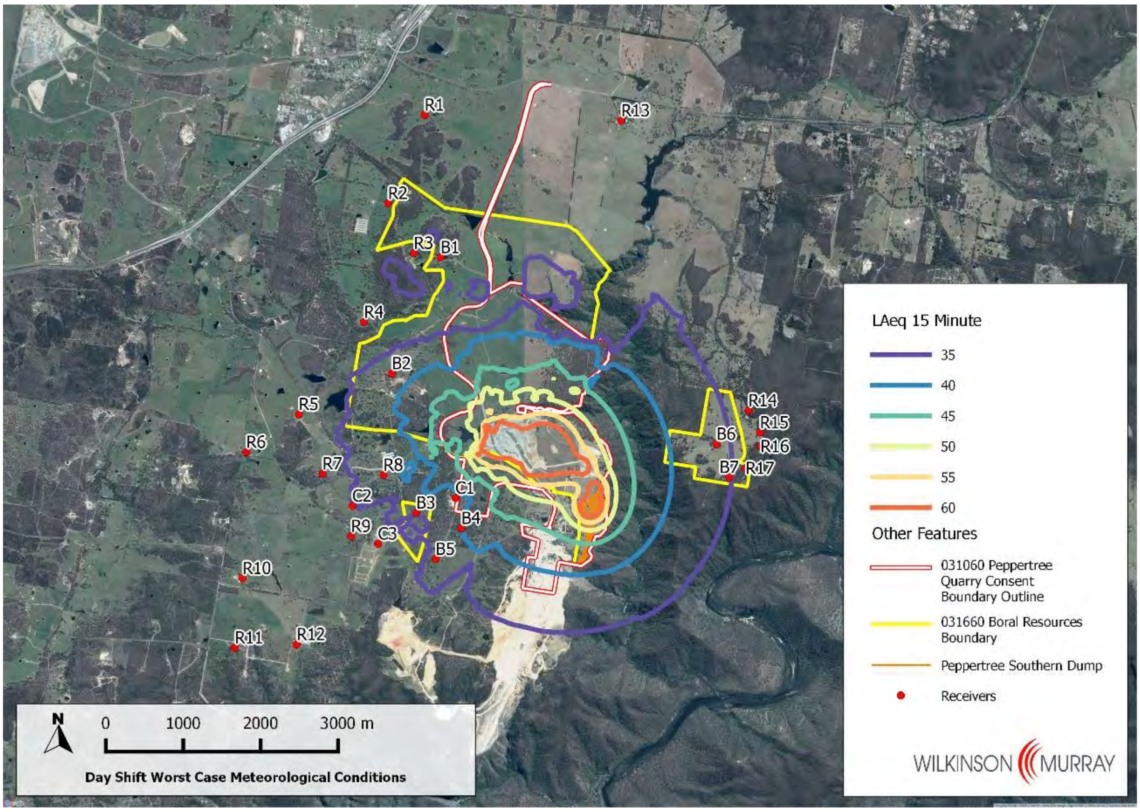

Marulan Mine
1 April 2015
Noise Level, LAeq dBA : Wind Spped m/sx10
Wind Dierction, degrees
Time of Day
B/O Max Level
B/O Min Level
Predicted Level
Wind Speed x 10
Stability
Wind Direction

# APPENDIX B

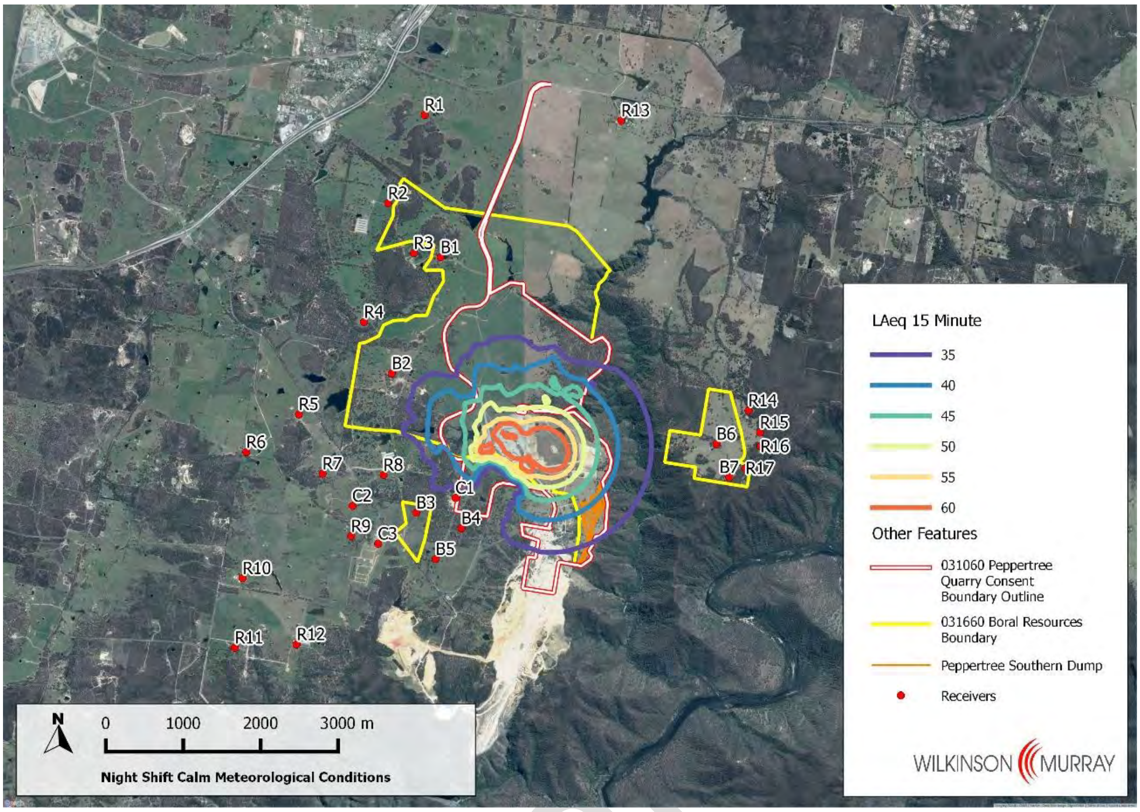
## NOISE CONTOURS

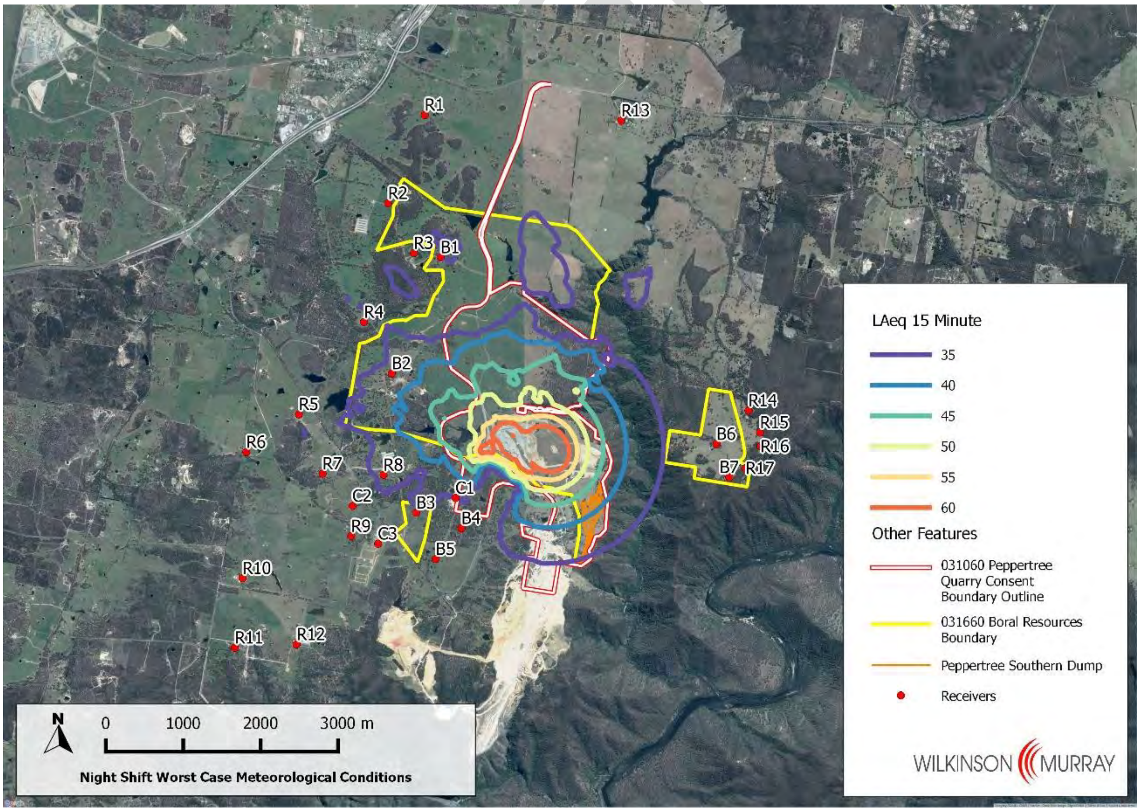
## Day Shift Noise



## Night Shift Noise Contours



# APPENDIX C

## AIR QUALITY IMPACT ASSESSMENT

# APPENDIX C

# AIR QUALITY IMPACT ASSESSMENT

# PEPPERTREE QUARRY

# MODIFICATION 4

Element Environment on behalf of
Boral Resources (NSW) Pty Ltd

11 February 2016

Job Number 14060337

Prepared by

Todoroski Air Sciences Pty Ltd
Suite 2B, 14 Glen Street
Eastwood, NSW 2122
Phone: (02) 9874 2123
Fax: (02) 9874 2125
Email: info@airsciences.com.au

# Air Quality Impact Assessment Peppertree Quarry Modification 4


| | | |
|---|---|---|
| **Author(s)**: | Aleks Todoroski | Philip Henschke |
| **Position**: | Director | Atmospheric Physicist |
| **Signature**: | | |
| **Date**: | 11/02/2016 | 11/02/2016 |


**DOCUMENT CONTROL**

| Report Version | Date | Prepared by | Reviewed by |
|---|---|---|---|
| DRAFT - 001 | 04/09/2015 | P. Henschke | A. Todoroski, N Hattingh & R. Wallace |
| DRAFT - 002 | 02/02/2015 | P. Henschke & A. Todoroski | N. Hattingh |
| FINAL - 001 | 11/02/2015 | P. Henschke | A. Todoroski |
| | | | |
| | | | |
| | | | |

TABLE OF CONTENTS

## LIST OF APPENDICES



## LIST OF TABLES

## LIST OF FIGURES

# 1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Element Environment on behalf of Boral Resources (NSW) Pty Ltd (hereafter referred to as Boral). It presents an assessment of the potential air quality impacts associated with the proposed modifications to the Peppertree Quarry (hereafter referred to as the modification).

The modification essentially seeks to establish an additional overburden emplacement area to the south of the existing approved overburden emplacement area and to extend the current consented operating hours for in-pit works of 7:00am to 7:00pm by six hours to 5:00am to 11:00pm.

To assess the potential air quality impacts associated with the proposed modification, this report incorporates the following aspects:

- A background to the Peppertree Quarry (the Quarry) and description of the modification;
- A review of the existing meteorological and air quality environment surrounding the site;
- A description of the dispersion modelling approach used to assess potential air quality impacts; and,
- Presentation of the predicted results and discussion of the potential air quality impacts.

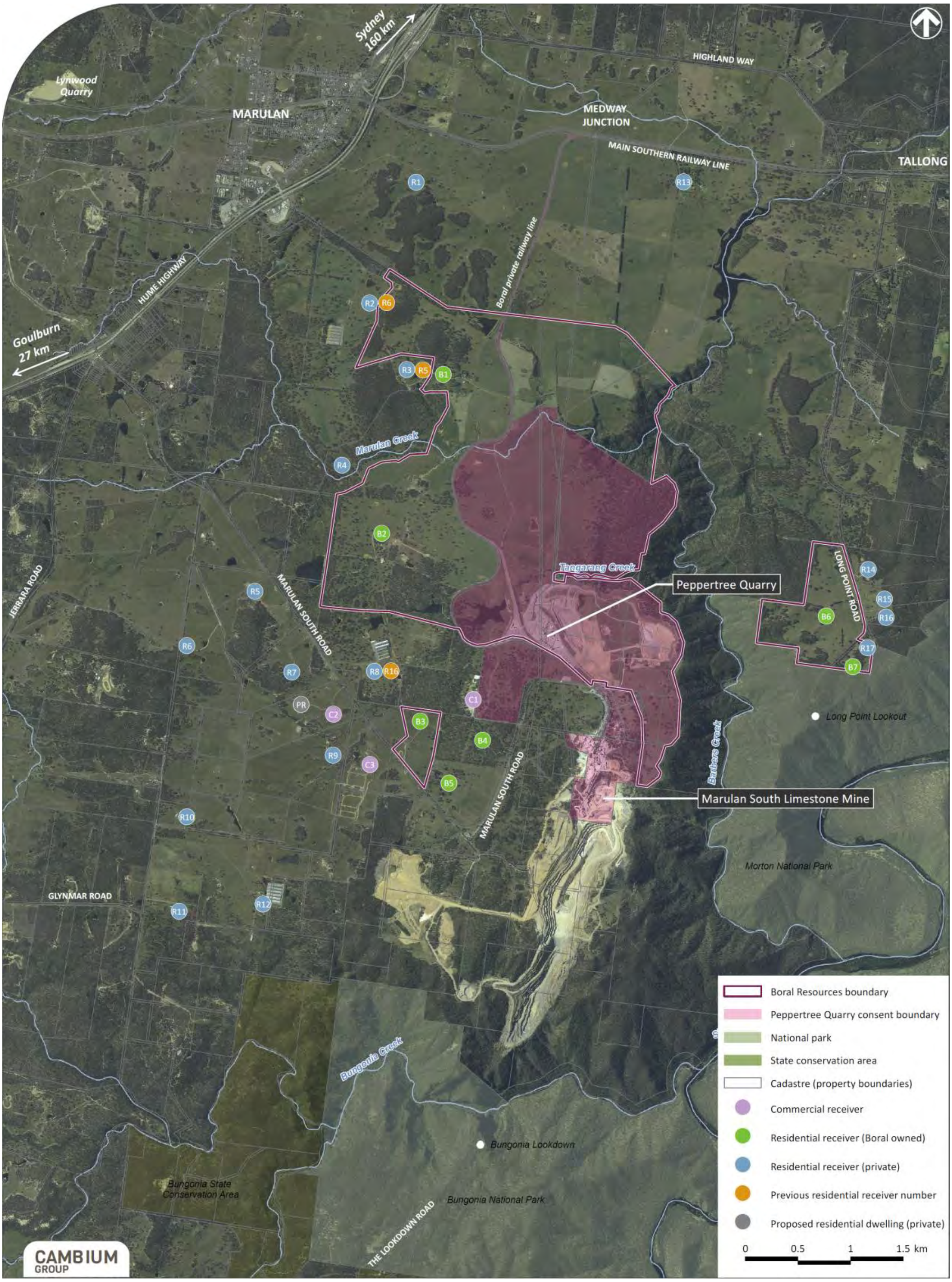
# 2 LOCAL SETTING

The Quarry is located in Marulan South, 10 kilometres (km) southeast of Marulan, 35km east of Goulburn and approximately 175km south-west of Sydney, within the Goulburn Mulwaree Local Government Area (LGA) in the Southern Tablelands of NSW (**Figure 2-1**). Access is via Marulan South Road, which connects the Quarry and Boral's Marulan South Limestone Mine with the Hume Highway approximately 9km to the northwest. Boral's private rail line connects the Quarry and Limestone Mine with the Main Southern Railway approximately 6km to the north.

The Quarry is located on Boral owned land approximately 650 hectares (ha) in size, which includes the Quarry site, approximately 70ha in size, additional granodiorite resources to the south and surrounding land. The site is zoned RU1 - Primary Production zone under the Goulburn Mulwaree Local Environmental Plan (LEP) 2009. Mining and extractive industries are permissible in this zone with consent.

The Quarry is bordered to the south by the Limestone Mine, to the east by Morton National Park and by rural properties to the north and west. Surrounding land uses include mining, grazing, rural properties including an agricultural lime manufacturing facility, fireworks storage facility, turkey farm and rural residential. The main access for these properties is via Marulan South Road. Rural residential properties are also located to the northeast of the mine along Long Point Road. These properties are separated from the mine by the deep Barbers Creek gorge.

**Figure 2-1** also presents the location of the modification in relation to sensitive receivers of relevance to this assessment. **Appendix A** provides a detailed list of all the sensitive receivers assessed in this report. The sensitive receivers surrounding the Quarry are identified as privately-owned residences, Boral-owned residences, commercial receivers and a proposed privately-owned residential dwelling.




Source: **PACT, 2016**

**Figure 2-1: Quarry setting and location**

**Figure 2-2** presents a three-dimensional visualisation of the topography in the general vicinity of the Quarry. The area can be characterised as complex to the southeast with the deep gorges and valleys associated with the Bungonia and Morton National Parks. To the west and northwest the terrain is generally more open and gently undulating. The complex local terrain in this area would have a significant effect on the wind patterns and dispersion of dust.

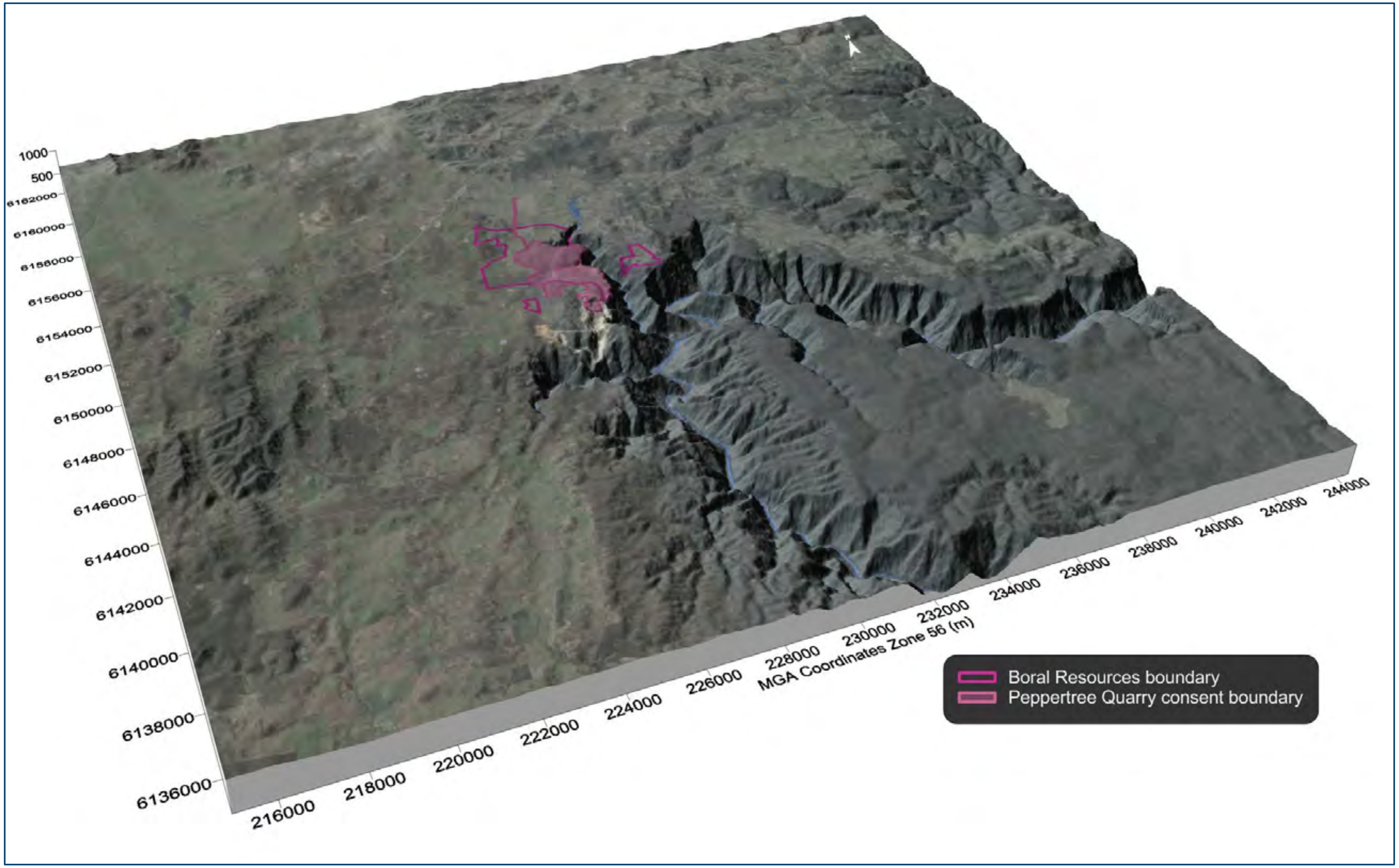



**Figure 2-2: Topography surrounding the Quarry location**

# 3 EXISTING OPERATIONS AND PROPOSED PROJECT DESCRIPTION

## 3.1 Existing operations

The Quarry is approved for extraction of 105 million tonnes of granodiorite over 30 years at an initial rate of 1 - 2 million tonnes per annum (Mtpa) and a maximum rate of 3.5Mtpa. Granodiorite is an intrusive igneous rock suitable for use as a construction and building material. The hard rock aggregates produced at the site are a range of different shapes and sizes for different purposes. Primary production is of concrete and asphalt aggregates (10 millimetres [mm]) and railway ballast (28 - 50 mm) with capacity to produce larger aggregates (>100 mm) for rock armour and gabion baskets. Fines (generally <5 mm) produced during crushing of product are blended with limestone sand from Boral's adjacent Limestone Mine or Penrose Quarry to produce a marketable manufactured sand.

Infrastructure at the Quarry includes a processing plant, rail loop and loading facilities, two water storage dams, an in-pit mobile crushing plant, overburden emplacement areas, noise and visual bunding, product stockpiles, and staff facilities.

Product from the Quarry is transported entirely by rail except in an emergency where it would be transported by road with the written approval of the Secretary of DP&E. The Quarry has approval to transport up to 3.5Mtpa of product from the site. At full production the Quarry will operate up to four trains per day which will transport product north to the Sydney market and other customers. In addition, the Limestone Mine currently operates up to six trains per day transporting product north to Berrima and Maldon and east to Port Kembla.

Trains to the Quarry and the Limestone Mine access Boral's private rail line from the Main Southern Railway at the Medway Junction. The rail line is mostly single track with a 1 km length of triple line track used for shunting and train loading. A rail loop has been constructed at the Quarry for separation of rail movements on the rail line between the two Boral sites. Rail loading facilities were also established on the rail loop adjacent to the Quarry's processing plant.

Loading of product from the Quarry onto trains and train movements occur 24 hours, seven days a week. This enables train trips on the Main Southern Railway to be scheduled away from peak commuter times.

## 3.2 Proposed modifications

The Quarry currently has approval to operate in-pit activities for 12 hours per day between 7am and 7pm. In-pit activities include:

- Drilling and blasting;
- Extraction;
- Delivering blast rock to the mobile crusher;
- Crushing of rock;
- Conveying crushed rock out of the pit.

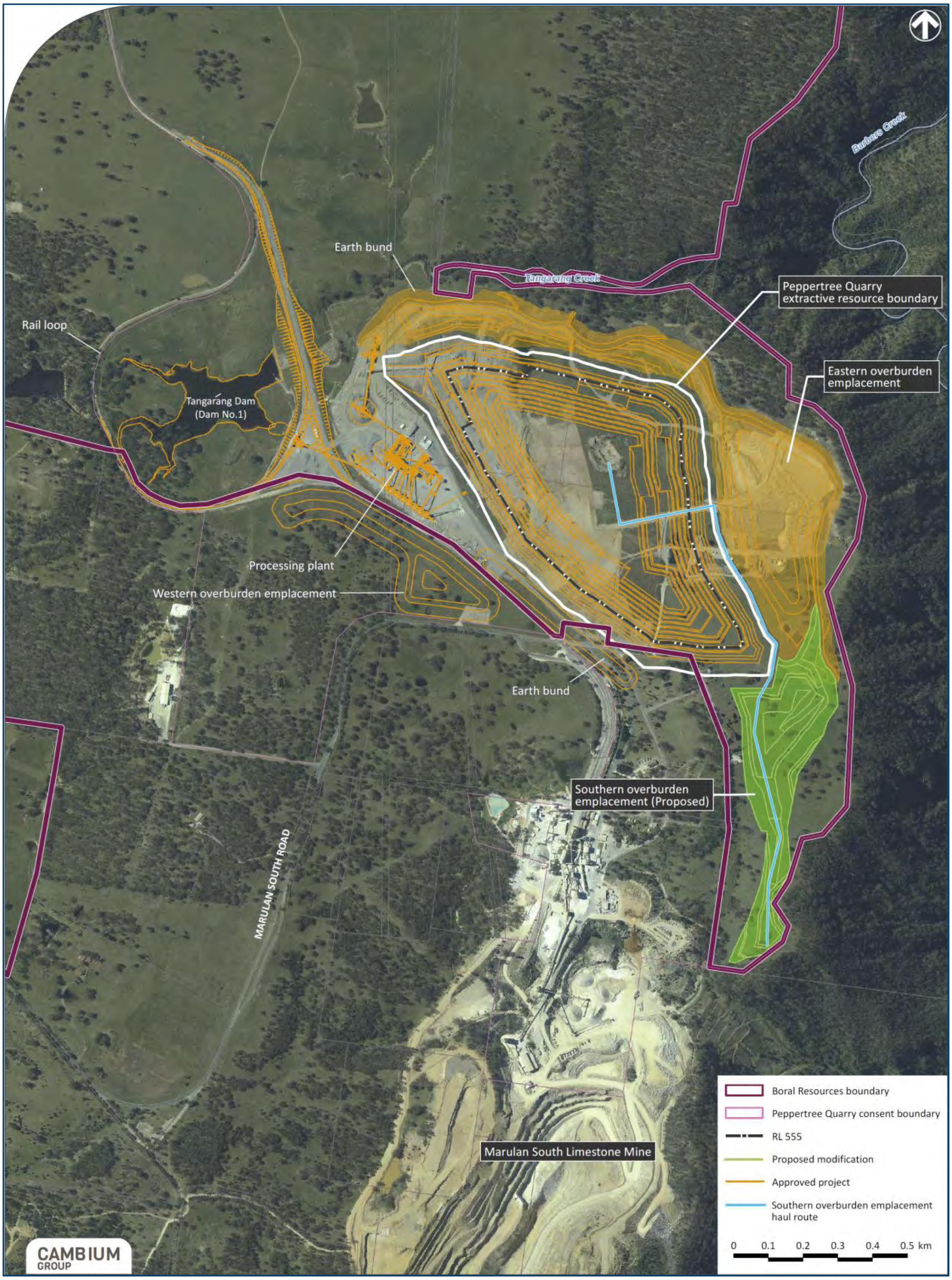
Boral is seeking to extend these in-pit operating hours by 6 hours per day in order to account for scalping of overburden material in early phases of pit development and meet annual production volumes up to the approved limit of 3.5Mtpa. Boral are proposing to extend the approved 7am - 7pm in-pit operating hours to 5:00am – 11:00pm.

Blasting will however continue within the current approved blasting hours of 9am - 5pm Monday to Saturday.

Overburden emplacement at the Quarry is currently approved within noise bunds located along the northern and eastern boundaries of the site, an emplacement area to the east of the approved quarry pit and a western emplacement area and noise bund to the west of the Quarry across Boral's private railway line. Remaining overburden was proposed to be emplaced within the south pit of Boral's adjoining Limestone Mine.

The noise bunds were completed during construction of the Quarry, and the eastern overburden emplacement area will reach capacity in early 2016. Mine planning for the Limestone Mine has ruled out emplacement within the south pit. The Limestone Mine, under its forthcoming development application, is seeking to hold 5 million cubic metres (approximately 13Mt) of overburden for the Quarry, however this will not be approved until late 2016. As an interim measure, Boral is seeking to place approximately 1 million cubic metres of overburden within a new overburden emplacement to the south of the approved 30-year quarry pit (refer to **Figure 3-1**). Overburden stripped from the pit will be transported by trucks along the most direct haul route possible (refer to **Figure 3-1**). This new overburden emplacement area will be needed in early 2016 and will take approximately 12 months to establish.

The proposed new overburden emplacement will be located within the south-eastern extent of the future hard rock (granodiorite) resource, which extends south from the existing Quarry pit, to the northern end of the Limestone Mine's north pit. A significant granodiorite resource also exists on Boral's lands to the north of the existing Quarry pit, extending northwards from Tangarang Creek. The proposed southern overburden emplacement will not sterilise the resource as Boral will relocate this southern emplacement in the future should the southern granodiorite resource need to be accessed. Although the southern overburden emplacement may be relocated in the future, this is unlikely to be required for at least the next 25 years. The proposed emplacement will therefore be landscaped and rehabilitated in accordance with the existing Peppertree Quarry Landscape and Rehabilitation Management Plan.




Source: **PACT, 2016**

**Figure 3-1: Indicative plan for the modification**

# 4 AIR QUALITY ASSESSMENT CRITERIA

## 4.1 Preamble

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the modification and the applicable air quality criteria.

## 4.2 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely $PM_{10}$, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

Quarrying and mining activities generate particles in all the above size categories. The great majority of the particles generated are due to the abrasion or crushing of rock and general disturbance of dusty material. These particulate emissions will generally be larger than 2.5µm, as sub-2.5µm particles are usually generated through combustion processes or as secondary particles formed from chemical reactions rather than through mechanical processes that dominate emissions on quarry and mine sites.

Combustion particulate matter can be more harmful to human health as the particles have the ability to penetrate deep into the human respiratory system, due to their size and can be comprised of acidic and carcinogenic substances.

A study of the particle size distribution from mine dust sources in 1986 conducted by the State Pollution Control Commission (SPCC) of 120 samples found that $PM_{2.5}$ comprised approximately 4.7 percent (%) of the TSP, and $PM_{10}$ comprised approximately 39.1% of the TSP in the samples (**SPCC, 1986**). The emissions of $PM_{2.5}$ occurring from mining activities are small in comparison to the total dust emissions and in practice, the concentrations of $PM_{2.5}$ in the vicinity of mining dust sources are likely to be low.

Particulate matter, typically in the upper size range, that settle from the atmosphere and deposit on surfaces is characterised as deposited dust. The deposition of dust on surfaces is considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

### 4.2.1 New South Wales Environment Protection Authority impact assessment criteria

**Table 4-1** summarises the air quality goals that are relevant to this study as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**NSW DEC, 2005**).

The air quality goals for total impact relate to the total dust burden in the air and not just the dust from the Quarry site. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

**Table 4-1: NSW EPA air quality impact assessment criteria**

| Pollutant | Averaging Period | Impact | Criterion |
|---|---|---|---|
| TSP | Annual | Total | 90µg/m³ |
| $PM_{10}$ | Annual | Total | 30µg/m³ |
| | 24-hour | Total | 50µg/m³ |
| Deposited dust | Annual | Incremental | 2g/m²/month |
| | | Total | 4g/m²/month |

Source: NSW DEC, 2005
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

### 4.2.2 National Environment Protection (Ambient Air Quality) Measure

The National Environment Protection Council (NEPC) Act 1994 and subsequent amendments define the National Environment Protection Measures (NEPM) as instruments for setting environmental objectives in Australia.

The Ambient Air Quality NEPM specifies national ambient air quality standards and goals for air pollutants including $PM_{10}$ and $PM_{2.5}$. The standard for $PM_{10}$ is outlined in **Table 4-2**. It is noted that the NEPM permits five days annually above the 24-hour average $PM_{10}$ criterion to allow for bush fires and similar events.

**Table 4-2: Standard for $PM_{10}$ concentrations**

| Pollutant | Averaging Period | Maximum concentration | Maximum allowable exceedances |
|---|---|---|---|
| $PM_{10}$ | 24 hour | 50µg/m³ | 5 days a year |

Source: NEPC, 2003

The NSW EPA currently do not have impact assessment criteria for $PM_{2.5}$ concentrations. The Ambient Air Quality NEPM applies advisory reporting standards for $PM_{2.5}$ to gather sufficient data nationally to facilitate a review. The advisory reporting standards for $PM_{2.5}$ are outlined in **Table 4-3**.

As with each of the NEPM goals, these apply to the average, or general exposure of a population, rather than to "hot spot" locations.

**Table 4-3: Advisory reporting standards for $PM_{2.5}$ concentrations**

| Pollutant | Averaging Period | Advisory Reporting Standard |
|---|---|---|
| $PM_{2.5}$ | 24 hour | 25µg/m³ |
| | Annual | 8µg/m³ |

Source: NEPC, 2003

### 4.2.3 NSW Voluntary Land Acquisition and Mitigation Policy

Part of the NSW Voluntary Land Acquisition and Mitigation Policy dated 15 December 2014 and gazetted on 19 December 2014 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-4** at any residence or workplace. [1]

**Table 4-4: Particulate matter mitigation criteria**

| Pollutant | Averaging period | Mitigation Criterion | | Impact Type |
|---|---|---|---|---|
| $PM_{10}$ | Annual | 30µg/m³* | | Human health |
| $PM_{10}$ | 24 hour | 50µg/m³** | | Human health |
| TSP | Annual | 90µg/m³* | | Amenity |
| Deposited dust | Annual | 2g/m²/month** | 4g/m²/month* | Amenity |

Source: NSW Government (2014)

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

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-5** at any residence, workplace or on more than 25% of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

**Table 4-5: Particulate matter acquisition criteria**

| Pollutant | Averaging period | Acquisition Criterion | | Impact Type |
|---|---|---|---|---|
| $PM_{10}$ | Annual | 30µg/m³* | | Human health |
| $PM_{10}$ | 24 hour | 50µg/m³** | | Human health |
| TSP | Annual | 90µg/m³* | | Amenity |
| Deposited dust | Annual | 2g/m²/month** | 4g/m²/month* | Amenity |

Source: NSW Government (2014)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).
**Incremental impact (i.e. increase in concentrations due to the development alone), with up to 5 allowable exceedances of the criteria over the life of the development.

## 4.3 Other air pollutants

Emissions of carbon monoxide, sulphur dioxide and nitrogen dioxide will also potentially arise from the quarrying activities and are typically associated with combustion emissions from the diesel powered equipment. These emissions are generally too low and widely dispersed to generate any significant off-site concentrations and have not been assessed further in this report.

Carbon monoxide and nitrogen dioxide can also arise from the blasting activities. The amount of fume produced by a blast can vary significantly depending on a number of factors that affect the quality of the detonation (such as soft ground, subsurface moisture, length of dwell time etc.). Relative to blasting activities in large open cut mineral mines, hard rock quarry operations inherently have less variability in the influencing factors and as a result the level of fume from such operations is generally consistent.

As the nature of the blasting would be of a relatively small scale, potential air quality impacts associated with this activity can be minimised with good blast practices such as restricting the size of each blast, ensuring blasts only occur during good dispersion conditions and when winds are blowing away from the sensitive receivers.

[1] Applies where any exceedance would be unreasonably detrimental to workers health or carrying out of the business.

In this context, as the required blasting willould be of a small scale with inherently low scope for impact, would be infrequent, and be readily managed by selecting a suitable blast time during the day, no impacts are expected to arise and have not been assessed further in this report. It is also noted that the approach to blasting at the Quarry will remain unchanged as a result of the proposed modification.

# 5 EXISTING ENVIRONMENT AND AIR QUALITY MANAGEMENT

This section describes the existing environment including the climate and ambient air quality in the general area surrounding the Quarry.

## 5.1 Local climate

The nearest long-term climatic data are available from the Bureau of Meteorology (BoM) weather station at Goulburn Airport Automatic Weather Station (AWS) (Site No. 070330). These data were analysed to characterise the climate in the general proximity of the Quarry. The Goulburn Airport AWS is located approximately 25km west-southwest of the Quarry. **The data** indicate that January is the hottest month with a mean maximum temperature of 27.8 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 0.3°C.

Rainfall peaks during the summer and the month of June. The data indicate that June is the wettest month with an average rainfall of 58.6 millimetres (mm) over 7.3 days and April is the driest month with an average rainfall of 26.5mm over 4.0 days.

Humidity levels exhibit variability and seasonal flux across the year. Mean 9am humidity levels range from 65% in October and December to 88% in June. Mean 3pm humidity levels range from 39% in December to 63% in June.

Wind speeds have a generally similar spread between the 9am and 3pm conditions. Mean 9am wind speeds range from 12.2 kilometres per hour (km/h) in March to 19.8km/h in September. Mean 3pm wind speeds range from 19.8km/h in March to 26.5km/h in August.

Table 5-1 and **Figure 5-1** present a summary of data from the Goulburn Airport AWS weather station collected over an 18 to 24-year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 27.8 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 0.3°C.

Rainfall peaks during the summer and the month of June. The data indicate that June is the wettest month with an average rainfall of 58.6 millimetres (mm) over 7.3 days and April is the driest month with an average rainfall of 26.5mm over 4.0 days.

Humidity levels exhibit variability and seasonal flux across the year. Mean 9am humidity levels range from 65% in October and December to 88% in June. Mean 3pm humidity levels range from 39% in December to 63% in June.

Wind speeds have a generally similar spread between the 9am and 3pm conditions. Mean 9am wind speeds range from 12.2 kilometres per hour (km/h) in March to 19.8km/h in September. Mean 3pm wind speeds range from 19.8km/h in March to 26.5km/h in August.

**Table 5-1: Monthly climate statistics summary – Goulburn Airport AWS**

| Parameter | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Temperature** | | | | | | | | | | | | |
| Mean max. temperature (ºC) | 27.8 | 26.2 | 23.6 | 19.8 | 15.9 | 12.4 | 11.7 | 13.5 | 16.5 | 19.7 | 22.9 | 25.6 |
| Mean min. temperature (ºC) | 12.6 | 12.7 | 9.9 | 5.6 | 2.5 | 1.4 | 0.3 | 0.5 | 3.1 | 5.1 | 8.2 | 10.6 |
| **Rainfall** | | | | | | | | | | | | |
| Rainfall (mm) | 47.2 | 54.7 | 39.7 | 26.5 | 32.6 | 58.6 | 33.1 | 38.9 | 46.2 | 51.2 | 54.5 | 58.0 |
| Mean No. of rain days (≥1mm) | 4.6 | 5.1 | 4.8 | 4.0 | 4.4 | 7.3 | 6.1 | 6.0 | 7.0 | 6.1 | 6.0 | 5.8 |
| **9am conditions** | | | | | | | | | | | | |
| Mean temperature (ºC) | 19.0 | 17.8 | 15.1 | 12.7 | 8.8 | 5.9 | 5.0 | 6.7 | 10.8 | 13.9 | 15.3 | 17.7 |
| Mean relative humidity (%) | 69 | 78 | 81 | 78 | 85 | 88 | 87 | 81 | 72 | 65 | 69 | 65 |
| Mean wind speed (km/h) | 15.5 | 13.8 | 12.2 | 12.6 | 12.5 | 13.3 | 13.5 | 17.1 | 19.8 | 19.4 | 17.5 | 16.8 |
| **3pm conditions** | | | | | | | | | | | | |
| Mean temperature (ºC) | 26.1 | 24.9 | 22.5 | 18.9 | 14.8 | 11.3 | 10.5 | 12.2 | 15.1 | 18.2 | 21.1 | 24.2 |
| Mean relative humidity (%) | 41 | 45 | 46 | 46 | 54 | 63 | 61 | 52 | 50 | 46 | 45 | 39 |
| Mean wind speed (km/h) | 22.2 | 21.4 | 20.5 | 19.8 | 20.7 | 22.2 | 23.2 | 26.5 | 26.4 | 25.3 | 23.7 | 23.0 |

Source: **Bureau of Meteorology, 2015 – accessed 24 June 2015**

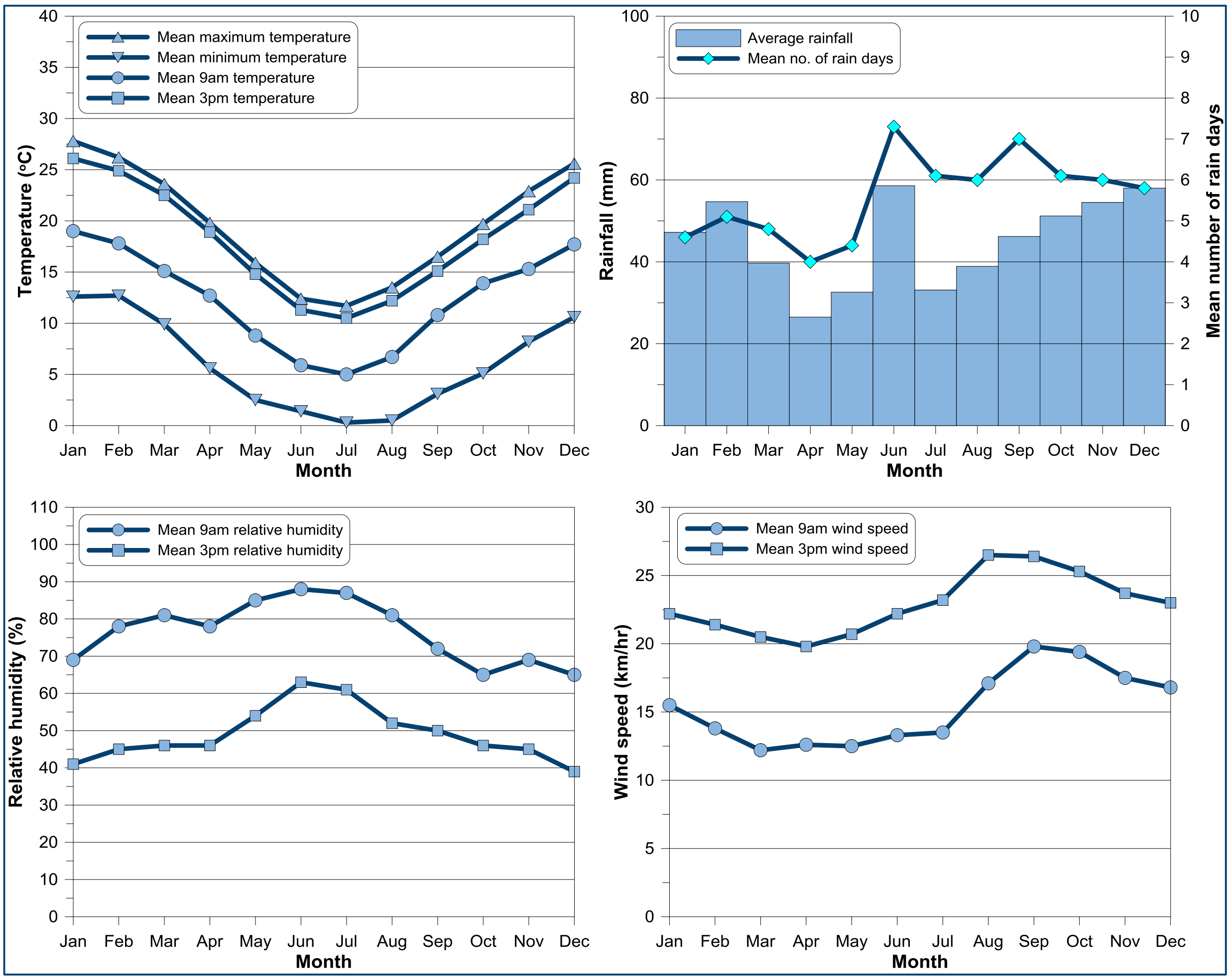



**Figure 5-1: Monthly climate statistics summary - Goulburn Airport AWS**

## 5.2 Local meteorological conditions

The Quarry and the neighbouring Marulan South Limestone Mine both operate 10-metre (m) high automatic weather stations to assist with the environmental management of site operations. The location of these stations is shown in **Figure 5-2**.

Annual and seasonal windroses prepared from data collected during the 2014 calendar period are presented in **Figure 5-3** and **Figure 5-4** for the Marulan South Limestone Mine and Quarry weather stations respectively.

The annual windroses from both stations tend to indicate that the typical wind flow of the area is on a west to east axis with the strongest winds originating from the west. The Marulan station data show a greater spread of winds ranging from the west-southwest to the north-northwest relative to the Peppertree station which only has limited winds from the northeast. This may be due to the different positioning of the stations, with the Marulan weather station situated near a dense line of vegetation to the west of the station, whereas the Quarry site is less obstructed with cleared land to the west.

In summer the winds predominately occur from the east and east-southeast at both stations. The autumn and spring wind distributions share similarities with the annual distributions with winds typically ranging from the west to the northwest and east. During winter, the Marulan weather station records varied winds from the west and south and south-southeast. In comparison the Peppertree weather station shows the dominant winds from the west with fewer winds from the other directions.

Overall, the wind distribution patterns of the stations are generally as expected of the local area considering the siting of the stations in relation to the local features such as terrain and vegetation.

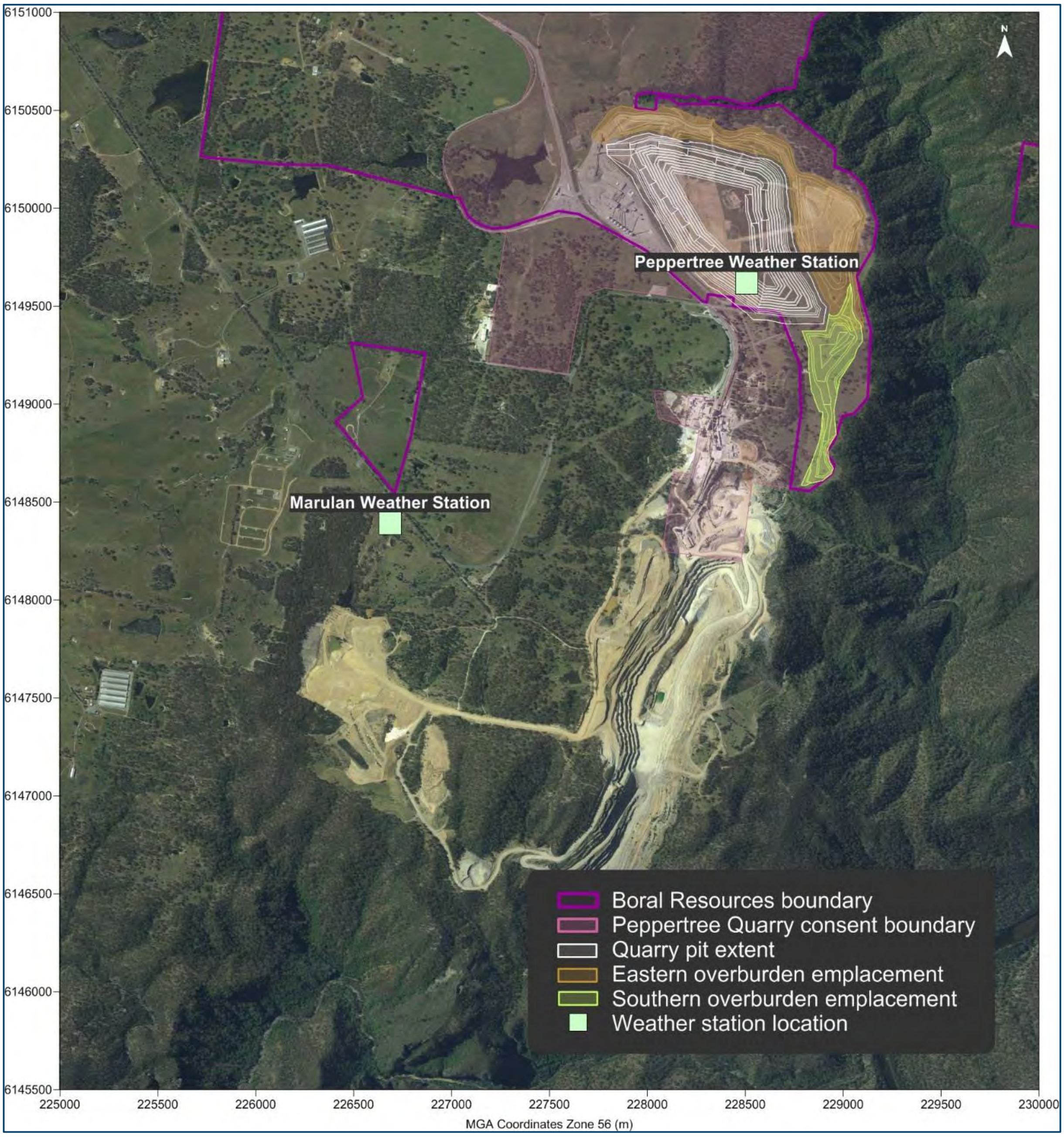



**Figure 5-2: Weather station locations**

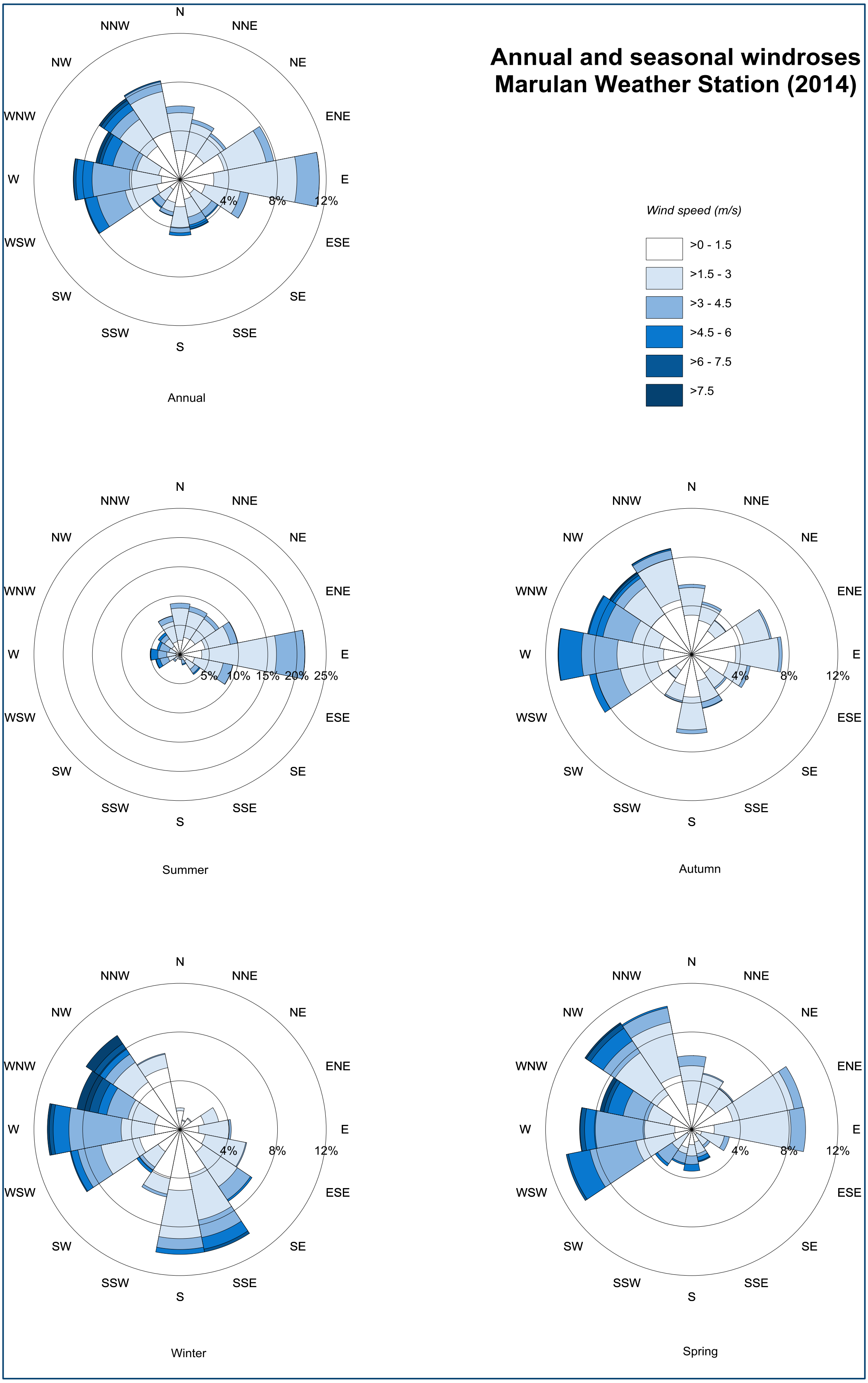



**Figure 5-3: Annual and seasonal windroses for the Marulan weather station (2014)**

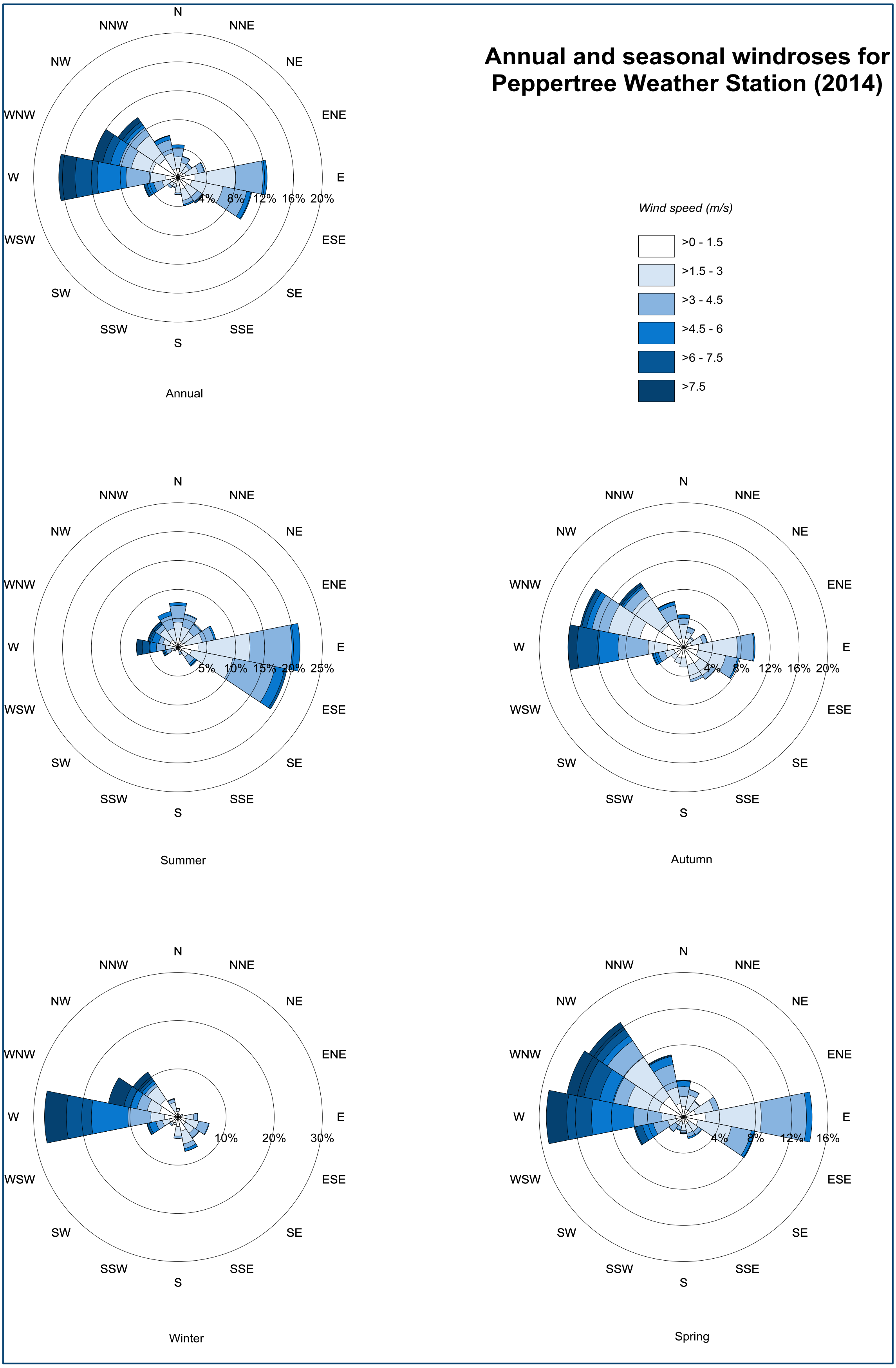



**Figure 5-4: Annual and seasonal windroses for the Peppertree weather station (2014)**

## 5.3 Local air quality monitoring

The main sources of air emissions in the wider area of the Quarry include extractive industries, commercial and industrial operations, agricultural activities, emissions from local anthropogenic activities (such as motor vehicle exhaust, dust from dirt roads, and domestic wood heaters) and various other rural activities.

This section reviews the available ambient monitoring data collected as part of the Marulan South Limestone Mine and Quarry ambient air quality monitoring program between 2011 and 2015 to characterise the existing background levels of the surrounding area.

In addition to these data, the results from air quality monitors operated by the Lynwood Quarry (**Holcim, 2015**) located approximately 10km north-west of the Quarry and the NSW EPA monitors at Bargo and Wollongong located approximately 73km north-east and 87km east-northeast of the Project respectively, have also been reviewed.

### 5.3.1 Air quality monitoring network description

The air quality monitors operated as part of the Marulan South Limestone Mine and Quarry air quality monitoring network include two High Volume Air Samplers (HVAS) measuring either TSP or $PM_{10}$ and six dust deposition gauges.

The Lynwood Quarry operates two HVAS stations measuring $PM_{10}$ and eight dust deposition gauges. The NSW EPA monitors ambient levels of $PM_{10}$, $NO_2$, and $SO_2$ at Bargo and Wollongong.

**Table 5-2** lists the monitoring stations reviewed in this section and **Figure 5-5** presents the approximate locations of these monitors. **Appendix B** provides a summary of selected monitoring data reviewed in this assessment.

**Table 5-2: Summary of ambient monitoring stations**

| Monitoring site ID | Type | Monitoring data analysed |
|---|---|---|
| HVAS – $PM_{10}$ (Marulan/Peppertree) | HVAS - $PM_{10}$ | July 2011 - April 2015 |
| HVAS - TSP (Marulan/Peppertree) | HVAS - TSP | July 2011 - April 2015 |
| Sub Station (Marulan) | Dust Gauge | January 2011 – March 2015 |
| D2 (Marulan/Peppertree) | Dust Gauge | July 2011 – April 2015 |
| Freddie's Hill (Marulan) | Dust Gauge | January 2011 – March 2015 |
| Store Paddock (Marulan) | Dust Gauge | January 2011 – March 2015 |
| D1 (Peppertree) | Dust Gauge | July 2011 – April 2015 |
| D3 (Peppertree) | Dust Gauge | July 2011 – April 2015 |
| Site 1 (Lynwood) | HVAS - $PM_{10}$ | July 2011 - April 2015 |
| Site 2 (Lynwood) | HVAS - $PM_{10}$ | July 2011 - April 2015 |
| DD1 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| DD2 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| DD3 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| DD4 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| DD5 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| DD6 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| DD7 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| DD8 (Lynwood) | Dust Gauge | January 2011 – April 2015 |
| Bargo (NSW EPA) | $PM_{10}$, $NO_2$ & $SO_2$ | January 2011 – April 2015 |
| Wollongong (NSW EPA) | $PM_{10}$, $NO_2$ & $SO_2$ | January 2011 – April 2015 |

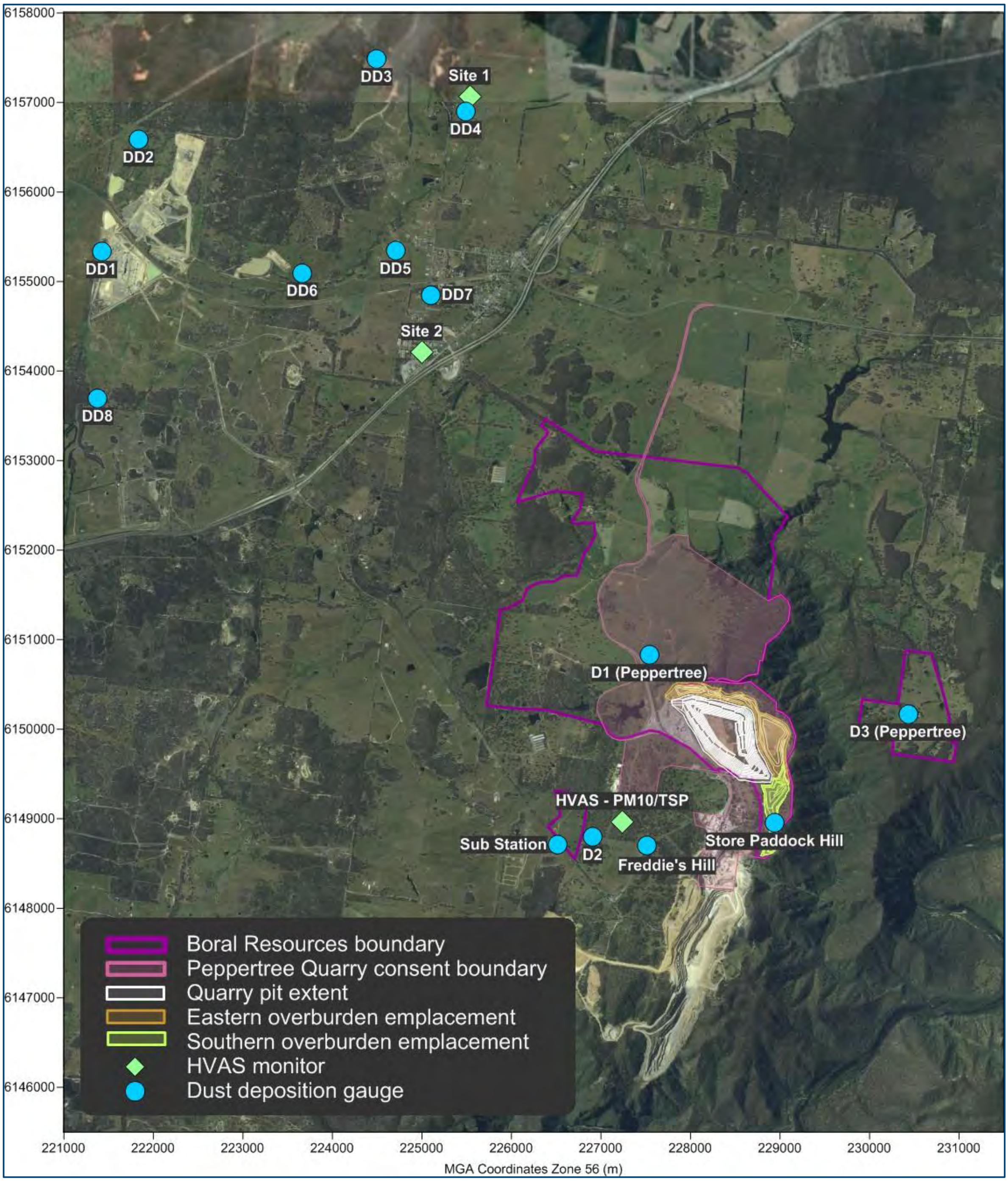



**Figure 5-5: Monitoring locations**

### 5.3.2 $PM_{10}$ monitoring

A summary of the results from the HVAS monitoring stations during 2011 to 2015 is presented in **Table 5-3** and **Figure 5-6**. The monitoring results in **Table 5-3** indicate that annual average $PM_{10}$ levels at these monitors are below the criteria of 30µg/m³ at all sites, the maximum 24-hour average $PM_{10}$ concentrations were on occasion above the criteria of 50µg/m³ during the monitoring period at the Marulan HVAS monitor.

The monitoring data indicate that levels are typically higher at the Marulan HVAS monitor compared to the Lynwood monitors. This may be due to the location of the Marulan HVAS monitor which is positioned close to mining activities that would influence the results. It is noted that the Site 2 – Lynwood monitor was subject to some technical difficulties and as a result recorded low levels (i.e. annual average levels less than 10µg/m³) (**Holcim, 2015**).

It can be seen from **Figure 5-6** that $PM_{10}$ concentrations recorded at the monitoring stations are nominally highest in the spring and summer months with the warmer weather raising the potential for drier ground elevating the occurrence of windblown dust, bushfires and pollen levels.

**Table 5-3: $PM_{10}$ levels from HVAS monitoring (µg/m³)**

| Year | Annual average | | | | Maximum 24-hour average | | | |
|---|---|---|---|---|---|---|---|---|
| | HVAS - Marulan | Site 1 - Lynwood | Site 2 - Lynwood | Criteria | HVAS - Marulan | Site 1 - Lynwood | Site 2 - Lynwood | Criteria |
| 2011(1) | 12.7 | 7.3 | 3.5 | **30** | 37.5 | 20.5 | 8.7 | **50** |
| 2012 | 16.2 | 8.0 | 3.9 | **30** | 70.4 | 38.1 | 11.8 | **50** |
| 2013 | 13.8 | 10.0 | 7.5 | **30** | 42.2 | 36.7 | 11.3 | **50** |
| 2014 | 17.9 | 7.9 | 8.8 | **30** | 50.5 | 20.6 | 18.2 | **50** |
| 2015(2) | 20.5 | 13.5 | 6.5 | **30** | 33.2 | 31.9 | 14.4 | **50** |

(1)Data available from July 2011
(2)Data available till April 2015

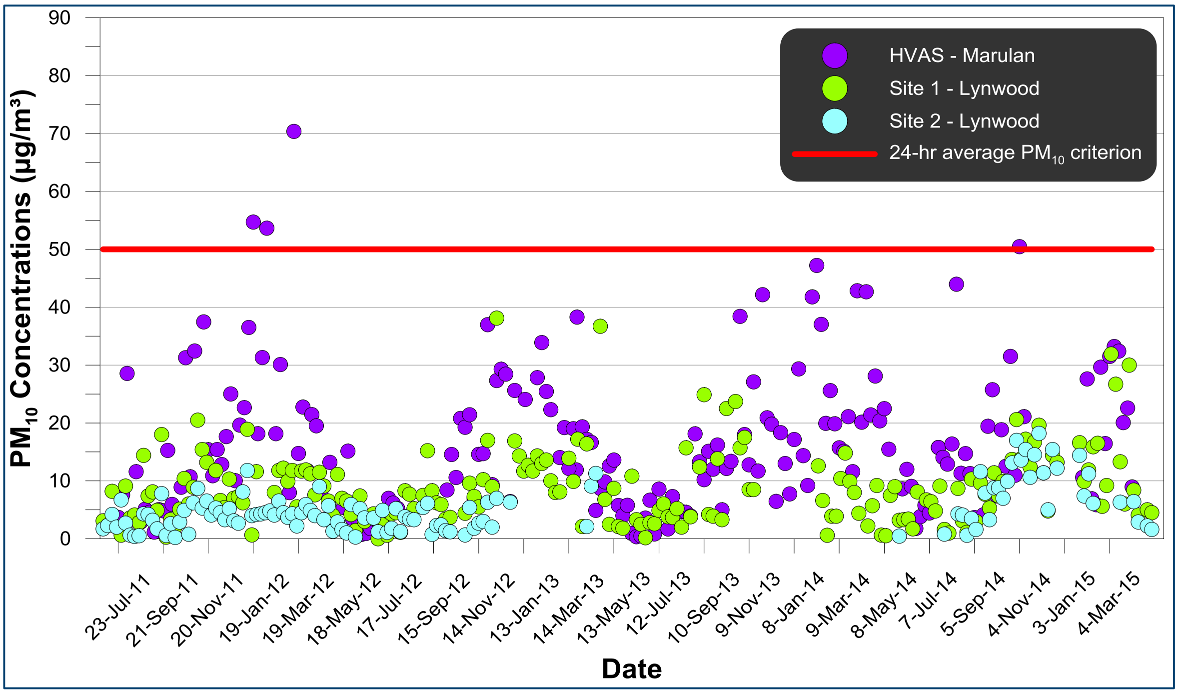



**Figure 5-6: HVAS 24-hour average $PM_{10}$ concentrations**

A summary of the available data from January 2011 to April 2015 at the NSW EPA Bargo and Wollongong monitoring stations is presented in **Table 5-4**. Measured 24-hour average concentrations are presented graphically in **Figure 5-8**.

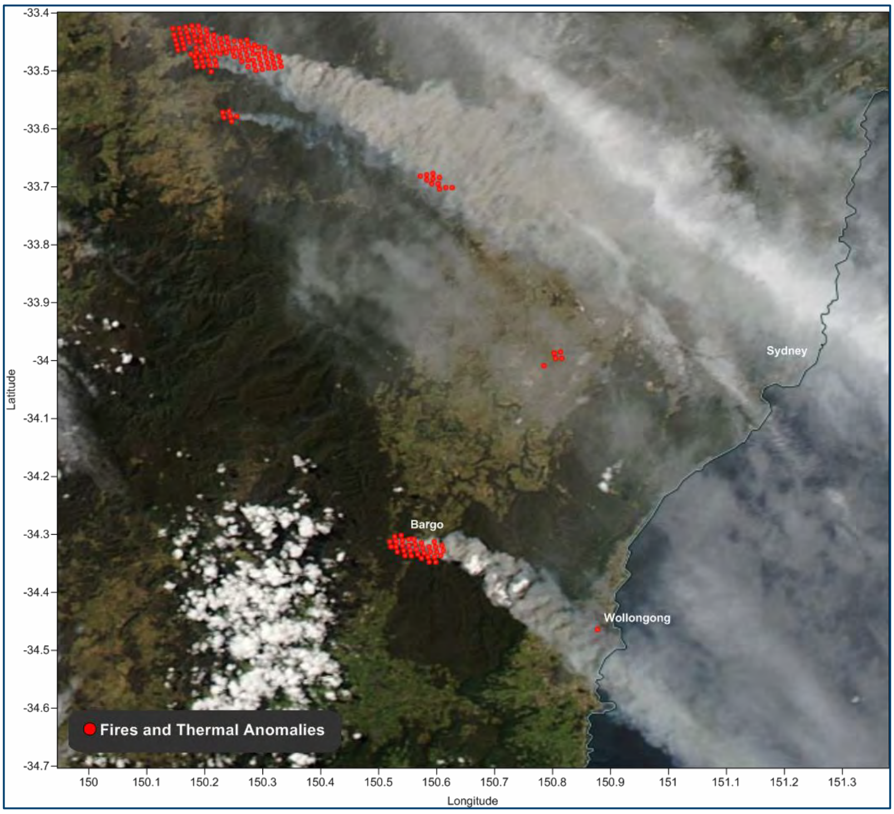
A review of the data in **Table 5-4** indicates that the annual average $PM_{10}$ concentrations recorded at the Bargo and Wollongong monitoring stations were below the relevant criterion of $30\mu g/m^3$ for all years reviewed indicating that air quality can be considered to be generally good.

The recorded maximum 24-hour average $PM_{10}$ concentrations were found to exceed the relevant criterion of $50\mu g/m^3$ at times during the review period. Most notable is the recorded maximum 24-hour average at the Bargo monitoring station on 17 October 2013 with a level of $208.9\mu g/m^3$. A large-scale bushfire event occurring nearby is identified as the likely main contributor to this reading. **Figure 5-7** presents satellite imagery which indicates the fire event and large smoke plumes affecting the area. The Wollongong monitor was also affected by this bushfire period which lasted for several days.

Table 5-4: Summary of $PM_{10}$ levels from NSW EPA Bargo and Wollongong monitors ($\mu g/m^3$)

| Year | Annual Average | | Maximum 24-hour average | |
|---|---|---|---|---|
| | Bargo | Wollongong | Bargo | Wollongong |
| 2011 | 12.9 | 17.0 | 89.7 | 48.5 |
| 2012 | 14.3 | 18.0 | 45.2 | 47.5 |
| 2013 | 15.3 | 17.6 | 208.9 | 93.8 |
| 2014 | 14.5 | 17.7 | 50.8 | 45.3 |
| 2015(1) | 13.4 | 15.7 | 27.5 | 37.8 |

(1)Data available till April 2015




Source: **NASA, 2015**

Figure 5-7: Satellite imagery of 17 October 2013

**Figure 5-8** shows a seasonal variation in the $PM_{10}$ levels recorded at the Bargo and Wollongong monitors, with higher levels during the warmer months. Bargo has recorded four days and Wollongong six days above the 24-hour average criterion during the period reviewed, all of which occur in spring and summer.

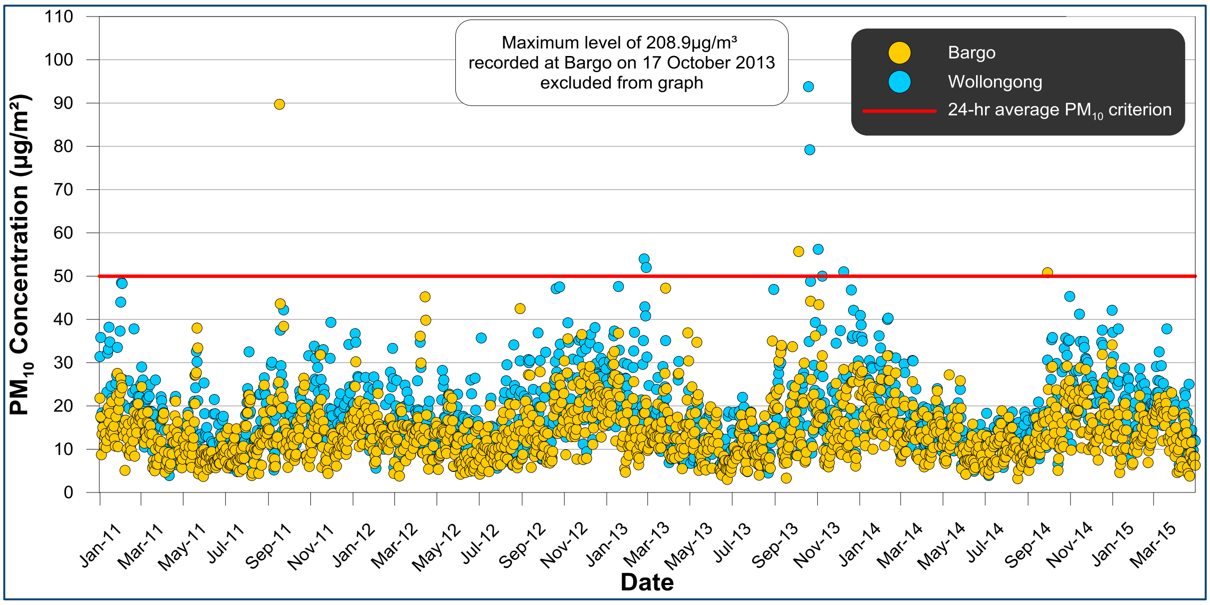



**Figure 5-8: 24-hour average $PM_{10}$ levels at Bargo and Wollongong**

### 5.3.3 TSP monitoring

The available TSP monitoring data collected between 2011 and 2015 are summarised in **Table 5-5** and presented in **Figure 5-9.** The monitoring data summarised in **Table 5-5** indicate that the annual average TSP concentrations at the Marulan HVAS monitor were below the criterion of 90µg/m$^3$.

**Figure 5-9** shows that the 24-hour average TSP concentrations follow a similar trend to the $PM_{10}$ monitoring data as expected, with generally higher levels occurring during the spring and summer months.

**Table 5-5: TSP levels from HVAS monitoring (µg/m³)**

| Year | Annual average | Criteria |
|---|---|---|
| | HVAS - Marulan | |
| 2011(1) | 32.1 | **90** |
| 2012 | 31.8 | **90** |
| 2013 | 28.3 | **90** |
| 2014 | 39.5 | **90** |
| 2015(2) | 52.0 | **90** |

(1)Data available from July 2011
(2)Data available till April 2015

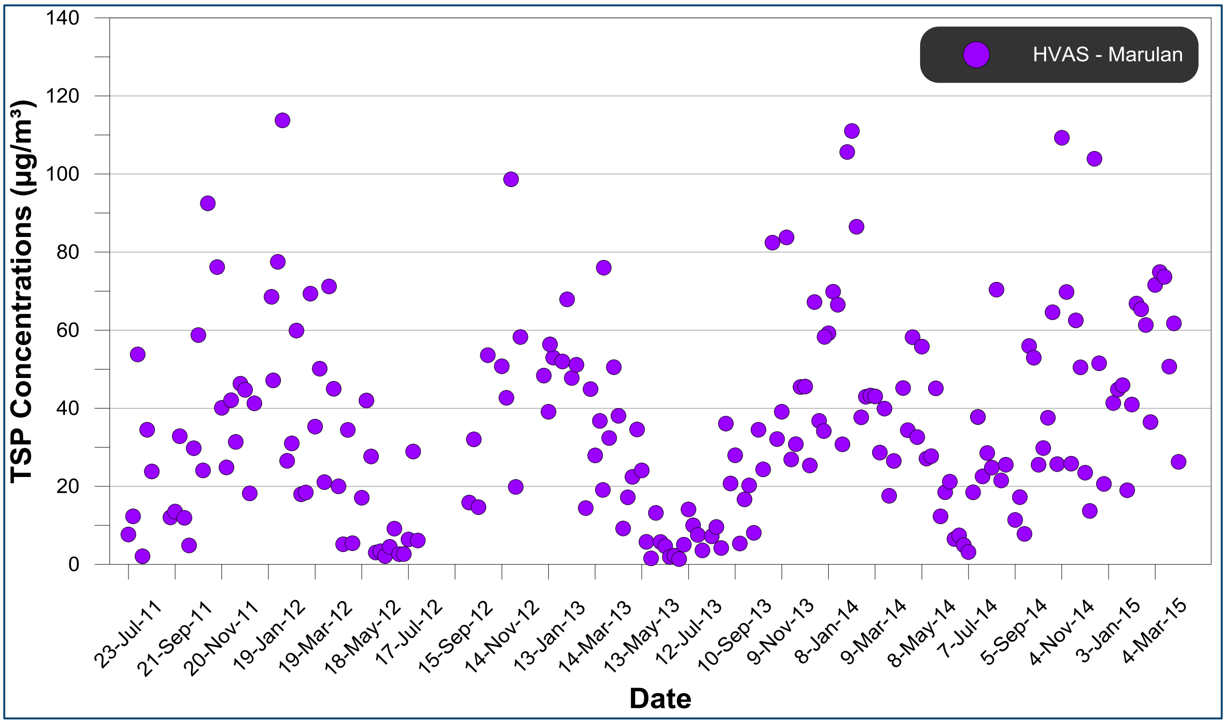



**Figure 5-9: HVAS 24-hour average TSP concentrations**

### 5.3.4 Dust deposition monitoring

The annual average dust deposition levels at each of the gauges between 2011 and 2015 are summarised in **Table 5-6** and **Table 5-7**. It should be noted that many of the gauges are generally located in close proximity to the mining and quarrying activities (see **Figure 5-5**). These locations are likely to show the highest levels of deposited dust in the area due to their close proximity to dust sources, other sources such as traffic on unsealed roads and driveways and animal grazing would also contribute to the measured deposited dust levels. In this case, the measured dust deposition levels at these locations would not be representative of the sensitive receiver locations.

The results in **Table 5-6** indicate that for the Marulan and Peppertree monitors, the majority of dust gauges recorded annual average insoluble deposition levels below the criterion of 4g/m²/month. As noted, the dust gauges that recorded generally higher levels are likely to be influenced by their location relative to the mining and quarrying activities (e.g. Freddie's Hill, Store Paddock and D1). Samples are also often contaminated with bird droppings and/or insects which can increase the insoluble solid content.

**Table 5-6: Annual average dust deposition (insoluble solids) – Marulan / Peppertree (g/m²/month)**

| Year | Annual average | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sub Station | D2[(1)] | Freddie's Hill | Store Paddock | D1[(1)] | D3[(1)] | Criteria |
| 2011 | 2.5 | **9.6** | 3.7 | **5.7** | **7.4** | 2.4 | **4** |
| 2012 | 3.7 | 1.9 | 3.4 | **7.0** | **6.8** | 2.3 | **4** |
| 2013 | 2.5 | 2.2 | 3.3 | 3.6 | **4.2** | 2.8 | **4** |
| 2014 | 2.5 | 1.8 | 3.4 | 3.5 | **4.5** | 2.8 | **4** |
| 2015 | 3.6[(2)] | 2.6[(3)] | 4.1[(2)] | 4.3[(2)] | 3.8[(3)] | 3.8[(3)] | **4** |

[(1)]Data available from July 2011
[(2)]Data available till March 2015
[(3)]Data available till April 2015

**Table 5-7: Annual average dust deposition - Lynwood (g/m²/month)**

| Year | Annual average | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | DD1 | DD2 | DD3 | DD4 | DD5 | DD6 | DD7 | DD8 | Criteria |
| 2011 | **4.9** | 3.5 | **11.7** | 0.9 | | **7.2** | 0.4 | 0.5 | **4** |
| 2012 | **4.6** | 1.8 | **8.5** | **4.4** | 1.4 | **23.8** | 1.5 | 0.8 | **4** |
| 2013 | 0.6 | 1.0 | **4.5** | 0.6 | 0.6 | **8.1** | 0.7 | 0.6 | **4** |
| 2014 | 2.1 | 2.3 | 1.3 | 1.4 | 2.9 | 1.6 | 1.0 | 1.3 | **4** |
| 2015[(1)] | 1.7 | 2.4 | **4.2** | 1.3 | 2.8 | 3.4 | 1.4 | 1.0 | **4** |

Source: **Holcim, 2015**
[(1)]Data available till April 2015

# 6 DISPERSION MODELLING APPROACH

## 6.1 Introduction

The following sections are included to provide the reader with an understanding of the dispersion model and modelling approach.

For this assessment the CALPUFF modelling suite is applied to dispersion modelling. The CALPUFF model is an advanced "puff" model which can deal with the effects of complex local terrain on the dispersion meteorology over the entire modelling domain in a three dimensional, hourly varying time step. CALPUFF is an air dispersion model approved by NSW EPA for use in air quality impact assessments. The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC, 2011**).

## 6.2 Modelling methodology

Modelling was undertaken using a combination of The Air Pollution Model (TAPM) and the CALPUFF Modelling System. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for 3D simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a 3D gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the 3D meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

### 6.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a three dimensional upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 34deg46min south and 150deg1min east (approx. 226886mE, 6148501mN). The simulation involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

CALMET modelling used a nested approach where the three dimensional wind field from the coarser grid outer domain is used as the initial guess (or starting) field for the finer grid inner domain. This approach has several advantages over modelling a single domain. Observed surface wind field data from the near field as well as from far field monitoring sites can be included in the model to generate a more representative three dimensional wind field for the modelled area. Off domain terrain features for the finer grid domain can be allowed to take effect within the finer domain, as would occur in reality, also the coarse scale wind flow fields give a better set of starting conditions with which to operate the finer grid run.

The CALMET initial domain was run on a 20 x 20km area with a 0.4km grid resolution and refined for the second domain on a 10 x 10km area with a 0.1km grid resolution. The available meteorological data for the 2014 calendar year from four surrounding meteorological monitoring sites were included in this run. **Table 6-1** outlines the parameters used from each station.

**Table 6-1: Surface observation stations**

| Weather Stations | Parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | WS | WD | CH | CC | T | RH | SLP |
| Marulan Weather Station | ✓ | ✓ | | | ✓ | ✓ | |
| Peppertree Weather Station | ✓ | ✓ | | | ✓ | ✓ | |
| Goulburn Airport Automatic Weather Station (BoM) (Station No. 070330) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Moss Vale Automatic Weather Station (BoM) (Station No. 068239) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity, SLP = station level pressure

Local land use and detailed topographical information including local mine topography was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 6-1**.



TODOROSKI AIR SCIENCES | info@airsciences.com.au | 02 9874 2123

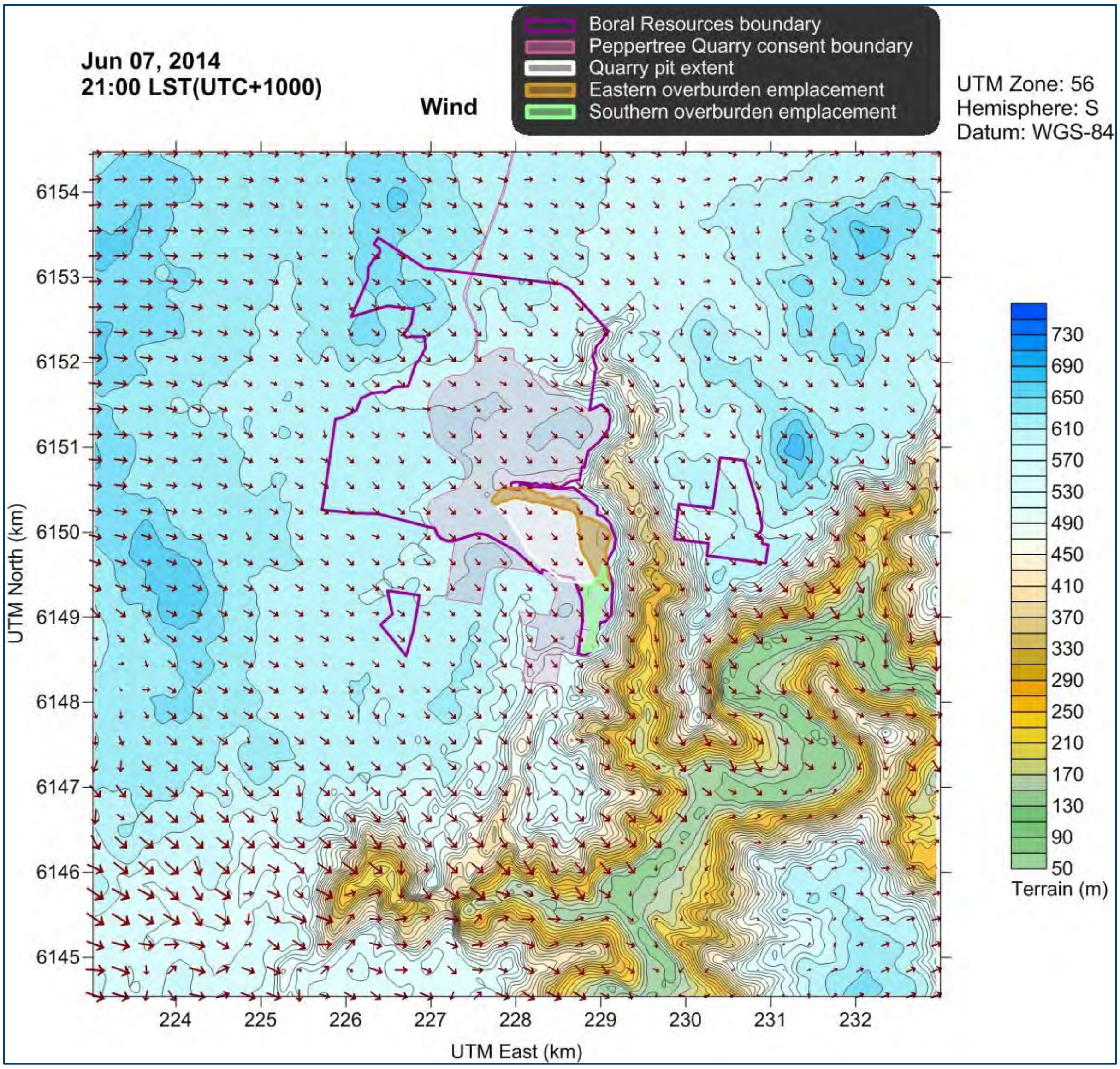



Figure 6-1: Representative snapshot of modelling wind field for the Quarry

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 6-2** and **Figure 6-3**.

**Figure 6-2** presents the annual and seasonal windroses from the CALMET data. On an annual basis, winds from the west are most frequent followed by winds from the northwest and the west-northwest. During summer, winds from the east dominate with a lesser portion of wind from the northeast quadrant. Autumn winds are predominately from the northwest quadrant. In winter, west and west-northwest winds are most dominant. The wind distribution during spring is similar to the annual distribution with winds ranging from west-southwest to the north-northwest and from the east-northeast and east.

Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. **Figure 6-3** includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and show sensible trends considered to be representative of the area.


**Figure 6-2: Windroses from CALMET extract (Cell Ref 3739)**

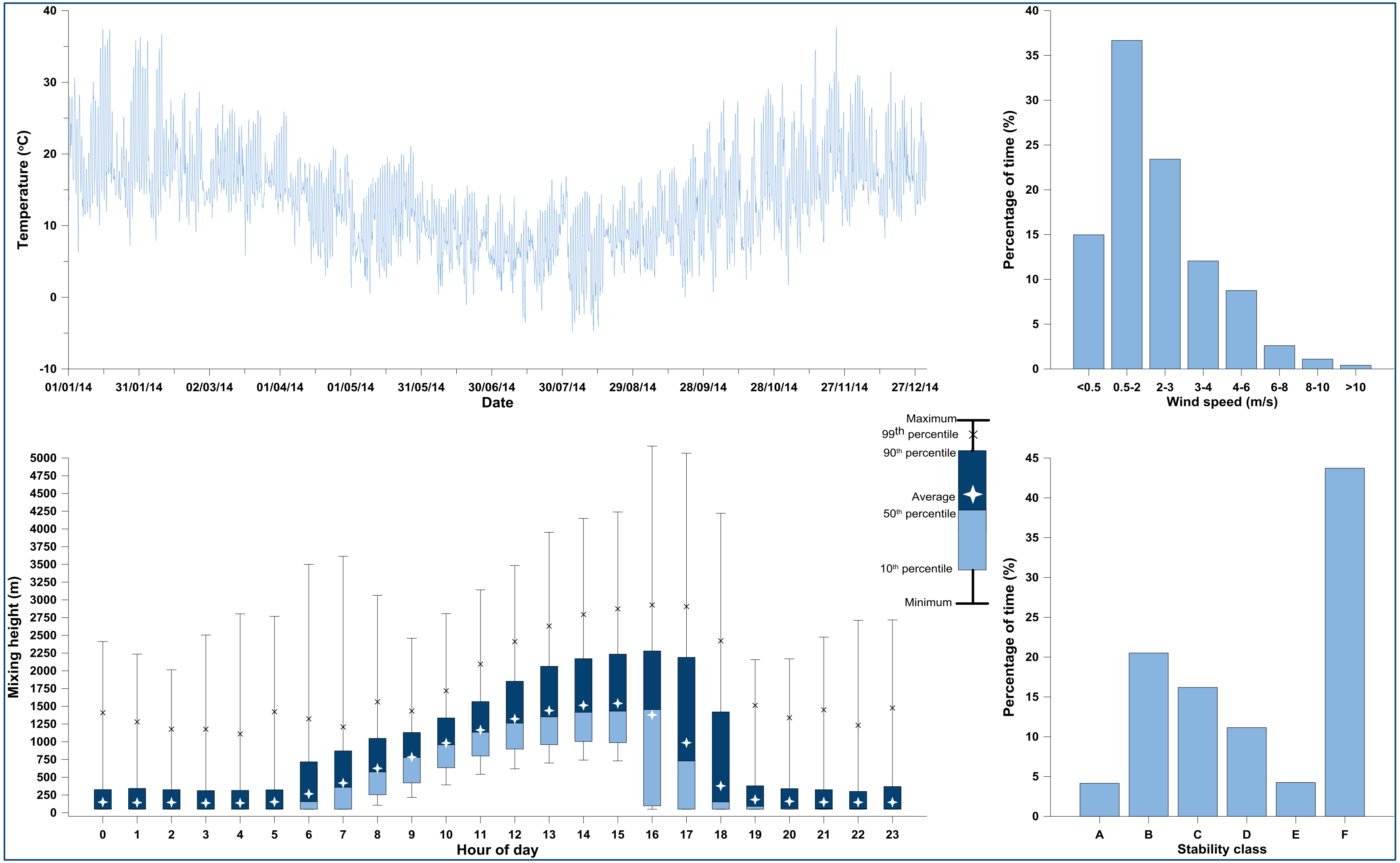



**Figure 6-3: Meteorological analyses of CALMET extract (Cell Ref 3739)**

### 6.2.2 Dispersion modelling

CALPUFF modelling for the dust emission sources is based on the application of three particle size categories; fine particulate, coarse matter and rest. The distribution of particles for each particle size category was derived from measurements in the **SPCC (1986)** study and is presented in **Table 6-2**.

**Table 6-2: Distribution of particles**

| Particle category | Size range | Distribution |
|---|---|---|
| Fine particulates | 0 to 2.5µm | 4.68% of TSP |
| Coarse matter | 2.5 to 10µm | 34.4% of TSP |
| Rest | 10 to 30µm | 60.92% of TSP |

(1)Particle distribution sources from **SPCC (1986)**

Emissions from each activity were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source. It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

Each particle size category is modelled separately and later combined to predict short-term and long-term average concentrations for $PM_{2.5}$, $PM_{10}$, and TSP. Dust deposition was predicted using the proven dry deposition algorithm within the CALPUFF model. Particle deposition is expressed in terms of atmospheric resistance through the surface layer, deposition layer resistance and gravitational settling (**Slinn and Slinn, 1980** and **Pleim *et al.,* 1984**). Gravitational settling is a function of the particle size and density, simulated for spheres by the Stokes equation (**Gregory, 1973**).

CALPUFF is capable of tracking the mass balance of particles emitted into the modelling domain. For each hour CALPUFF tracks the mass emitted, the amount deposited, the amounts remaining in the surface mixed layer or the air above the mixed layer and the amount advected out of the modelling domain. The versatility to address both dispersion and deposition algorithms in CALPUFF, combined with the three dimensional meteorological and land use field generally results in a more accurate model prediction compared to other Gaussian plume models (**Pfender *et al.*, 2006**).

## 6.3 Modelling scenarios

The assessment considers a single worst case scenario to represent the proposed modifications to the Quarry. The scenario selected was chosen to represent the potential worst-case impact situation having regard to the quantity of material extracted in each year, the location of the operations occurring on-site and the potential to generate dust at the surrounding sensitive receivers.

The quarrying operations involve the stripping of overburden and the extraction of hard rock using open-cut drill and blast techniques. Overburden is transported by trucks to the overburden emplacement areas, where it is spread and shaped by dozer. Overburden emplacement occurs in the active eastern overburden emplacement to the east and thereafter within the new southern overburden emplacement to the southeast of the extraction area (quarry pit). Rehabilitation of these overburden emplacement areas will be undertaken in stages as the emplacements progress. The active quarrying area and exposed areas are kept to a minimum for the efficiency of the operation and this also has a positive effect in minimising the potential dust levels generated from the operations.

Quarried material is processed on-site using various crushers and screens to obtain the desired product. Material is initially crushed in a primary mobile crusher located within the pit, which is currently fed by an excavator, front end loaders and trucks. The mobile crusher/ conveyor system can be positioned close to the extraction location, thus a key aim of the proposed modification is to configure the pit such that the future in-pit works would be "truck-less". This would eliminate the dust emissions from unnecessary material handling and hauling activity. Blasted rock would be fed directly into the primary mobile crusher by excavator. After passing through the primary crusher, the crushed material is taken from the pit along a series of conveyors to the first set of screens located to the northwest of the pit and material is stockpiled in a surge pile. Material in the surge pile is reclaimed and conveyed to the main processing area where it undergoes further crushing and screening. Product material is stored in the various storage bins prior to being dispatched off-site by trains.

A number of improvements to the processing activities at the Quarry have been implemented to assist with the efficiency of the operation and to minimise the potential for dust emissions. These improvements and the implementation of air quality controls are reflected in the emissions inventory for the modification.

An indicative plan for the selected operational scenario is presented in **Figure 6-4**.

The modelled year represents a potential worst-case scenario with regard to dust generation with the proposed maximum approved amount of material handled, at the closest possible locations to the nearby receivers. As outlined above, for the modelled operational scenario, the existing approved eastern overburden emplacement area is assumed to have been completed and the new southern overburden emplacement area to the south of the eastern overburden emplacement area is in operation. Overburden will be initially placed in the southern section of this overburden emplacement area and will progressively move northward toward the existing eastern emplacement area.

To account for the proposed increase of in-pit operational hours, the activities associated with the in-pit crusher and extraction equipment area are assumed to operate from 5:00am to 11:00pm. Overburden stripping and emplacement at the new southern overburden emplacement will be the same as the current approved operations from 7:00am to 7:00pm. All other processing operations at the

Quarry are assumed to occur in accordance with the current approved operations 24-hours per day/ seven days per week.

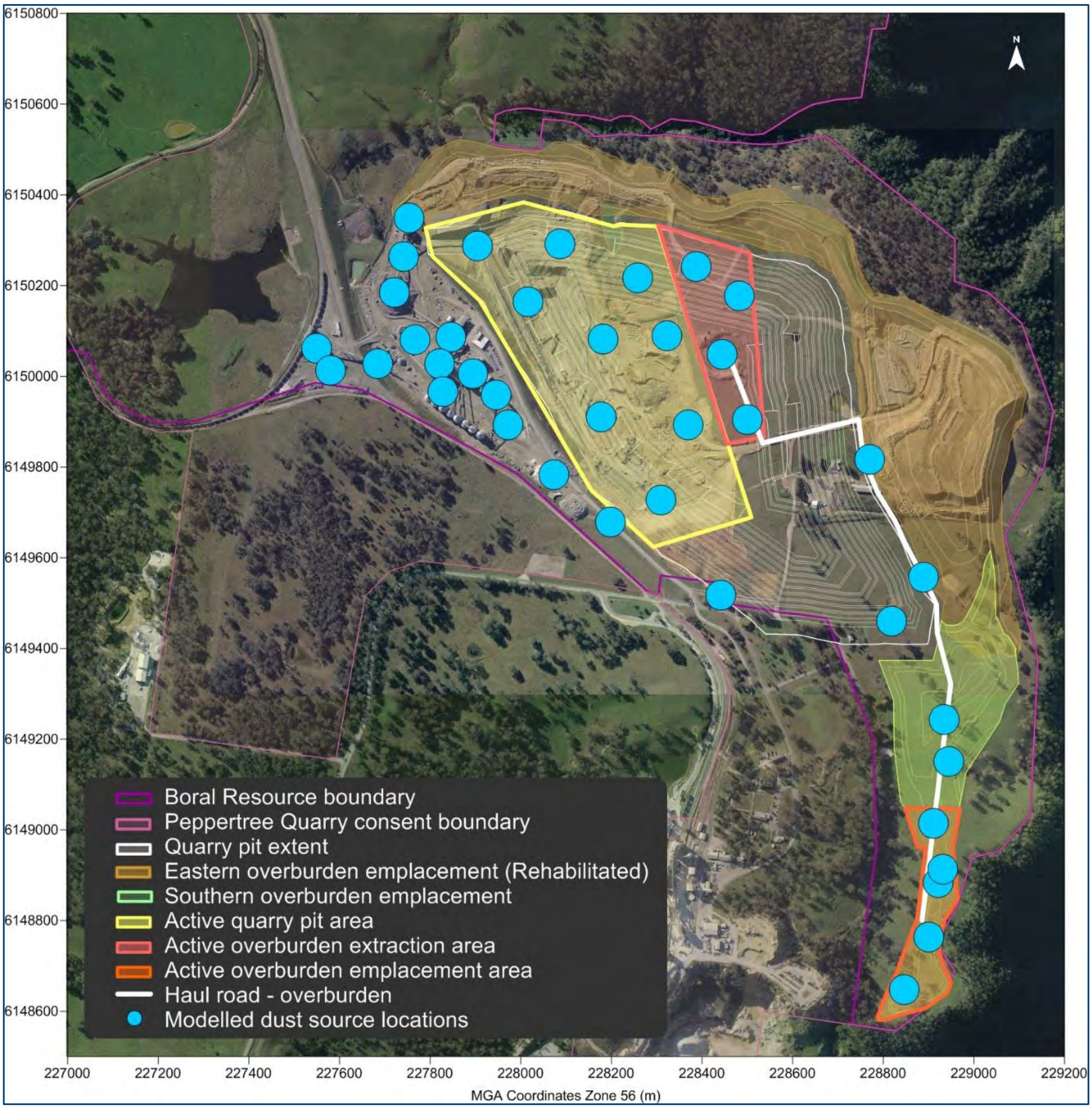



**Figure 6-4: Indicative modelling scenario for the modification**

### 6.3.1 Dust emission estimation

The chosen modelling scenario represents the potential worst-case impact situation having regard to the quantity of material extracted in each year, the location of the operations occurring on-site and the potential to generate dust at the surrounding sensitive receivers. Dust emission estimates have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emission factors.

The emission factors applied are considered the most applicable and representative for determining dust generation rates for the proposed activities. The emission factors were sourced from both locally developed and United States EPA (US EPA) documentation. Total dust emissions from all significant dust generating activities for the modification are summarised in **Table 6-3**. Detailed emission inventories and emission estimation calculations are presented in **Appendix C**.

The dust emissions presented in **Table 6-3** are commensurate with a best practice quarry operation utilising reasonable and feasible best practice dust mitigation applied where applicable. Further details on the dust control measures applied for the modification are outlined in **Section 8.3.4**.

**Table 6-3: Estimated emissions for the Quarry (kg of TSP)**

| ACTIVITY | TSP emission (kg/y) |
|---|---:|
| Excavator loading overburden to haul truck | 1,859 |
| Hauling overburden to emplacement area | 32,190 |
| Unloading overburden at emplacement area | 1,859 |
| Dozer shaping overburden emplacement area | 20,886 |
| Drilling rock | 3,068 |
| Blasting rock | 1,880 |
| Excavator loading rock to haul truck | 6,465 |
| Hauling rock to hopper | 35,772 |
| Unloading rock at stockpile | 6,465 |
| Excavator loading rock to hopper | 6,465 |
| Primary crushing of material | 2,400 |
| Conveying material to screens (grizzly + scalp) | 244 |
| Conveyor transfer x5 | 9,697 |
| Screening material | 4,400 |
| Conveying material to surge pile | 34 |
| Unloading material to surge pile | 5,657 |
| Unloading scalp material | 1,293 |
| Loading scalp material to haul truck | 1,293 |
| Hauling scalp material to stockpile (near train load out) | 6,797 |
| Unloading scalp material at stockpile | 1,293 |
| Loading scalp material to trains | 1,293 |
| Conveying material from surge pile to crusher | 33 |
| Crushing of material | 2,100 |
| Conveying material to screen | 17 |
| Conveying material to screen w/ transfer | 22 |
| Conveyor transfer x1 | 622 |
| Screening material | 4,235 |
| Conveying material to train load out Silo 1 | 114 |
| Conveying material to train load out Silo 2 | 34 |
| Conveyor transfer x1 | 246 |
| Conveying material to train load out Silo 3 | 37 |
| Conveyor transfer x1 | 338 |
| Conveying material to crusher (2) | 36 |
| Conveyor transfer x1 | 1,230 |
| Crushing (2) of material | 3,806 |

| ACTIVITY | TSP emission (kg/y) |
|---|---|
| Conveying material to screen (2) | 15 |
| Screening (2) material | 1,975 |
| Conveying material to train load out Silo 4 | 27 |
| Conveying material to train load out Silo 5 | 27 |
| Conveying material to train load out Silo 6 + 7 | 75 |
| Conveyor transfer x2 | 1,396 |
| Screening (air sort) material | 2,592 |
| Unloading Limestone sand from Marulan | 242 |
| Conveying material to train load out Silo 8 | 33 |
| Conveying material to train load out from all Bins | 140 |
| Loading product material to trains | 1,697 |
| Unloading overflow material from radial stacker | 194 |
| Excavator loading overflow material to haul truck | 194 |
| Hauling overflow material to stockpile (near train load out) | 423 |
| Unloading overflow material at stockpile | 194 |
| Loading overflow material to trains | 194 |
| Unloading test material from radial stacker | 57 |
| Excavator loading test material to hopper | 57 |
| Unloading rejects (weathered material) to haul truck | 283 |
| Excavator loading rejects (weathered material) to haul truck | 283 |
| Hauling rejects (weathered material) to emplacement area | 5,271 |
| Unloading rejects (weathered material) at emplacement area | 283 |
| Grading roads | 1,418 |
| Wind erosion - Overburden emplacement area | 18,450 |
| Wind erosion - Open pit | 120,474 |
| Wind erosion - Infrastructure stockpiles | 18,828 |
| **Total TSP emissions (kg/yr)** | **338,997** |

Note: Totals may vary slightly due to rounding.

### 6.3.2 Dust emissions from other operations

In addition to the estimated dust emissions from the modification, the adjacent Marulan South Limestone Mine has been included in the modelling to assess potential for cumulative dust effects.

Other activities in the local area include an agricultural lime production facility. This is a relatively small operation, and the background data (HVAS) monitor is located within approximately 300m of the activity. This background data would capture any significant environmental emissions associated with this facility, hence it has not been explicitly modelled.

Emission estimates from this operation were derived from information provided in the most up to date public air quality assessment available at the time of modelling. **Table 6-4** summarises the emissions adopted in this assessment for the modelled scenario.

**Table 6-4: Estimated emissions for neighbouring mining operation (kg of TSP)**

| Mine operation | TSP emission (kg/y) |
|---|---|
| Marulan South Limestone Mine | 412,881 |

Sources: **PAEHolmes (2009)**

Additionally, there would be numerous smaller or very distant sources that contribute to the total background dust level. Modelling these non-mining sources explicitly is impractical, however the residual level of dust due to all other such non-modelled sources (as estimated in **Section 6.4**) has been included in the cumulative results, as discussed in **Section 7**.

### 6.3.3 Best practice operational dust mitigation measures

The Quarry has carefully considered the possible range of air quality mitigation measures that are feasible and can be applied to achieve a standard of operation consistent with current best practice for the control of dust emissions from coal mines in NSW, as outlined in the recent NSW EPA document, *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining*, prepared by Katestone Environmental (**Katestone Environmental, 2010**).

A summary of the key current dust controls applied to the Quarry operations and as outlined in the *Peppertree Quarry Air Quality Management Plan* (**ERM, 2012**), is shown in **Table 6-5**. Where applicable these controls have been applied in the dust emission estimates shown in **Table 6-3**. Further detail on the level of control applied is set out in **Appendix C**.

**Table 6-5: Best practice dust mitigation measures**

| Activity | Dust Control |
|---|---|
| Hauling on unsealed roads | ✦ Watering roads<br>✦ Use the largest practical truck size<br>✦ Road edges to be clearly defined with marker post or equivalent to control locations<br>✦ Obsolete roads will be ripped and re-vegetated as soon as practical<br>✦ Impose speed restrictions |
| Hauling on sealed roads | ✦ Keep roads maintained<br>✦ Regular cleaning with road sweeper<br>✦ Covering of loads<br>✦ Impose speed restrictions |
| Drilling | ✦ Dust suppression systems<br>✦ Cease operations if systems are not operating properly resulting in excessive visible dust<br>✦ Take care not to disturb drill cuttings |
| Blasting | ✦ Meteorological conditions assessed prior to blasting<br>✦ Adequate stemming |
| Bulldozer activity | ✦ Modify activities during periods of high visible dust |
| Loading/unloading material | ✦ Minimise drop heights<br>✦ Modify activities during periods of high visible dust |
| Crushing / Screening | ✦ Dust suppression sprays on the primary crusher<br>✦ Enclosure with dust extraction system<br>✦ Regular housekeeping in and around buildings<br>✦ Regular servicing and inspection of dust cyclone |
| Conveyor and transfers | ✦ Water sprays<br>✦ Belt cleaning and spillage minimisation<br>✦ Enclosures<br>✦ Adjusting belt speed at the optimum level<br>✦ Daily cleaning of areas |
| Wind erosion on stockpiles and exposed surfaces | ✦ Profiling of surfaces to reduce surface speed<br>✦ Contouring of dump shape where practical to avoid strong wind flows and smooth gradients to reduce turbulence at surface<br>✦ Rehabilitation as soon as practical<br>✦ Topsoil stockpiles not regularly used to be re-vegetated |

| Activity | Dust Control |
|---|---|
| | ✦ Review weather conditions and modify activities to minimise stockpile disturbance during adverse conditions<br>✦ Water sprays<br>✦ Containment of aggregate materials within silos limiting the need to stockpile materials |
| Train loading | ✦ Enclosed<br>✦ Regular cleaning of any spillage |

## 6.4 Accounting for background air quality levels

All significant dust generating operations in the vicinity of the Quarry (i.e. estimated emissions from the Marulan South Limestone Mine) were included in the dispersion model to assess the total potential dust impact.

Other, non-mining sources of particulate matter in the wider area would also contribute to existing ambient dust levels. These sources have not been included in the dispersion modelling as it is impractical to do so; however an allowance for their contribution to total dust levels is required to fully assess the total potential impact.

For annual average predictions, the contribution to the prevailing background dust level of other non-modelled dust sources was estimated by modelling the past (known) quarrying activities (including the Marulan South Limestone Mine) during January 2014 to December 2014 and comparing the model predictions with the actual measured data from the monitoring stations.

The average difference between the measured and predicted $PM_{10}$, TSP and deposited dust levels from each of the monitoring points was considered to be the contribution from other non-modelled dust sources, and was added to the future predicted values to account for the background dust levels (not explicitly included in the model as a source) that would be due to the numerous small or distant, non-modelled dust sources.

This approach is preferable to modelling the modification alone and adding a single constant background level at all points across the modelling domain to estimate cumulative impacts. This is because the approach includes modelling of the other major dust sources in the area (i.e. the Marulan South Limestone Mine) that more reliably represent the higher dust levels near such sources, and also accounts for the seasonal and time varying changes in the background levels that arise from these major dust sources. In addition, to account for any underestimation due to not including every source (as it is not possible to do that reasonably), the relatively smaller contribution arising from the other non-modelled dust sources, as determined above, was added to the results to obtain the most accurate predictions of future cumulative impacts across the modelled domain.

Using the approach described above, the estimated annual average contribution from other non-modelled dust sources is presented in **Table 6-6**.

**Table 6-6: Estimated contribution from other non-modelled dust sources**

| Pollutant | Averaging period | Unit | Estimated contribution |
|---|---|---|---|
| TSP | Annual | µg/m³ | 27.0 |
| $PM_{10}$ | Annual | µg/m³ | 11.0 |
| Dust deposition | Annual | g/m²/month | 2.8 |

It is important that the above values are not confused with measured background levels, background levels excluding only the Quarry, or the change in existing levels as a result of the modification. The values above are not background levels in that sense, but are the residual amount of the background dust that is not accounted for directly in the air dispersion modelling.

To account for background levels when assessing total (cumulative) 24-hour average $PM_{10}$ concentration impacts, the 24-hour average predicted incremental levels associated with the modification are added to the total measured 24-hour average ambient dust levels.

As there is no readily available ambient monitoring for $PM_{2.5}$ in the vicinity of the Quarry, a conservative estimate of background levels was calculated based on the assumption that an annual average $PM_{2.5}$ concentration of 8µg/m$^3$ is equivalent to an annual average $PM_{10}$ concentration of 30µg/m$^3$. The calculated $PM_{2.5}$ level to account for non-modelled sources applied in this assessment is 2.9µg/m$^3$.

# 7 DISPERSION MODELLING RESULTS

The dispersion model predictions for the assessed worst case modified Quarry operational scenario are presented in this section. The results presented are for the operation in isolation (incremental impact) and operating with other sources (total cumulative impact) and show the estimated:

- maximum 24-hour average $PM_{2.5}$ and $PM_{10}$ concentrations;
- annual average $PM_{2.5}$ and $PM_{10}$ concentrations;
- annual average TSP concentrations; and
- annual average dust (insoluble solids) deposition rates.

When assessing impacts per the maximum 24-hour average $PM_{10}$ criterion, it should be noted that the predictions show the highest predicted 24-hour average concentration at each point within the modelling domain for the worst day (a 24-hour period) in the one year long modelling period at the point. When assessing the total (cumulative) 24-hour average impacts based on model predictions, challenges arise with identification and quantification of emissions from non-modelled sources over the 24-hour period as the levels vary greatly over the area and over time. Due to these issues, the 24-hour average impacts need to be calculated differently to annual averages and as such, the predicted total (cumulative) impacts for maximum 24-hour average $PM_{10}$ concentrations have been addressed specifically in **Section 7.2**.

Each of the sensitive receivers (residences) shown in **Figure 2-1** and detailed in **Appendix A** were assessed individually as discrete receptors with associated isopleth diagrams of the dispersion modelling results presented in **Appendix D**.

For sources not explicitly included in the model, and to fully account for all cumulative levels, the unaccounted fractions of background levels (which arise from the other non-modelled sources), were added to the annual average model predictions as described in **Section 6.4**.

## 7.1 Modelling predictions

**Figure D-1** to **Figure D-6** in **Appendix D** present isopleths showing the spatial distribution of the incremental impacts predicted to arise due to the modification in isolation (incremental impact) for maximum 24-hour average $PM_{2.5}$ and $PM_{10}$, and annual average $PM_{2.5}$, $PM_{10}$, TSP and deposited dust levels, respectively.

**Figure D-7** to **Figure D-10** in **Appendix D** present isopleths showing the spatial distribution of the total (cumulative) impacts predicted to arise due to the modification and other sources for annual average $PM_{2.5}$, $PM_{10}$, TSP and deposited dust levels, respectively.

**Table 7-1** presents the predicted particulate dispersion modelling results for the incremental impact at each of the assessed sensitive receiver locations. The results show minimal incremental effects would arise at the privately-owned sensitive receiver locations (Receptors 1 to 17) due to the modification.

Note the proposed residential dwelling (see **Figure 2-1**) does not actually exist at this time. As a conservative measure potential impacts at this potential future dwelling have been considered on the basis of the modelled levels at the existing receivers located substantially closer to the modification where impacts would be higher.

Table 7-1: Predicted particulate dispersion modelling results – Incremental impact

| Receiver ID | $PM_{2.5}$ (µg/m³) | | $PM_{10}$ (µg/m³) | | TSP (µg/m³) | DD (g/m²/month) |
|---|---|---|---|---|---|---|
| | Incremental impact | | | | | |
| | 24-hour average | Annual average | 24-hour average | Annual average | Annual average | Annual average |
| | Air quality impact criteria | | | | | |
| | - | - | - | - | - | 2 |
| R1 | 0.4 | 0.0 | 3.2 | 0.1 | 0.2 | 0.01 |
| R2 | 0.6 | 0.0 | 5.1 | 0.3 | 0.4 | 0.01 |
| R3 | 0.9 | 0.1 | 7.2 | 0.5 | 0.7 | 0.02 |
| R4 | 1.1 | 0.1 | 8.0 | 0.6 | 1.0 | 0.02 |
| R5 | 1.0 | 0.1 | 7.4 | 1.0 | 1.6 | 0.03 |
| R6 | 0.7 | 0.1 | 5.5 | 0.9 | 1.4 | 0.03 |
| R7 | 1.4 | 0.2 | 10.8 | 1.5 | 2.5 | 0.04 |
| R8 | 2.6 | 0.3 | 20.2 | 2.6 | 4.4 | 0.07 |
| R9 | 1.0 | 0.1 | 7.9 | 1.1 | 1.7 | 0.02 |
| R10 | 0.7 | 0.1 | 5.4 | 0.5 | 0.7 | 0.01 |
| R11 | 0.4 | 0.0 | 3.4 | 0.3 | 0.4 | 0.01 |
| R12 | 0.6 | 0.0 | 4.4 | 0.4 | 0.5 | 0.01 |
| R13 | 0.1 | 0.0 | 1.2 | 0.1 | 0.1 | 0.00 |
| R14 | 0.6 | 0.1 | 4.3 | 0.6 | 1.0 | 0.10 |
| R15 | 0.9 | 0.1 | 5.2 | 0.6 | 1.1 | 0.13 |

| Receiver ID | PM$_{2.5}$ (µg/m³) | | PM$_{10}$ (µg/m³) | | TSP (µg/m³) | DD (g/m²/month) |
|---|---|---|---|---|---|---|
| | Incremental impact | | | | | |
| | 24-hour average | Annual average | 24-hour average | Annual average | Annual average | Annual average |
| | Air quality impact criteria | | | | | |
| | - | - | - | - | - | 2 |
| R16 | 0.9 | 0.1 | 5.8 | 0.6 | 1.2 | 0.14 |
| R17 | 0.9 | 0.1 | 5.3 | 0.7 | 1.3 | 0.16 |
| B1 | 1.2 | 0.1 | 9.2 | 0.6 | 0.9 | 0.02 |
| B2 | 1.8 | 0.2 | 14.0 | 1.5 | 2.5 | 0.05 |
| B3 | 1.8 | 0.3 | 13.1 | 2.1 | 3.3 | 0.05 |
| B4 | 1.8 | 0.3 | 13.6 | 2.5 | 4.1 | 0.06 |
| B5 | 1.2 | 0.2 | 8.7 | 1.5 | 2.4 | 0.04 |
| B6 | 1.2 | 0.1 | 7.2 | 0.9 | 1.7 | 0.21 |
| B7 | 0.9 | 0.1 | 5.3 | 0.8 | 1.4 | 0.18 |
| C1 | 2.4 | 0.5 | 18.8 | 3.8 | 6.2 | 0.09 |
| C2 | 1.8 | 0.2 | 14.0 | 1.5 | 2.3 | 0.03 |
| C3 | 1.1 | 0.2 | 8.4 | 1.2 | 1.9 | 0.03 |
| PR* | 1.8 | 0.2 | 14.0 | 1.5 | 2.3 | 0.03 |

*Impact is conservatively assumed to be the same as that at Receiver C2.

The predicted cumulative annual average PM$_{2.5}$, PM$_{10}$, TSP and dust deposition levels due to the modification and other sources, including the estimated background levels in **Section 6.4**, are presented in **Table 7-2**. The results indicate the predicted levels would be below the relevant criteria at the assessed locations for each of the assessed dust metrics.

**Table 7-2: Predicted particulate dispersion modelling results – Cumulative impact**

| Receiver ID | PM$_{2.5}$ (µg/m³) | PM$_{10}$ (µg/m³) | TSP (µg/m³) | DD (g/m²/month) |
|---|---|---|---|---|
| | Cumulative impact | | | |
| | Annual average | | | |
| | Air quality impact criteria | | | |
| | 8* | 30 | 90 | 4 |
| R1 | 3.0 | 11.3 | 27.5 | 2.8 |
| R2 | 3.0 | 11.6 | 27.8 | 2.8 |
| R3 | 3.1 | 11.9 | 28.3 | 2.9 |
| R4 | 3.1 | 12.2 | 28.7 | 2.9 |
| R5 | 3.2 | 12.8 | 29.9 | 2.9 |
| R6 | 3.2 | 12.7 | 29.7 | 2.9 |
| R7 | 3.4 | 14.0 | 31.7 | 2.9 |
| R8 | 3.6 | 15.6 | 34.5 | 2.9 |
| R9 | 3.5 | 14.8 | 33.0 | 2.9 |
| R10 | 3.3 | 13.1 | 30.3 | 2.9 |
| R11 | 3.2 | 12.8 | 29.8 | 2.9 |
| R12 | 3.4 | 14.3 | 32.1 | 2.9 |
| R13 | 3.0 | 11.2 | 27.3 | 2.8 |
| R14 | 3.1 | 11.9 | 28.5 | 2.9 |
| R15 | 3.1 | 12.1 | 28.8 | 3.0 |
| R16 | 3.1 | 12.1 | 28.9 | 3.0 |
| R17 | 3.2 | 12.3 | 29.2 | 3.0 |
| B1 | 3.1 | 12.0 | 28.5 | 2.9 |
| B2 | 3.3 | 13.4 | 30.7 | 2.9 |
| B3 | 3.8 | 16.7 | 36.1 | 2.9 |

| Receiver ID | PM2.5 (µg/m³) | PM10 (µg/m³) | TSP (µg/m³) | DD (g/m²/month) |
|---|---|---|---|---|
| | Cumulative impact | | | |
| | Annual average | | | |
| | Air quality impact criteria | | | |
| | 8* | 30 | 90 | 4 |
| B4 | 4.3 | 20.1 | 42.1 | 3.0 |
| B5 | 4.1 | 19.4 | 40.8 | 3.0 |
| B6 | 3.2 | 12.5 | 29.5 | 3.1 |
| B7 | 3.2 | 12.5 | 29.5 | 3.1 |
| C1 | 4.1 | 19.0 | 39.8 | 3.0 |
| C2 | 3.5 | 14.6 | 32.7 | 2.9 |
| C3 | 3.6 | 15.8 | 34.7 | 2.9 |
| PR** | 3.5 | 14.6 | 32.7 | 2.9 |

*Advisory NEPM reporting standard

**Impact is conservatively assumed to be the same as that at Receiver C2.

## 7.2 Assessment of total (cumulative) 24-hour average $PM_{10}$ concentrations

### 7.2.1 Introduction

The NSW EPA contemporaneous assessment method was applied to examine the potential maximum total (cumulative) 24-hour average $PM_{10}$ impacts arising from the modification.

This analysis has focused on the nearest privately-owned sensitive receiver locations surrounding the Quarry that would be most likely to experience maximum cumulative impacts due to the modification. All other receivers would be expected to experience levels lower than those assessed. **Figure 7-1** shows the location for the contemporaneous impact assessment.

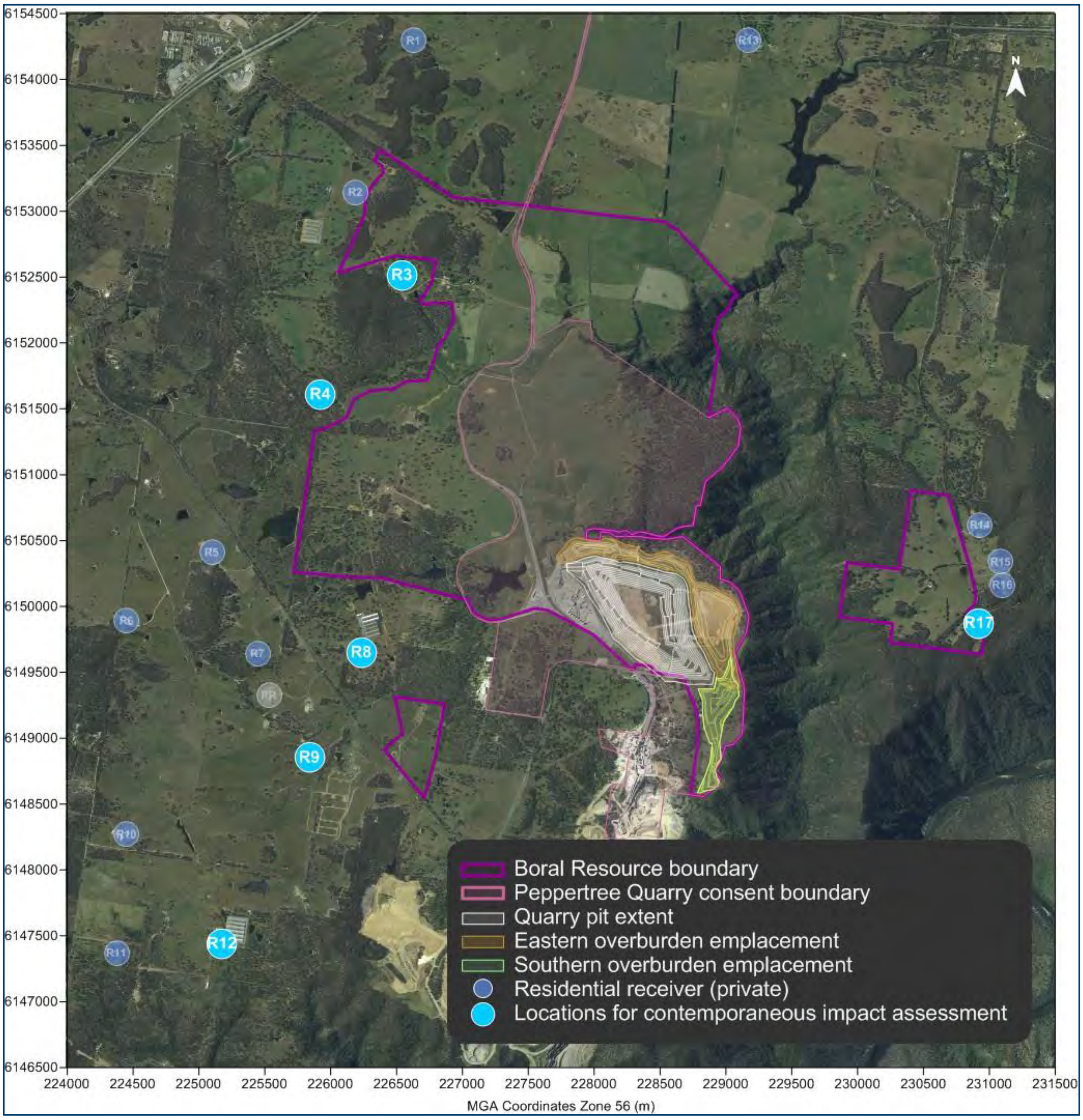



**Figure 7-1: Locations for the contemporaneous impact assessment**

An assessment of cumulative 24-hour average $PM_{10}$ impacts was undertaken in accordance with methods outlined in Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW DEC, 2005**). The "Level 2 assessment – Contemporaneous impact and background approach" was applied to assess potential impacts at private receivers near monitoring locations.

As shown in **Section 5**, maximum background levels have in the past reached levels near to the 24-hour average $PM_{10}$ criterion level (depending on the monitoring location and time). As a result, the screening Level 1 NSW EPA approach of adding maximum background levels to maximum predicted modified Quarry only levels would show levels above the criterion.

In such situations, (where a Level 1 assessment indicates that an impact may be possible due to elevated background levels) the NSW EPA approach requires a more thorough Level 2 assessment whereby the measured background level on a given day is added contemporaneously with the corresponding modified Quarry only level predicted using the same day's weather data. This method factors into the assessment the spatial and temporal variation in background levels affected by the weather and existing sources of dust in the area on a given day. However, even with a detailed Level 2 approach, any air dispersion modelling has limitations (as described in **Section 6.4**) in predicting short term impacts which may arise many years into the future, and these limitations need to be understood when interpreting the results.

Ambient (background) dust concentration data for January 2014 to December 2014 from the HVAS monitoring station have been applied in the Level 2 contemporaneous 24-hour average $PM_{10}$ assessment and represent the prevailing measured background levels at the monitoring location which is near to the Quarry.

As the Quarry and other nearby operations (the Marulan South Limestone Mine) were operational during 2014, they would have contributed to the measured levels of dust at the monitor, making the levels higher than the likely background levels further away at residential receivers. Due to this it is important to account for these existing activities in the cumulative assessment.

To consider the Quarry's influence on prevailing dust levels, modelling of the actual operating scenario for the 2014 period (in which the weather and background dust data were collected) was conducted to estimate the existing contribution to the measured levels of dust. The results were applied in the cumulative assessment to minimise potential double counting of existing emissions (otherwise the contribution would occur in the measured data and in the modelled levels), and thus to make a more reliable prediction of the likely cumulative total dust level.

Specifically, to calculate the background levels at receivers, the predicted air quality concentrations from the Quarry and the Marulan South Limestone Mine during 2014 at the HVAS monitoring station location were subtracted from the measured levels at the HVAS. However, for conservatism, and as the models tend to over predict mine contributions, no level lower than the $25^{th}$ percentile of the measured HVAS results for the 2014 period was applied to represent the underlying background level on any day.

As the HVAS monitoring data are only available on every sixth day in 2014 (per the EPA run cycle) and as on a few occasions no result was recorded, the $70^{th}$ percentile of the HVAS data for the period from July 2011 to April 2015 (19.8µg/m$^3$) was applied to substitute for these gaps.

This approach was tested by applying the complete set of 24-hour average $PM_{10}$ monitoring data from Bargo in a contemporaneous 24-hour average $PM_{10}$ assessment. The application of the Bargo data resulted in lower levels than calculated with the above approach, providing a reasonable indication that assessment is likely to be conservative and thus to overestimate the actual background level and cumulative 24-hour average $PM_{10}$ impacts.

**Table 7-3** provides a summary of the findings of the contemporaneous assessment at each assessed sensitive receivers location. The results in **Table 7-3** indicate that it is unlikely that systemic (i.e. greater than five days) cumulative impacts would arise at assessed receiver locations during the assessed years.

Detailed tables of the full assessment results are provided in **Appendix E**.

**Table 7-3: NSW EPA contemporaneous assessment – maximum number of additional days above 24-hour average criterion**

| Receptor ID | Number of additional days above 24-hour average $PM_{10}$ criterion |
|---|---|
| R3 | 0 |
| R4 | 0 |
| R8 | 0 |
| R9 | 0 |
| R12 | 0 |
| R17 | 0 |

The contemporaneous assessment indicates only a low potential for any cumulative 24-hour average $PM_{10}$ impacts to occur at the assessed sensitive receiver locations. The sensitive receiver locations are considered to represent areas where the highest cumulative impacts are most likely to occur. Given that these locations show little potential for any significant impact to occur, it can be inferred that there would also be little prospect of any significant impact to occur at all other sensitive receivers locations.

Time series plots of the predicted cumulative 24-hour average $PM_{10}$ concentrations for R4 and R8 are presented in **Figure 7-2.** The yellow bars in the figure represent the contribution from the Quarry and the Marulan South Limestone Mine and the black bars represent the background levels at the HVAS monitor. Note that on the days on which there is no HVAS data, the 70$^{th}$ percentile level of the HVAS data is used to elevate the total cumulative level. It is clear from the figures that the Quarry (and Marulan South Limestone Mine combined) would have a relatively small influence at these receiver locations and the cumulative levels would remain within criteria.

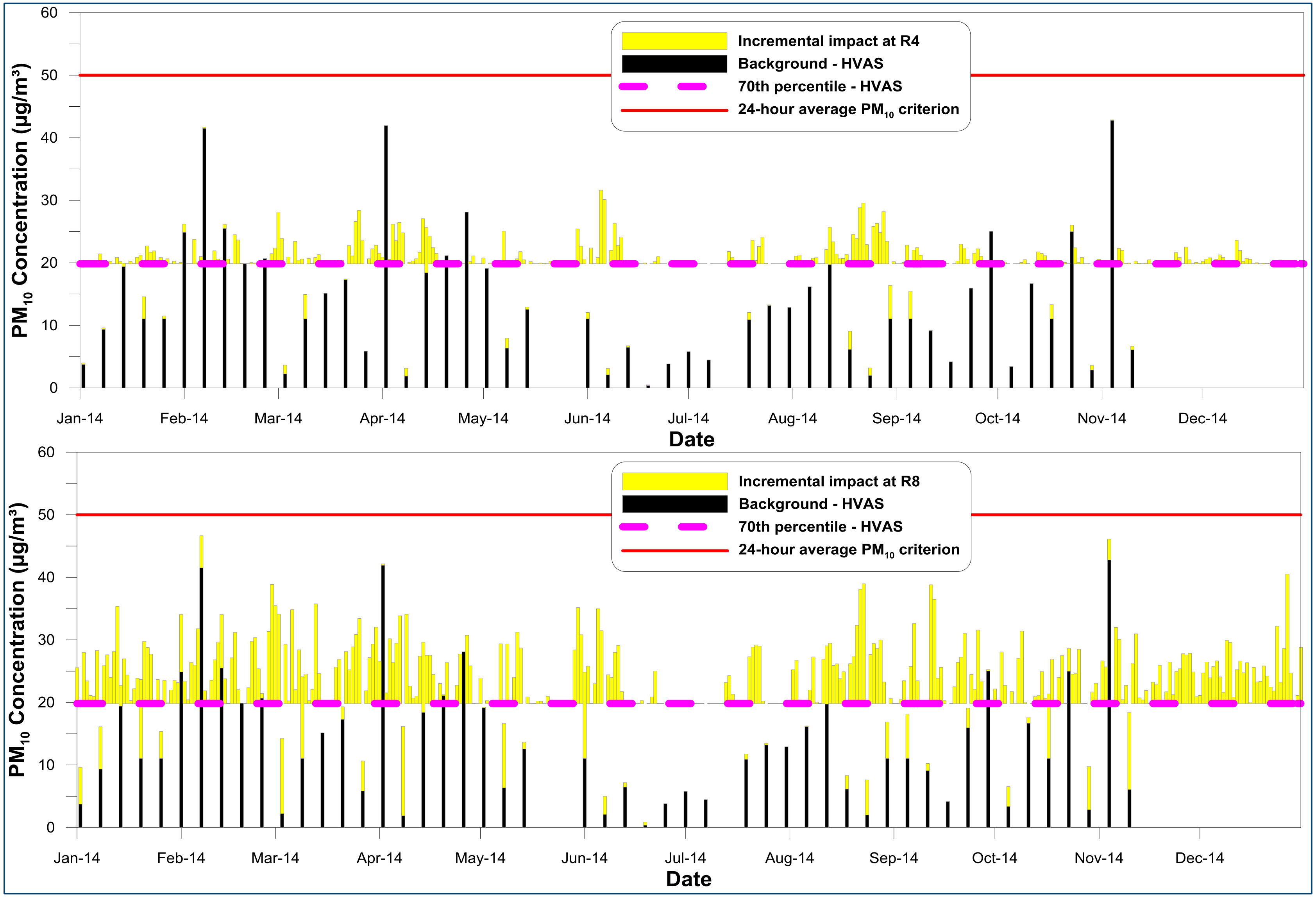



**Figure 7-2: Time series plots of predicted cumulative 24-hour average $PM_{10}$ concentrations for R4 and R8**

## 7.3 Dust impacts on more than 25 per cent of privately-owned land

An assessment was made to ascertain where the potential impacts due to the modification may extend over more than 25 per cent of any privately-owned land. Such an assessment can only be conducted approximately, based on the predicted pollutant dispersion contours.

For the modification, the maximum extent of the 24-hour average $PM_{10}$ impact due to the operation of the Quarry was greater than the extent of any of the other assessed dust metrics and hence represents the most impacting parameter in every case.

The contour presented in **Figure 7-3** defines the likely maximum 24-hour average $PM_{10}$ level assessed over the life of the modification. The contour indicates that the modification would not result in any impact of greater than 25 per cent of privately-owned land.

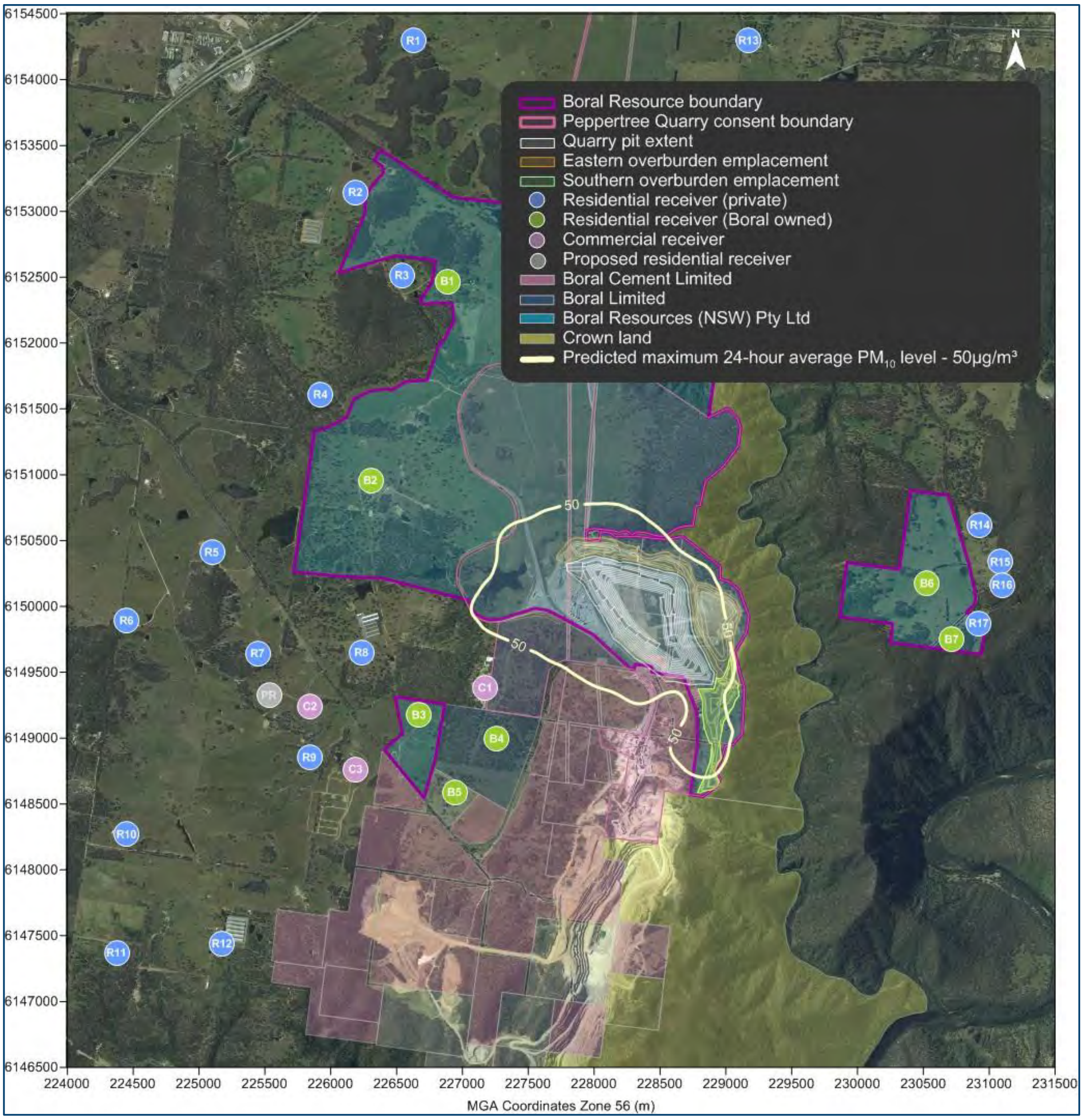



**Figure 7-3: Predicted maximum 24-hour average $PM_{10}$ level**

# 8 DUST MITIGATION AND MANAGEMENT

The existing operations at the Quarry implement various dust mitigation and management measures, in accordance with the existing Peppertree Quarry Air Quality Management Plan to minimise the potential for air quality impacts in the surrounding environment.

The monitoring data presented in **Section 5** indicate that the Quarry has generally been in clear compliance with NSW EPA air quality criteria, except for the D1 dust gauge[2].

Relative to the existing operations, the proposed modifications to the Quarry are unlikely to lead to any significant change in dust levels at receivers. This is supported by the air quality assessment for the modified Quarry operations which predicts that there would be no exceedances of NSW EPA air quality criteria at any privately-owned receivers due to the modified Quarry operations and background sources (including the Marulan South Limestone Mine).

Given this situation and the demonstrated performance of existing operations, it is considered that the continued implementation of the Air Quality Management Plan management measures would be suitable to manage potential air quality impacts from the modified Quarry operations.

It is however recommended that the Air Quality Management Plan include a simple procedure to follow in the event of any measured exceedance at the monitors in the network. This would outline the procedure for an investigation to be performed into the potential cause of the elevated reading, and to make any necessary recommendations to minimise reoccurrence of the elevated reading, if reoccurrence is likely.

[2] It is suggested that an investigation be performed to determine the likely cause of the high level of organic matter (e.g. leaves. pollens etc.) recorded by the D1 Dust gauge and if required to move this monitor to a nearby location less affected by such organic matter.

## 9 SUMMARY AND CONCLUSIONS

This study has examined potential air quality impacts that may arise from the proposed modifications to the Peppertree Quarry.

Air dispersion modelling was used to predict the potential for off-site dust impacts in the surrounding area due to the operation of the modified Quarry operations. The results indicate that the assessed air pollutants generated by the modified Quarry operations would comply with the applicable assessment criteria at all locations assessed and therefore would not lead to any unacceptable level of environmental impact in the surrounding area.

The Peppertree Quarry would continue to apply appropriate dust mitigation and management measures to ensure it minimises the potential occurrence of excessive dust emissions from the site.



TODOROSKI AIR SCIENCES | info@airsciences.com.au | 02 9874 2123

## 10 REFERENCES


Bureau of Meteorology (2015)

Climate Averages Australia, Bureau of Meteorology website. <http://www.bom.gov.au/climate/averages>

ERM (2012)

"Peppertree Quarry Air Quality Management Plan", prepared by ERM for Boral Resources (NSW) Pty Ltd, August 2012.

Holcim (2015)

Pollution Monitoring Data. < http://www.holcim.com.au/sustainability/environment/pollution-monitoring-data>

Gregory P. H. (1973)

"The microbiology of the atmosphere", Halstead Press, New York.

Katestone Environmental Pty Ltd (2010)

"NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining", Katestone Environmental Pty Ltd prepared for DECCW, 2010.

NASA (2015)

NASA Worldview Alpha website. <https://earthdata.nasa.gov/labs/worldview/>, accessed June 2015.

NEPC (2003)

"Variation to the National Environment Protection (Ambient Quality) Measure for Particles as PM2.5", National Environment Protection Council, Canberra, May 2003.

NPI (2012)

"Emission Estimation Technique Manual for Mining Version 3.1", National Pollutant Inventory, January 2012. ISBN 0 642 54700 9

NSW DEC (2005)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", Department of Environment and Conservation (NSW), August 2005.

PAEHolmes (2009)

"Marulan South Limestone Mine Air Quality Impact Assessment", prepared for GSS Environmental for Blue Circle Southern Cement Ltd (BCSC) by PAEHolmes, October 2009.

Pfender W., Graw R., Bradley W., Carney M. And Maxwell L. (2006)

"Use of a complex air pollution model to estimate dispersal and deposition of grass stem rust urendiniospores at landscape scale", Agriculture and Forest Meteorology, Vol 139.

Pleim J., Venkatram A. and Yamartino R. J. (1984)
"ADOM/TADAP model development program, Vol 4, The Dry Deposition Model", Ministry of the Environment, Rexdale, Ontario, Canada.

Slinn S. A. and Slinn W. G. N. (1980)
"Predictions for particle deposition on natural waters", Atmospheric Environment, Vol 14.

SPCC (1983)
"Air Pollution from Coal Mining and Related Developments", State Pollution Control Commission.

SPCC (1986)
"Particle size distributions in dust from open cut mines in the Hunter Valley", Report Number 10636-002-71. Prepared for the State Pollution Control Commission of NSW by Dames & Moore, 41 McLaren Street, North Sydney, NSW, 2060.

TRC (2011)
"Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

US EPA (1985 and updates)
"Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

# Appendix A

## *Sensitive Receivers*

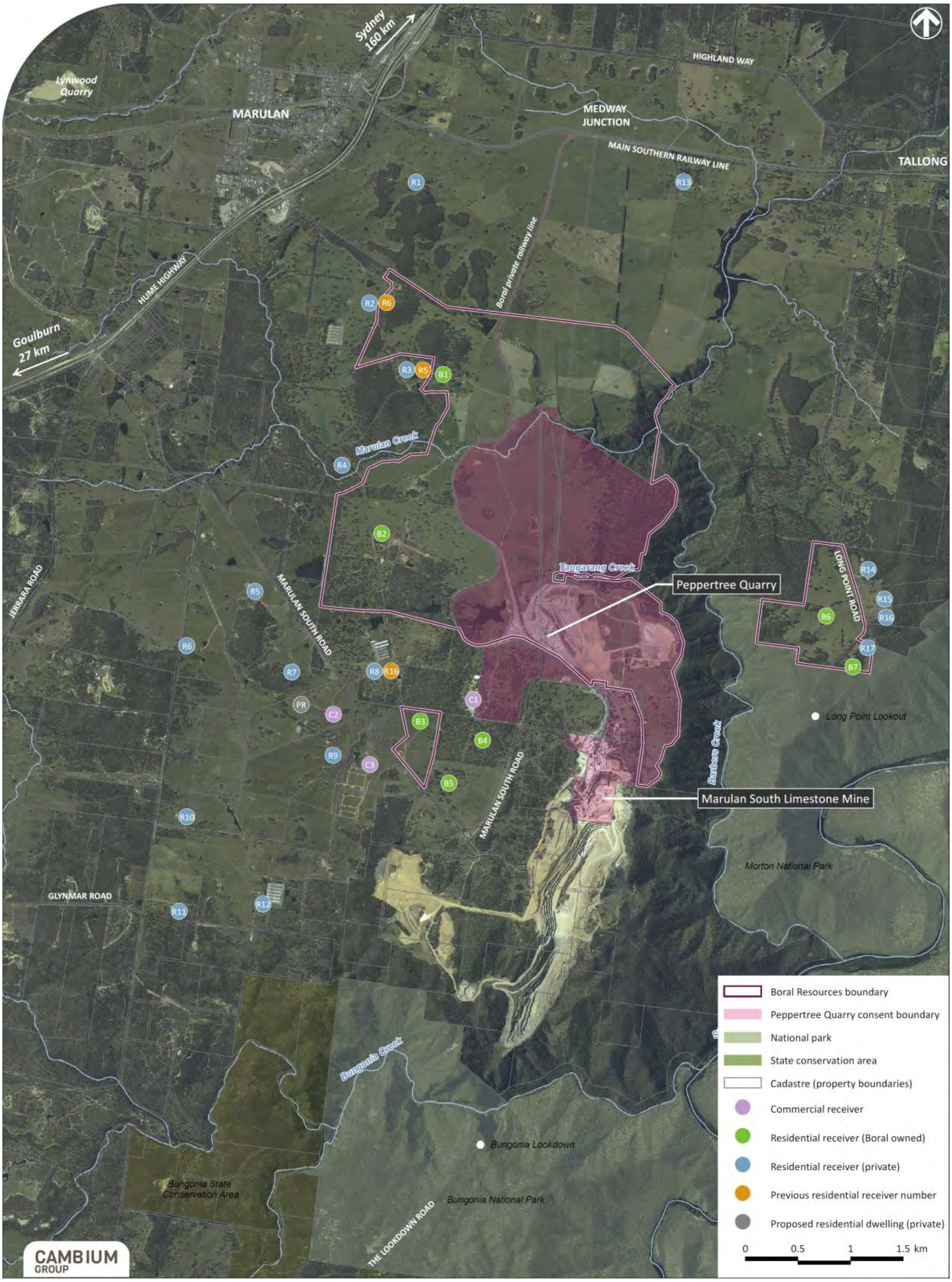



**Figure A-1: Sensitive receiver locations**

**Table A-1: List of sensitive receivers considered in the study**

| Receiver ID | Easting (m) | Northing (m) |
|---|---|---|
| R1 | 226630 | 6154295 |
| R2 | 226189 | 6153145 |
| R3 | 226542 | 6152514 |
| R4 | 225923 | 6151609 |
| R5 | 225098 | 6150410 |
| R6 | 224452 | 6149891 |
| R7 | 225446 | 6149643 |
| R8 | 226234 | 6149650 |
| R9 | 225840 | 6148852 |
| R10 | 224452 | 6148269 |
| R11 | 224375 | 6147370 |
| R12 | 225176 | 6147439 |
| R13 | 229173 | 6154296 |
| R14 | 230928 | 6150618 |
| R15 | 231084 | 6150338 |
| R16 | 231098 | 6150163 |
| R17 | 230921 | 6149873 |
| C1 | 227175 | 6149382 |
| C2 | 225844 | 6149241 |
| C3 | 226190 | 6148764 |
| B1 | 226889 | 6152469 |
| B2 | 226302 | 6150958 |
| B3 | 226671 | 6149175 |
| B4 | 227261 | 6148995 |
| B5 | 226941 | 6148589 |
| B6 | 230527 | 6150174 |
| B7 | 230715 | 6149749 |
| PR | 225532 | 6149325 |

R - residential receiver (private)

C - commercial receiver

B - residential receiver (Boral owned)

PR - proposed residential dwelling (private)

# Appendix B
## *Monitoring data*

Table B-1: HVAS monitoring data

| Date | PM10 | TSP | Date | PM10 | TSP |
|---|---|---|---|---|---|
| 23/07/2011 | 3.7 | 7.64 | 30/06/2013 | 6.66 | 1.35 |
| 29/07/2011 | 7.6 | 12.32 | 6/07/2013 | 0.82 | 5.05 |
| 4/08/2011 | 28.55 | 53.79 | 12/07/2013 | 8.58 | 14.08 |
| 10/08/2011 | 3.24 | 2.06 | 18/07/2013 | 5.73 | 9.98 |
| 16/08/2011 | 11.6 | 34.47 | 24/07/2013 | 1.69 | 7.54 |
| 22/08/2011 | 2.89 | 23.78 | 30/07/2013 | 7.28 | 3.59 |
| 28/08/2011 | 5.11 | ND | 5/08/2013 | ND | ND |
| 3/09/2011 | 4.58 | ND | 11/08/2013 | 4.7 | 7.2 |
| 9/09/2011 | 1.16 | ND | 17/08/2013 | 4.57 | 9.59 |
| 15/09/2011 | 5.03 | 12.03 | 23/08/2013 | 3.93 | 4.2 |
| 21/09/2011 | 4.82 | 13.52 | 29/08/2013 | 18.13 | 36.07 |
| 27/09/2011 | 15.27 | 32.81 | 4/09/2013 | 13.29 | 20.72 |
| 3/10/2011 | 5.93 | 11.91 | 10/09/2013 | 10.21 | 27.94 |
| 9/10/2011 | 2.52 | 4.84 | 16/09/2013 | 15.1 | 5.35 |
| 15/10/2011 | 8.9 | 29.75 | 22/09/2013 | 12.02 | 16.64 |
| 21/10/2011 | 31.27 | 58.74 | 28/09/2013 | 16.19 | 20.21 |
| 27/10/2011 | 10.71 | 24.08 | 4/10/2013 | 5.01 | 8.09 |
| 2/11/2011 | 32.44 | 92.48 | 10/10/2013 | 12.14 | 34.47 |
| 8/11/2011 | ND | ND | 16/10/2013 | 13.38 | 24.32 |
| 14/11/2011 | 37.45 | 76.16 | 22/10/2013 | 0 | 0 |
| 20/11/2011 | 15.39 | 40.09 | 28/10/2013 | 38.41 | 82.4 |
| 26/11/2011 | 10.88 | 24.83 | 3/11/2013 | 18.01 | 32.08 |
| 2/12/2011 | 15.4 | 42.05 | 9/11/2013 | 12.77 | 39.1 |
| 8/12/2011 | 12.82 | 31.38 | 15/11/2013 | 27.11 | 83.76 |
| 14/12/2011 | 17.64 | 46.28 | 21/11/2013 | 11.68 | 26.86 |
| 20/12/2011 | 25.02 | 44.69 | 27/11/2013 | 42.15 | 30.8 |
| 26/12/2011 | 10.03 | 18.18 | 3/12/2013 | 20.89 | 45.45 |
| 1/01/2012 | 19.64 | 41.25 | 9/12/2013 | 19.79 | 45.55 |
| 7/01/2012 | 22.66 | ND | 15/12/2013 | 6.46 | 25.32 |
| 13/01/2012 | 36.5 | ND | 21/12/2013 | 18.32 | 67.21 |
| 19/01/2012 | 54.7 | ND | 27/12/2013 | 12.99 | 36.76 |
| 23/01/2012 | ND | 68.55 | 2/01/2014 | 7.74 | 34.13 |
| 25/01/2012 | 18.15 | 47.13 | 8/01/2014 | 17.15 | 59.21 |
| 31/01/2012 | 31.3 | 77.5 | 14/01/2014 | 29.33 | 69.85 |
| 6/02/2012 | 53.65 | 113.76 | 20/01/2014 | 14.35 | 66.52 |
| 12/02/2012 | 0 | 26.53 | 26/01/2014 | 9.19 | 30.74 |
| 18/02/2012 | 18.14 | 31 | 1/02/2014 | 41.78 | 105.63 |
| 24/02/2012 | 30.08 | 59.88 | 7/02/2014 | 47.22 | 111.02 |
| 1/03/2012 | 0 | 17.96 | 13/02/2014 | 37.03 | 86.51 |
| 7/03/2012 | 7.97 | 18.4 | 19/02/2014 | 19.94 | 37.68 |
| 13/03/2012 | 70.36 | 69.34 | 25/02/2014 | 25.58 | 42.93 |
| 19/03/2012 | 14.74 | 35.3 | 3/03/2014 | 19.87 | 43.25 |
| 25/03/2012 | 22.74 | 50.13 | 9/03/2014 | 15.7 | 43 |
| 31/03/2012 | 11.76 | 21.05 | 15/03/2014 | 15.12 | 28.62 |
| 6/04/2012 | 21.44 | 71.2 | 21/03/2014 | 21.1 | 39.9 |
| 12/04/2012 | 19.52 | 44.96 | 27/03/2014 | 11.59 | 17.57 |
| 18/04/2012 | 8.08 | 19.97 | 2/04/2014 | 42.84 | 26.49 |
| 24/04/2012 | 3.36 | 5.15 | 8/04/2014 | 20.14 | 0 |
| 30/04/2012 | 13.21 | 34.45 | 14/04/2014 | 42.67 | 45.16 |
| 6/05/2012 | 3.4 | 5.42 | 20/04/2014 | 21.4 | 34.36 |
| 12//5/12 | 1.05 | 11.13 | 26/04/2014 | 28.11 | 58.2 |
| 18/05/2012 | 5.4 | 17.07 | 2/05/2014 | 20.36 | 32.58 |
| 24/05/2012 | 15.14 | 41.98 | 8/05/2014 | 22.47 | 55.77 |
| 30/05/2012 | 3.49 | 27.62 | 14/05/2014 | 15.46 | 27.1 |
| 5/06/2012 | 3.54 | 3.03 | 20/05/2014 | 0 | 27.73 |
| 11/06/2012 | 0.76 | 3.36 | 26/05/2014 | 0 | 45.09 |
| 17/06/2012 | 0.9 | 2.13 | 1/06/2014 | 8.63 | 12.29 |

| Date | PM10 | TSP | Date | PM10 | TSP |
|---|---|---|---|---|---|
| 23/06/2012 | 1.77 | 4.48 | 7/06/2014 | 12 | 18.49 |
| 29/06/2012 | 3.45 | 9.15 | 13/06/2014 | 9.04 | 21.18 |
| 5/07/2012 | 1.89 | 2.6 | 19/06/2014 | 1.79 | 6.49 |
| 11/07/2012 | 4.91 | 2.67 | 25/06/2014 | 3.81 | 7.4 |
| 17/07/2012 | 6.99 | 6.4 | 1/07/2014 | 5.78 | 4.91 |
| 23/07/2012 | 6.15 | 28.89 | 7/07/2014 | 4.45 | 3.17 |
| 29/07/2012 | 5.25 | 6.1 | 13/07/2014 | 0 | 18.44 |
| 3/10/2012 | 8.42 | 15.85 | 19/07/2014 | 15.76 | 37.76 |
| 9/10/2012 | 14.56 | 32.04 | 19/07/2014 | 15.76 | 37.76 |
| 15/10/2012 | 10.58 | 14.65 | 25/07/2014 | 14.05 | 22.51 |
| 21/10/2012 | 20.8 | ND | 31/07/2014 | 12.89 | 28.51 |
| 27/10/2012 | 19.25 | 53.6 | 6/08/2014 | 16.37 | 24.8 |
| 2/11/2012 | 21.41 | 0 | 12/08/2014 | 43.98 | 70.39 |
| 8/11/2012 | 6.97 | 0 | 18/08/2014 | 11.31 | 21.47 |
| 14/11/2012 | 14.58 | 50.76 | 24/08/2014 | 14.71 | 25.52 |
| 20/11/2012 | 14.71 | 42.67 | 30/08/2014 | 11.27 | ND |
| 26/11/2012 | 36.98 | 98.63 | 5/09/2014 | 3.66 | 11.37 |
| 2/12/2012 | 9.35 | 19.84 | 11/09/2014 | 10.66 | 17.22 |
| 8/12/2012 | 27.32 | 58.25 | 17/09/2014 | 4.14 | 7.79 |
| 14/12/2012 | 29.3 | ND | 23/09/2014 | 19.43 | 55.92 |
| 20/12/2012 | 28.44 | ND | 29/09/2014 | 25.75 | 52.93 |
| 26/12/2012 | 6.44 | ND | 5/10/2014 | 7.42 | 25.54 |
| 1/01/2013 | 25.61 | ND | 11/10/2014 | 18.83 | 29.79 |
| 7/01/2013 | ND | 48.36 | 17/10/2014 | 12.53 | 37.55 |
| 13/01/2013 | ND | 39.09 | 23/10/2014 | 31.49 | 64.58 |
| 19/01/2013 | ND | 52.99 | 29/10/2014 | 10.97 | 25.68 |
| 15/01/2013 | 24.05 | 56.34 | 4/11/2014 | 50.46 | 109.29 |
| 31/01/2013 | 27.84 | 51.97 | 10/11/2014 | 21.09 | 69.78 |
| 6/02/2013 | 33.9 | 67.9 | 16/11/2014 | ND | 25.81 |
| 12/02/2013 | 25.45 | 47.73 | 22/11/2014 | ND | 62.52 |
| 18/02/2013 | 22.31 | 51.12 | 28/11/2014 | ND | 50.48 |
| 24/03/2013 | 11.89 | 19.05 | 4/12/2014 | ND | 23.49 |
| 2/03/2013 | 14.02 | 14.43 | 10/12/2014 | ND | 13.68 |
| 8/03/2013 | 19.2 | 44.91 | 16/12/2014 | ND | 103.9 |
| 14/03/2013 | 12.14 | 27.89 | 22/12/2014 | ND | 51.5 |
| 20/03/2013 | 19.01 | 36.74 | 28/12/2014 | ND | 20.59 |
| 25/03/2013 | 38.3 | 76.01 | 3/01/2014 | ND | 58.28 |
| 1/04/2013 | 19.34 | 32.35 | 9/01/2015 | ND | 41.31 |
| 7/04/2013 | 17.16 | 50.52 | 15/01/2015 | ND | 44.78 |
| 13/04/2013 | 16.64 | 38.04 | 21/01/2015 | ND | 45.9 |
| 19/04/2013 | 4.91 | 9.18 | 27/01/2015 | 10.62 | 18.98 |
| 25/04/2013 | 8.71 | 17.2 | 2/02/2015 | 27.6 | 40.95 |
| 1/05/2013 | 9.84 | 22.41 | 8/02/2015 | 6.92 | 66.82 |
| 7/05/2013 | 12.57 | 34.54 | 14/02/2015 | 5.88 | 65.34 |
| 13/05/2013 | 13.61 | 24.07 | 20/02/2015 | 29.64 | 61.3 |
| 19/05/2013 | 5.76 | 5.76 | 26/02/2015 | 16.44 | 36.44 |
| 25/05/2013 | 4 | 1.53 | 4/03/2015 | 31.49 | 71.58 |
| 31/05/2013 | 5.78 | 13.2 | 10/03/2015 | 33.22 | 74.9 |
| 6/06/2013 | 0.9 | 5.72 | 16/03/2015 | 32.41 | 73.64 |
| 12/06/2013 | 0.35 | 4.65 | 22/03/2015 | 20.06 | 50.67 |
| 18/06/2013 | 0.47 | 1.9 | 28/03/2015 | 22.57 | 61.75 |
| 24/06/2013 | 3.57 | 2.24 | 3/04/2015 | 8.94 | 26.25 |

ND No data

## Appendix C

### *Emission Inventory*

**Emission Calculation**

The quarry production schedule and quarry plan designs provided by Boral have been combined with emissions factor equations that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- National Pollutant Inventory (NPI) documents "*Emission Estimation Technique Manual for Mining, Version 3.1*" (**NPI, 2012**);
- State Pollution Control Commission document "Air Pollution from Coal Mining and Related Developments" (**SPCC, 1983**); and,
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: International Best Practise Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining", prepared by Katestone Environmental (**Katestone Environmental, 2010**).

The emission factor equations used for each dust generating activity are outlined in **Table C-1** below. Detailed emission inventory for the modelled year is presented in **Table C-2**.

**Table C-1: Emission factor equations**

| Activity | Emission factor equation | Variables | Control |
|---|---|---|---|
| Loading / emplacing material | $EF = k \times 0.0016 \times \left( \frac{U}{2.2}^{1.3} \Big/ \frac{M}{2}^{1.4} \right) kg/tonne$ | $K_{TSP}$ = 0.74<br>U = wind speed (m/s)<br>M = moisture content (%) | - |
| Hauling on unsealed surfaces | $EF = \left( \frac{0.4536}{1.6093} \right) \times k \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45} kg/VKT$ | S = silt content (%)<br>M = average vehicle gross mass (tonnes) | 80% - watering of trafficked areas |
| Dozers activity | $EF = 2.6 \times \frac{s^{1.2}}{M^{1.3}} kg/hour$ | S = silt content (%)<br>M = moisture content (%) | - |
| Drilling | $EF = 0.59\ kg/hole$ | - | 70% - dust suppression |
| Blasting | $EF = 0.00022 \times A^{1.5} kg/blast$ | A = area to be blasted (m²) | - |
| Screening | $EF = 0.0011\ kg/tonne$ | - | - |
| Crushing (tertiary) | $EF = 0.0083\ kg/tonne$ | - | - |
| Fines Screening | $EF = 0.0011\ kg/tonne$ | - | - |
| Crushing (fines) | $EF = 0.0083\ kg/tonne$ | - | - |
| Conveying material | $EF = 0.4\ kg/ha\ /hour$ | - | 70% - wind shielding |
| Conveyor transfers | $EF = k \times 0.001184 \times \left( \frac{U}{2.2}^{1.3} \Big/ \frac{M}{2}^{1.4} \right) kg/tonne$ | $K_{PM10}$ = 0.75<br>U = wind speed (m/s)<br>M = moisture content (%) | 70% - enclosure |
| Loading product to trains | $EF = k \times 0.0016 \times \left( \frac{U}{2.2}^{1.3} \Big/ \frac{M}{2}^{1.4} \right) kg/tonne$ | $K_{TSP}$ = 0.74<br>U = wind speed (m/s)<br>M = moisture content (%) | 70% - enclosure |
| Wind erosion from exposed areas / stockpiles | $EF = 0.4\ kg/ha\ /hour$ | - | - |
| Grading roads | $EF = 0.0034 \times s^{2.5} kg/VKT$ | S = speed of grader (km/hr) | - |

## Table C-2: Emissions inventory

| ACTIVITY | TSP emission (kg/y) | Intensity | Units | Emission Factor | Units | Variable 1 | Units | Variable 2 | Units | Variable 3 | Units | Variable 4 | Units | Variable 5 | Units | Variable 6 | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Excavator loading overburden to haul truck | 1,859 | 1,150,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Hauling overburden to emplacement area | 32,190 | 1,150,000 | tonnes/ye | 0.140 | kg/t | 40 | tonnes/load | 3.1 | km/return trip | 1.8 | kg/VKT | 2.5 | % silt cont | 55 | Ave GMV (tonn | 80 | % Control |
| Unloading overburden at emplacement area | 1,859 | 1,150,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Dozer shaping overburden emplacement area | 20,886 | 1,248 | hours/year | 16.7 | kg/h | 10 | silt content in % | 2 | moisture content in % | | | | | | | | |
| Drilling rock | 3,068 | 17,333 | holes/year | 0.59 | kg/hole | | | | | | | | | | | 70 | % Control |
| Blasting rock | 1,880 | 52 | blasts/yea | 36 | kg/blast | 3,000 | Area of blast in square metres | | | | | | | | | | |
| Excavator loading rock to haul truck | 6,465 | 4,000,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Hauling rock to hopper | 35,772 | 4,000,000 | tonnes/ye | 0.045 | kg/t | 40 | tonnes/load | 1.0 | km/return trip | 1.8 | kg/VKT | 2.5 | % silt cont | 55 | Ave GMV (tonn | 80 | % Control |
| Unloading rock at stockpile | 6,465 | 4,000,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Excavator loading rock to hopper | 6,465 | 4,000,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Primary crushing of material | 2,400 | 4,000,000 | tonnes/ye | 0.0006 | kg/t | | | | | | | | | | | | |
| Conveying material to screens (grizzly + scalp) | 244 | 0.2 | ha | 3,504 | kg/ha/year | | | | | | | | | | | 70 | % Control |
| Conveyor transfer x5 | 9,697 | 4,000,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | 70 | % Control |
| Screening material | 4,400 | 4,000,000 | tonnes/ye | 0.0011 | kg/t | | | | | | | | | | | | |
| Conveying material to surge pile | 34 | 0.03 | ha | 3,504 | kg/ha/year | | | | | | | | | | | 70 | % Control |
| Unloading material to surge pile | 5,657 | 3,500,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Unloading scalp material | 1,293 | 800,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Loading scalp material to haul truck | 1,293 | 800,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Hauling scalp material to stockpile (near train lo | 6,797 | 800,000 | tonnes/ye | 0.042 | kg/t | 40 | tonnes/load | 1.0 | km/return trip | 1.8 | kg/VKT | 2.5 | % silt cont | 55 | Ave GMV (tonn | 80 | % Control |
| Unloading scalp material at stockpile | 1,293 | 800,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Loading scalp material to trains | 1,293 | 800,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Conveying material from surge pile to crusher | 33 | 0.03 | ha | 3,504 | kg/ha/year | | | | | | | | | | | 70 | % Control |
| Crushing of material | 2,100 | 3,500,000 | tonnes/ye | 0.0006 | kg/t | | | | | | | | | | | | |
| Conveying material to screen | 17 | 0.01 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveying material to screen w/ transfer | 22 | 0.02 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveyor transfer x1 | 622 | 1,165,500 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Screening material | 4,235 | 3,500,000 | tonnes/ye | 0.0011 | kg/t | | | | | 1.1 | 10% rehandle factor | | | | | | |
| Conveying material to train load out Silo 1 | 114 | 0.10 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveying material to train load out Silo 2 | 34 | 0.03 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveyor transfer x1 | 246 | 462,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveying material to train load out Silo 3 | 37 | 0.03 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |

| ACTIVITY | TSP emission (kg/y) | Intensity | Units | Emission Factor | Units | Variable 1 | Units | Variable 2 | Units | Variable 3 | Units | Variable 4 | Units | Variable 5 | Units | Variable 6 | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conveyor transfer x1 | 338 | 633,500 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveying material to crusher (2) | 36 | 0.03 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveyor transfer x1 | 1,230 | 2,306,500 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Crushing (2) of material | 3,806 | 2,306,500 | tonnes/ye | 0.0015 | kg/t | | | | | 1.1 | 10% rehandle factor | | | | | | |
| Conveying material to screen (2) | 15 | 0.01 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Screening (2) material | 1,975 | 997,500 | tonnes/ye | 0.0018 | kg/t | | | | | 1.1 | 10% rehandle factor | | | | | | |
| Conveying material to train load out Silo 4 | 27 | 0.02 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveying material to train load out Silo 5 | 27 | 0.02 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveying material to train load out Silo 6 + 7 | 75 | 0.07 | ha | 3,504 | kg/ha/year | | | | | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Conveyor transfer x2 | 1,396 | 1,309,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content | 1.1 | 10% rehandle factor | | | | | 70 | % Control |
| Screening (air sort) material | 2,592 | 1,309,000 | tonnes/ye | 0.0018 | kg/t | | | | | 1.1 | 10% rehandle factor | | | | | | |
| Unloading Limestone sand from Marulan | 242 | 500,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | 70 | % Control |
| Conveying material to train load out Silo 8 | 33 | 0.03 | ha | 3,504 | kg/ha/year | | | | | | | | | | | 70 | % Control |
| Conveying material to train load out from all Bin | 140 | 0.13 | ha | 3,504 | kg/ha/year | | | | | | | | | | | 70 | % Control |
| Loading product material to trains | 1,697 | 3,500,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | 70 | % Control |
| Unloading overflow material from radial stacker | 194 | 120,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Excavator loading overflow material to haul truck | 194 | 120,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Hauling overflow material to stockpile (near trai | 423 | 120,000 | tonnes/ye | 0.018 | kg/t | 40 | tonnes/load | 0.4 | km/return trip | 1.8 | kg/VKT | 2.5 | % silt cont | 55 | Ave GMV (tonn | 80 | % Control |
| Unloading overflow material at stockpile | 194 | 120,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Loading overflow material to trains | 194 | 120,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Unloading test material from radial stacker | 57 | 35,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Excavator loading test material to hopper | 57 | 35,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Unloading rejects (weathered material) to haul t | 283 | 175,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Excavator loading rejects (weathered material) t | 283 | 175,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Hauling rejects (weathered material) to emplace | 5,271 | 175,000 | tonnes/ye | 0.151 | kg/t | 40 | tonnes/load | 3.4 | km/return trip | 1.8 | kg/VKT | 2.5 | % silt cont | 55 | Ave GMV (tonn | 80 | % Control |
| Unloading rejects (weathered material) at empla | 283 | 175,000 | tonnes/ye | 0.00162 | kg/t | 1.365 | average of (WS/2.2)^1.3 | 2 | moisture content in % | | | | | | | | |
| Grading roads | 1,418 | 2,304 | km | 0.62 | kg/VKT | 8 | speed of graders in km/h | | | | | | | | | | |
| Wind erosion - Overburden emplacement area | 18,450 | 5.3 | ha | 3,504 | kg/ha/year | | | | | | | | | | | | |
| Wind erosion - Open pit | 120,474 | 34.4 | ha | 3,504 | kg/ha/year | | | | | | | | | | | | |
| Wind erosion - Infrastructure stockpiles | 18,828 | 5.4 | ha | 3,504 | kg/ha/year | | | | | | | | | | | | |
| **Total TSP emissions (kg/yr)** | **338,997** | | | | | | | | | | | | | | | | |

## Appendix D

### *Isopleth Diagrams*



TODOROSKI AIR SCIENCES | info@airsciences.com.au | 02 9874 2123

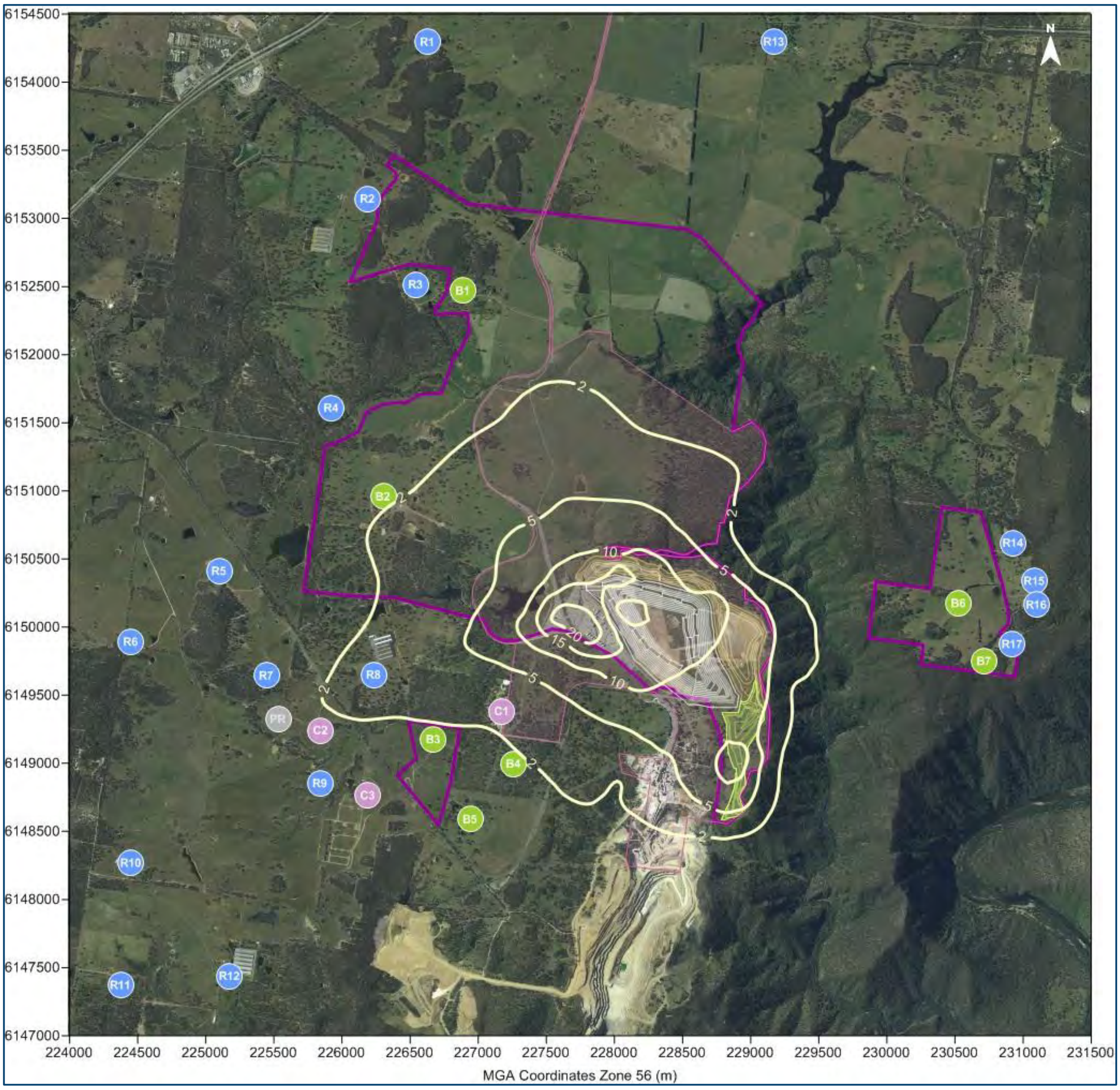



Figure D-1: Predicted maximum incremental 24-hour average $PM_{2.5}$ concentrations (µg/m³)

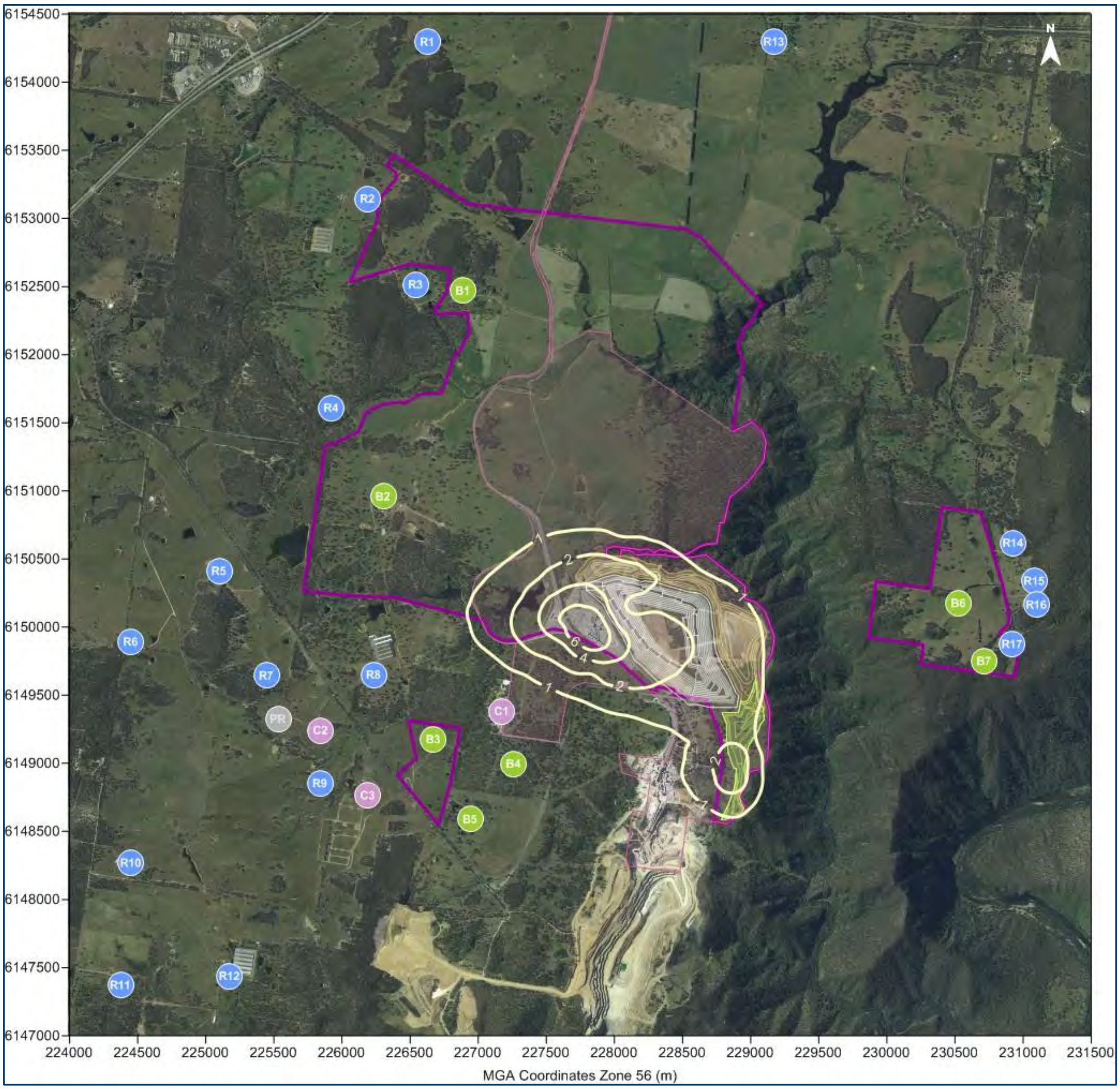



**Figure D-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)**

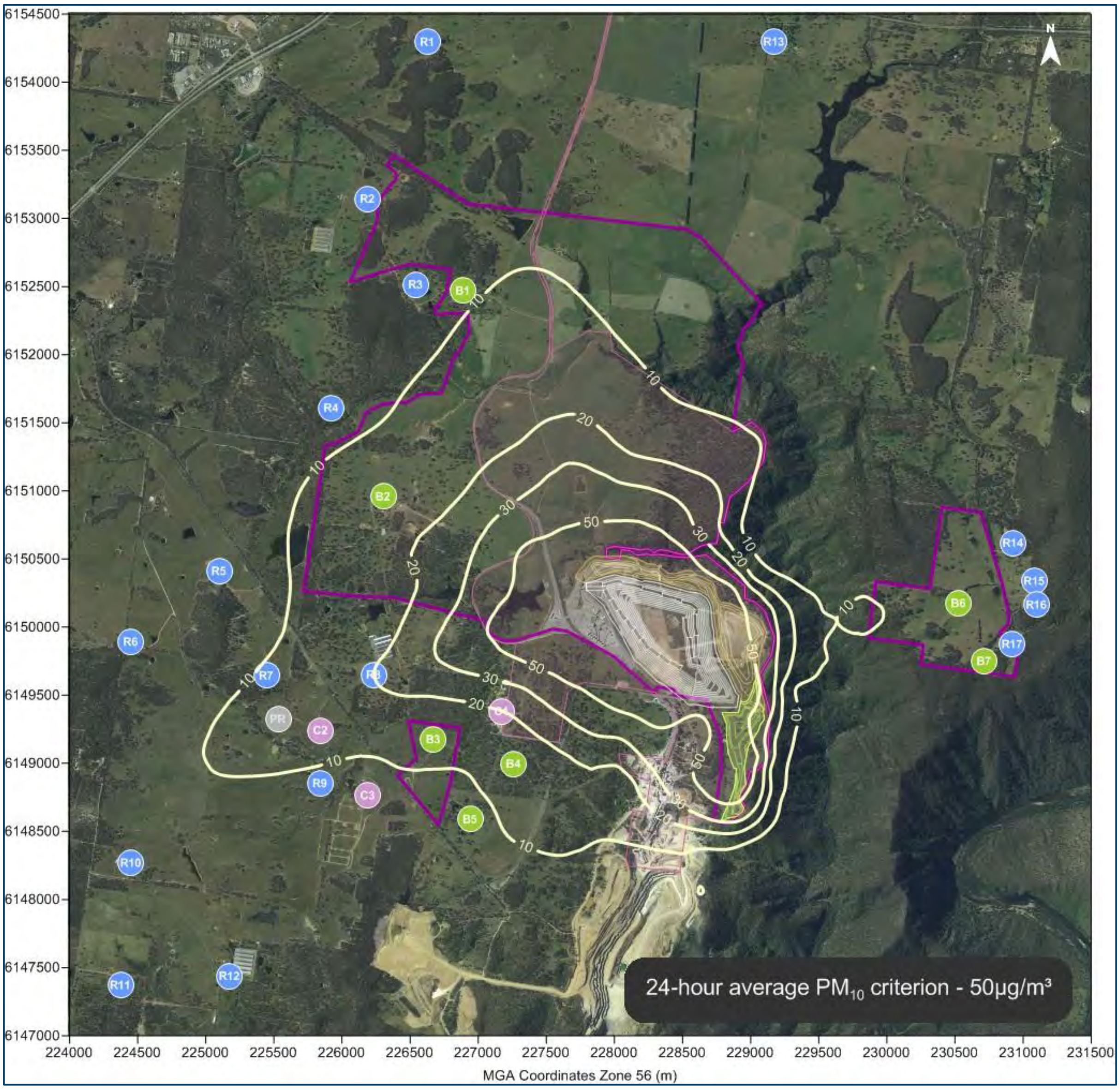



**Figure D-3: Predicted maximum incremental 24-hour average $PM_{10}$ concentrations (µg/m³)**

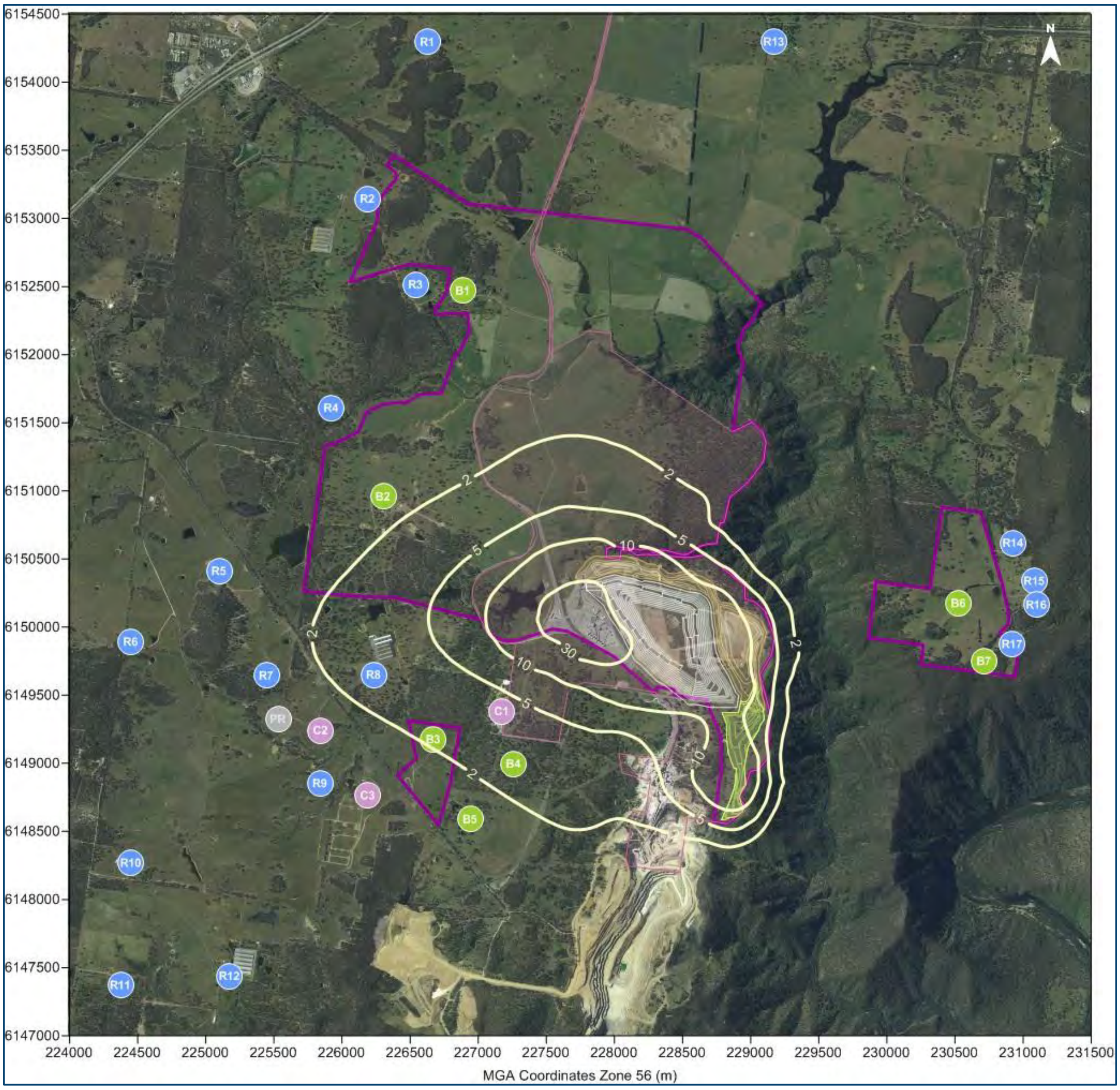



Figure D-4: Predicted incremental annual average $PM_{10}$ concentrations (µg/m³)

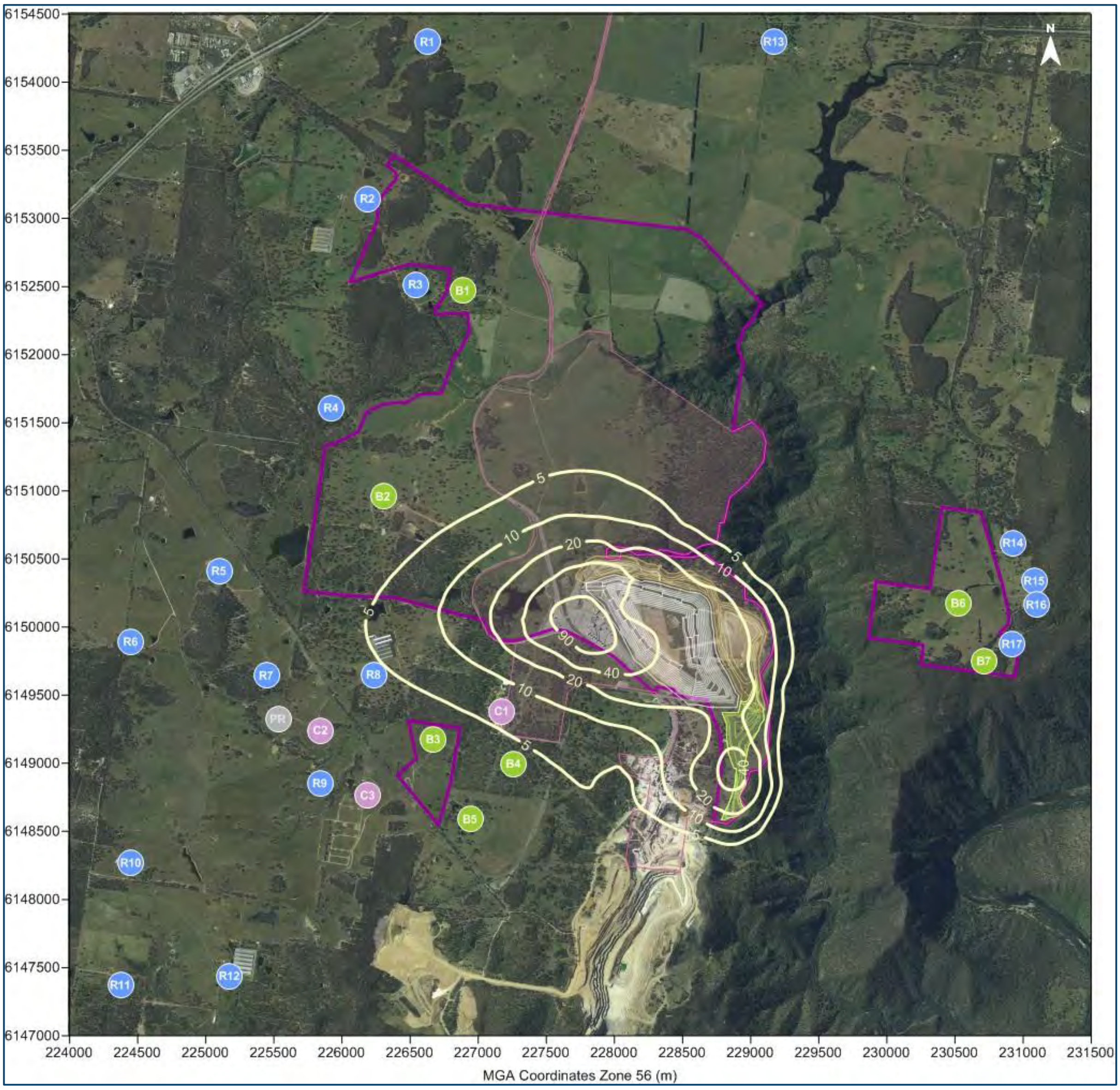



**Figure D-5: Predicted incremental annual average TSP concentrations (µg/m³)**

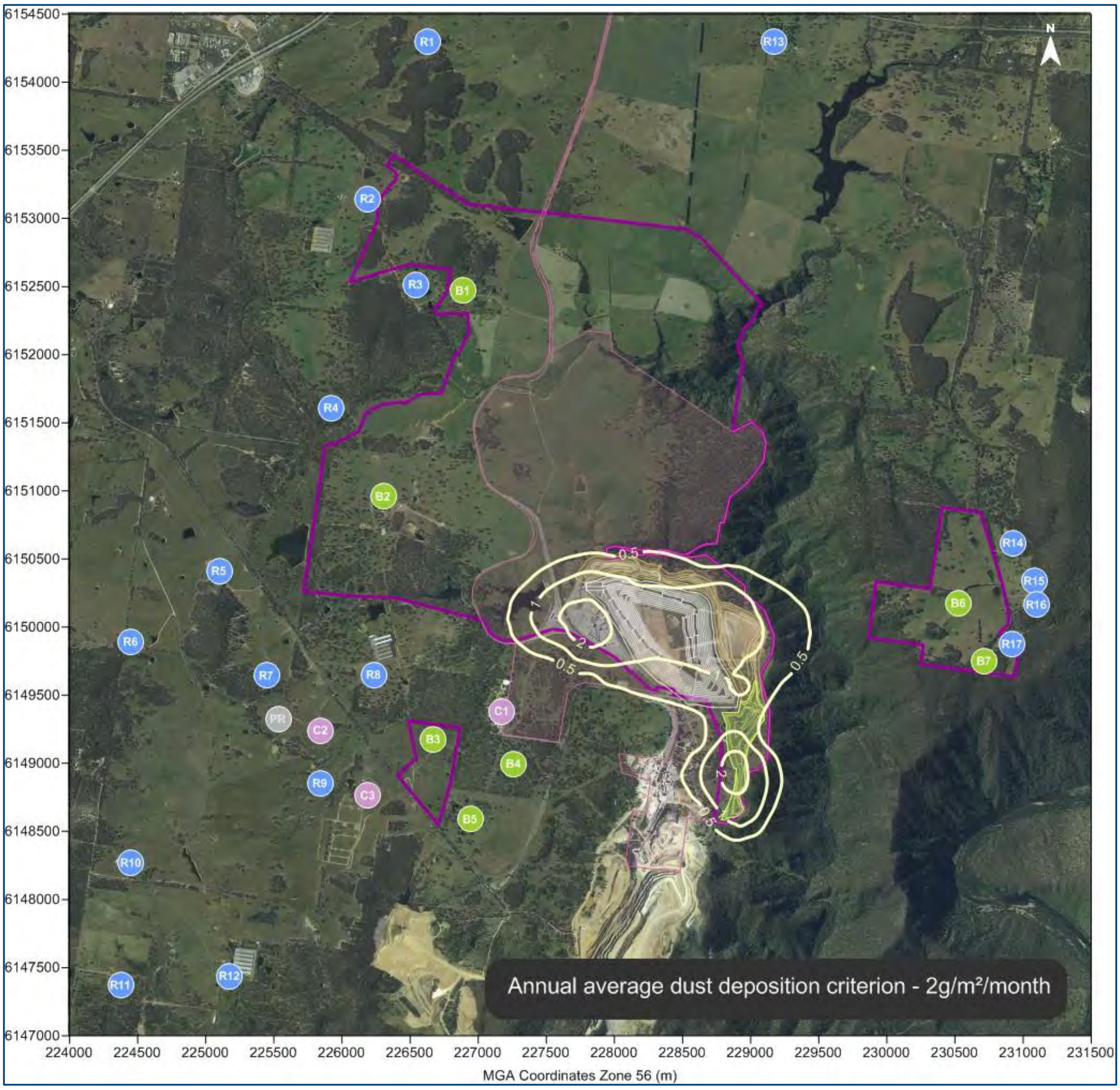



**Figure D-6: Predicted incremental annual average dust deposition levels (g/m²/month)**

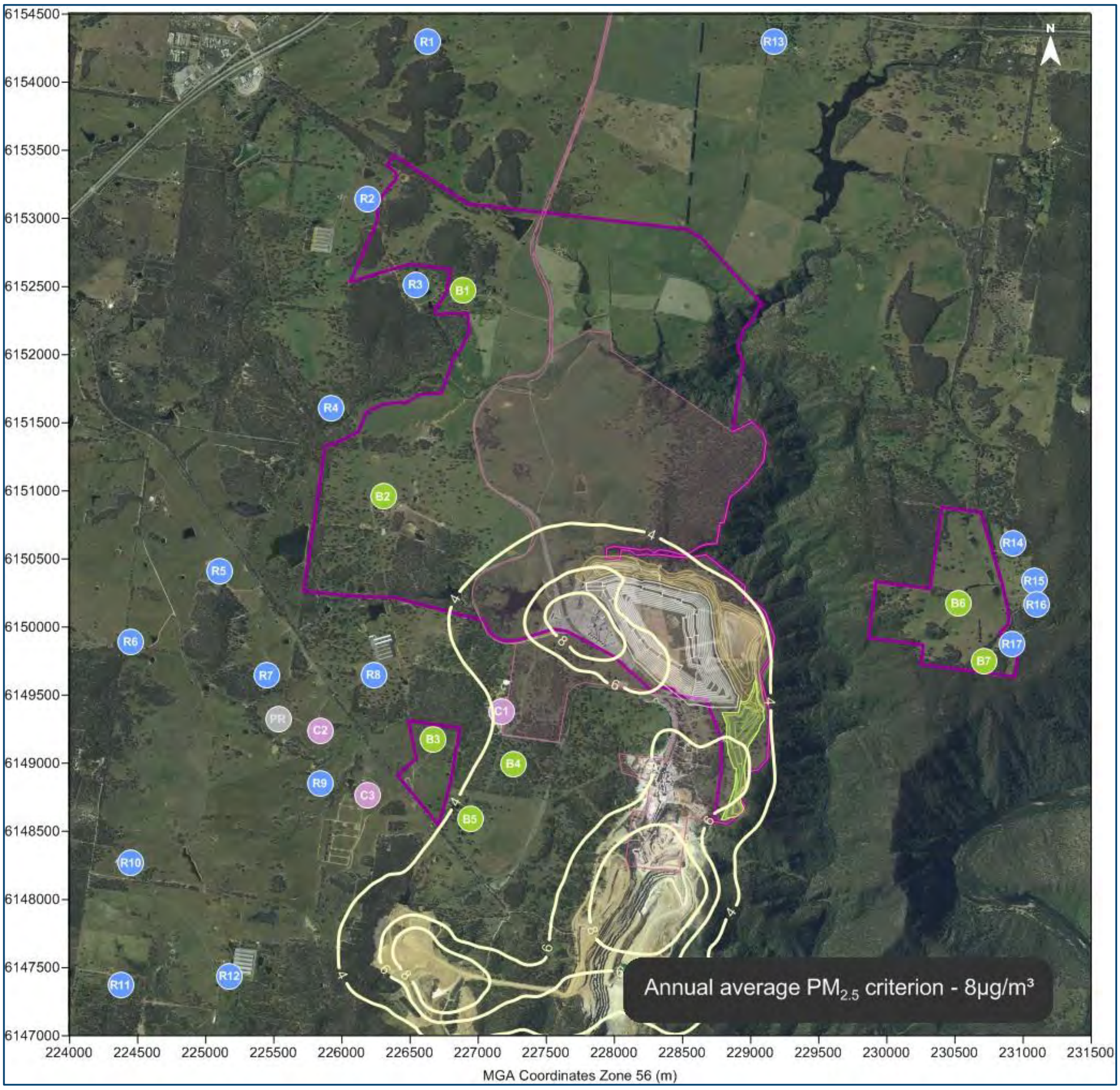



**Figure D-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)**

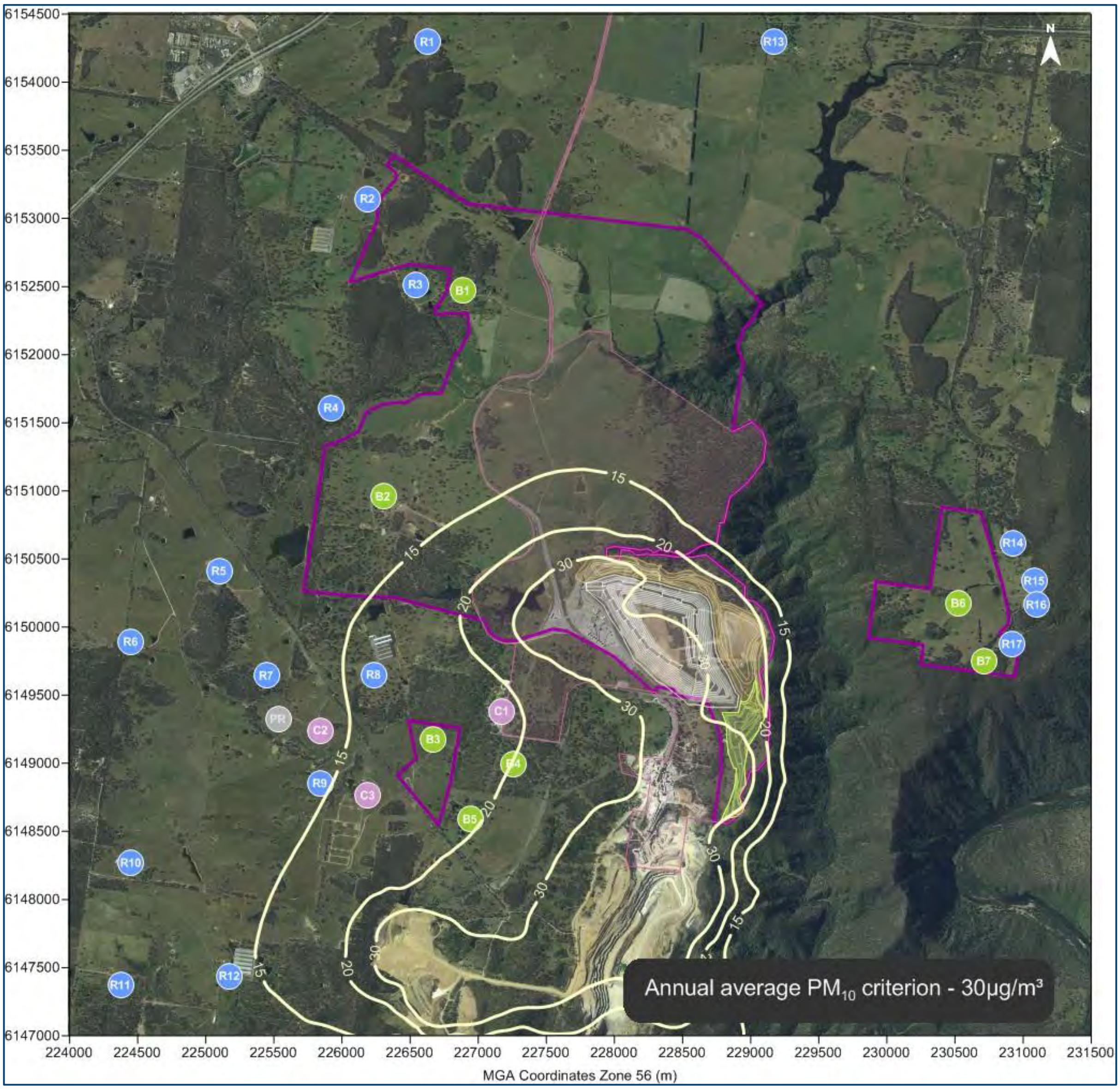



**Figure D-8: Predicted cumulative annual average $PM_{10}$ concentrations (µg/m³)**

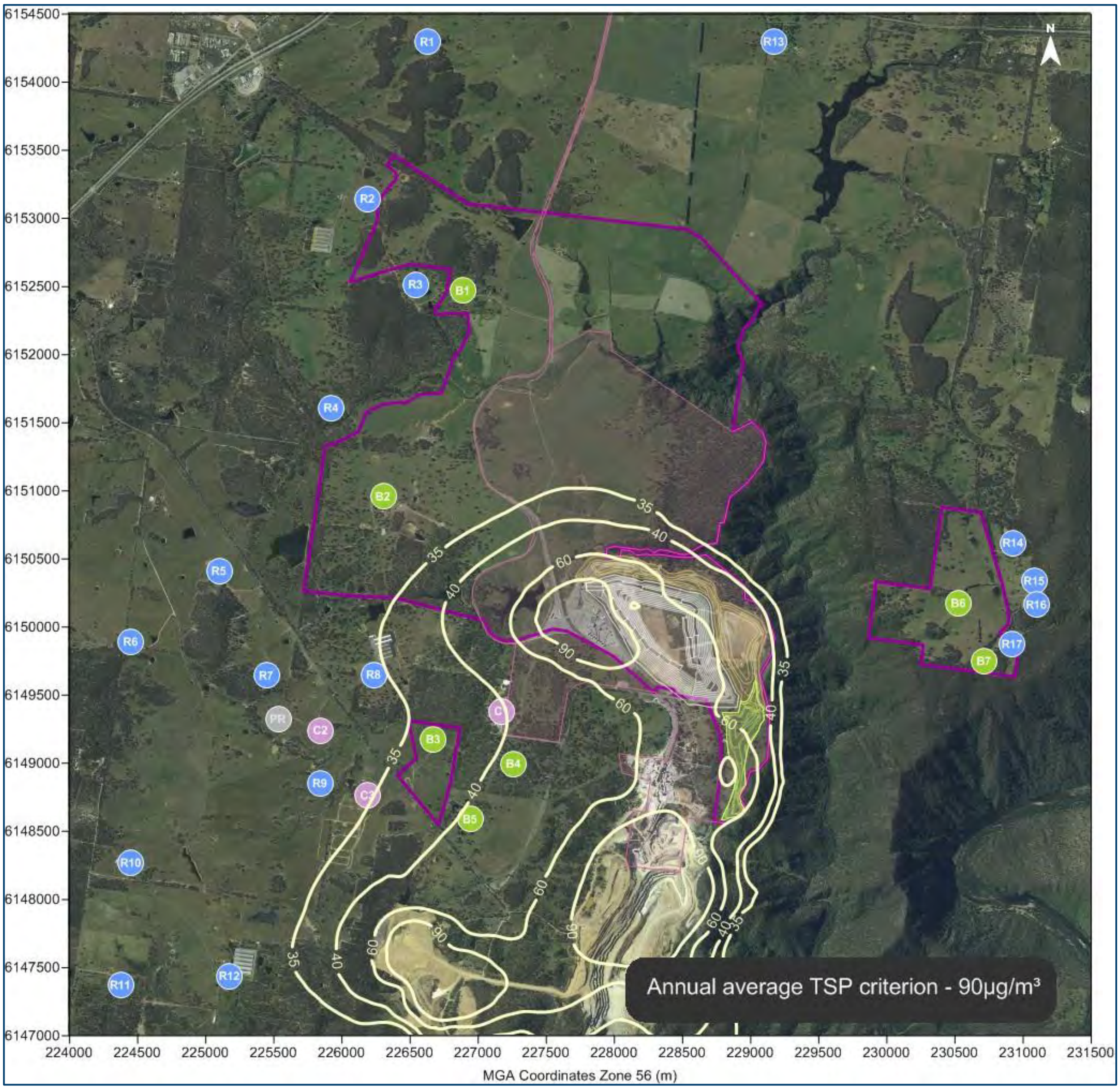



**Figure D-9: Predicted cumulative annual average TSP concentrations (µg/m³)**

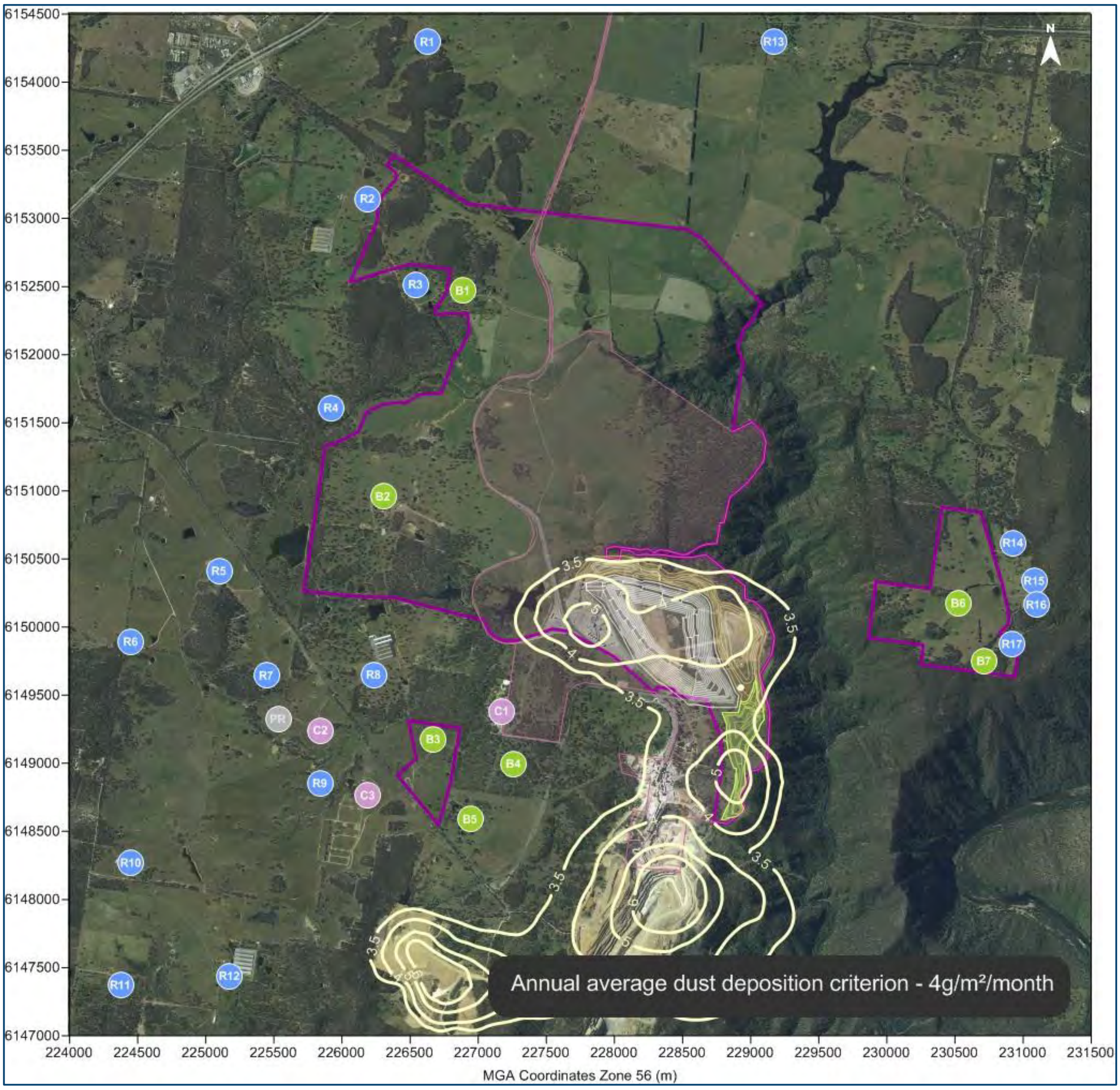



**Figure D-10: Predicted cumulative annual average dust deposition levels (g/m²/month)**

# Appendix E

## *Further detail regarding 24-hour $PM_{10}$ analysis*

The analysis below provides a cumulative 24-hour $PM_{10}$ impact assessment in accordance with the NSW EPA (OEH) Approved Methods; refer to the worked example on Page 52 to 54 of the Approved Methods.

The background level is the estimated ambient level at the nearest monitoring station (HVAS) excluding the contribution from the Peppertree Quarry and Marulan South Limestone Mine.

The predicted increment is the predicted level to occur at the receiver due to the modified Quarry operations and incorporating the Marulan South Limestone Mine.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Each table assesses one receiver. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the modified Quarry operations and Marulan South Limestone Mine.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

Any value above the criterion of 50µg/m$^3$ are in **bold red**

**Tables E-1** to **E-6** show the predicted maximum cumulative levels at each receiver surrounding the Quarry.

**Please note that the 70th percentile of the measured HVAS level (19.8µg/m$^3$) is used on days when there is no monitoring data, hence this number appears frequently in the background levels in the tables.**



TODOROSKI AIR SCIENCES | info@airsciences.com.au | 02 9874 2123

**Table E-1: Receiver R3**

| Ranked by Highest to Lowest Background Concentrations | | | | Ranked by Highest to Lowest Predicted Incremental Concentration | | | |
|---|---|---|---|---|---|---|---|
| Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level | Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level |
| 4/11/2014 | 42.8 | 0.0 | 42.8 | 19/08/2014 | 19.8 | 12.4 | 32.2 |
| 2/04/2014 | 41.9 | 0.0 | 42.0 | 24/03/2014 | 19.8 | 11.5 | 31.4 |
| 7/02/2014 | 41.5 | 0.1 | 41.6 | 9/06/2014 | 19.8 | 9.3 | 29.2 |
| 26/04/2014 | 28.1 | 0.0 | 28.1 | 6/06/2014 | 19.8 | 8.9 | 28.8 |
| 13/02/2014 | 25.5 | 0.3 | 25.8 | 5/04/2014 | 19.8 | 8.6 | 28.4 |
| 29/09/2014 | 25.0 | 0.0 | 25.0 | 14/04/2014 | 18.4 | 8.1 | 26.5 |
| 23/10/2014 | 25.0 | 0.2 | 25.1 | 30/08/2014 | 11.0 | 7.6 | 18.6 |
| 1/02/2014 | 24.9 | 0.5 | 25.3 | 29/08/2014 | 19.8 | 6.9 | 26.7 |
| 20/04/2014 | 21.1 | 0.0 | 21.1 | 28/08/2014 | 19.8 | 6.3 | 26.1 |
| 25/02/2014 | 20.7 | 0.0 | 20.7 | 4/09/2014 | 19.8 | 5.9 | 25.7 |

**Table E-2: Receiver R4**

| Ranked by Highest to Lowest Background Concentrations | | | | Ranked by Highest to Lowest Predicted Incremental Concentration | | | |
|---|---|---|---|---|---|---|---|
| Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level | Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level |
| 4/11/2014 | 42.8 | 0.1 | 42.8 | 5/06/2014 | 19.8 | 11.8 | 31.6 |
| 2/04/2014 | 41.9 | 0.0 | 42.0 | 6/06/2014 | 19.8 | 10.3 | 30.1 |
| 7/02/2014 | 41.5 | 0.2 | 41.7 | 22/08/2014 | 19.8 | 9.7 | 29.5 |
| 26/04/2014 | 28.1 | 0.0 | 28.1 | 21/08/2014 | 19.8 | 9.0 | 28.8 |
| 13/02/2014 | 25.5 | 0.7 | 26.2 | 25/03/2014 | 19.8 | 8.5 | 28.3 |
| 29/09/2014 | 25.0 | 0.0 | 25.1 | 28/08/2014 | 19.8 | 8.3 | 28.2 |
| 23/10/2014 | 25.0 | 1.0 | 26.0 | 1/03/2014 | 19.8 | 8.3 | 28.1 |
| 1/02/2014 | 24.9 | 1.3 | 26.2 | 14/04/2014 | 18.4 | 7.2 | 25.6 |
| 20/04/2014 | 21.1 | 0.0 | 21.2 | 13/04/2014 | 19.8 | 7.2 | 27.0 |
| 25/02/2014 | 20.7 | 0.0 | 20.7 | 24/03/2014 | 19.8 | 6.8 | 26.6 |

**Table E-3: Receiver R8**

| Ranked by Highest to Lowest Background Concentrations | | | | Ranked by Highest to Lowest Predicted Incremental Concentration | | | |
|---|---|---|---|---|---|---|---|
| Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level | Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level |
| 4/11/2014 | 42.8 | 3.3 | 46.1 | 27/12/2014 | 19.8 | 20.7 | 40.5 |
| 2/04/2014 | 41.9 | 0.2 | 42.2 | 23/08/2014 | 19.8 | 19.1 | 39.0 |
| 7/02/2014 | 41.5 | 5.1 | 46.6 | 28/02/2014 | 19.8 | 19.0 | 38.8 |
| 26/04/2014 | 28.1 | 0.0 | 28.1 | 12/09/2014 | 19.8 | 19.0 | 38.8 |
| 13/02/2014 | 25.5 | 8.6 | 34.1 | 22/08/2014 | 19.8 | 18.3 | 38.1 |
| 29/09/2014 | 25.0 | 0.2 | 25.3 | 13/09/2014 | 19.8 | 16.7 | 36.5 |
| 23/10/2014 | 25.0 | 3.7 | 28.7 | 13/03/2014 | 19.8 | 15.9 | 35.8 |
| 1/02/2014 | 24.9 | 9.2 | 34.1 | 1/03/2014 | 19.8 | 15.6 | 35.5 |
| 20/04/2014 | 21.1 | 0.1 | 21.3 | 13/01/2014 | 19.8 | 15.5 | 35.4 |
| 25/02/2014 | 20.7 | 0.8 | 21.4 | 30/05/2014 | 19.8 | 15.3 | 35.2 |

**Table E-4: Receiver R9**

| Ranked by Highest to Lowest Background Concentrations | | | | Ranked by Highest to Lowest Predicted Incremental Concentration | | | |
|---|---|---|---|---|---|---|---|
| Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level | Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level |
| 4/11/2014 | 42.8 | 3.5 | 46.3 | 1/03/2014 | 19.8 | 18.5 | 38.4 |
| 2/04/2014 | 41.9 | 0.3 | 42.2 | 21/01/2014 | 19.8 | 16.8 | 36.7 |
| 7/02/2014 | 41.5 | 3.3 | 44.8 | 20/01/2014 | 11.0 | 15.6 | 26.6 |
| 26/04/2014 | 28.1 | 0.0 | 28.1 | 22/08/2014 | 19.8 | 15.4 | 35.3 |
| 13/02/2014 | 25.5 | 8.7 | 34.2 | 28/02/2014 | 19.8 | 15.4 | 35.2 |
| 29/09/2014 | 25.0 | 0.1 | 25.2 | 7/04/2014 | 19.8 | 15.1 | 34.9 |
| 23/10/2014 | 25.0 | 4.7 | 29.7 | 13/03/2014 | 19.8 | 14.1 | 34.0 |
| 1/02/2014 | 24.9 | 9.0 | 33.9 | 30/05/2014 | 19.8 | 13.5 | 33.4 |
| 20/04/2014 | 21.1 | 0.1 | 21.2 | 23/08/2014 | 19.8 | 12.7 | 32.6 |
| 25/02/2014 | 20.7 | 1.5 | 22.2 | 25/03/2014 | 19.8 | 12.3 | 32.2 |

**Table E-5: Receiver R12**

| Ranked by Highest to Lowest Background Concentrations | | | | Ranked by Highest to Lowest Predicted Incremental Concentration | | | |
|---|---|---|---|---|---|---|---|
| Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level | Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level |
| 4/11/2014 | 42.8 | 1.9 | 44.7 | 10/11/2014 | 6.1 | 17.9 | 24.0 |
| 2/04/2014 | 41.9 | 0.4 | 42.3 | 27/04/2014 | 19.8 | 15.1 | 34.9 |
| 7/02/2014 | 41.5 | 4.8 | 46.3 | 13/01/2014 | 19.8 | 15.1 | 34.9 |
| 26/04/2014 | 28.1 | 0.0 | 28.1 | 6/02/2014 | 19.8 | 14.4 | 34.2 |
| 13/02/2014 | 25.5 | 6.9 | 32.4 | 30/05/2014 | 19.8 | 14.4 | 34.2 |
| 29/09/2014 | 25.0 | 0.0 | 25.1 | 23/02/2014 | 19.8 | 13.8 | 33.6 |
| 23/10/2014 | 25.0 | 4.1 | 29.0 | 2/03/2014 | 19.8 | 13.2 | 33.0 |
| 1/02/2014 | 24.9 | 10.1 | 35.0 | 12/02/2014 | 19.8 | 13.2 | 33.0 |
| 20/04/2014 | 21.1 | 0.0 | 21.2 | 3/03/2014 | 2.2 | 12.8 | 15.0 |
| 25/02/2014 | 20.7 | 1.3 | 22.0 | 7/04/2014 | 19.8 | 12.7 | 32.5 |

**Table E-6: Receiver R17**

| Ranked by Highest to Lowest Background Concentrations | | | | Ranked by Highest to Lowest Predicted Incremental Concentration | | | |
|---|---|---|---|---|---|---|---|
| Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level | Date | Background level | Predicted increment due to Project | Total cumulative 24-hr average level |
| 4/11/2014 | 42.8 | 0.3 | 43.1 | 4/06/2014 | 19.8 | 5.9 | 25.8 |
| 2/04/2014 | 41.9 | 1.2 | 43.1 | 26/06/2014 | 19.8 | 5.8 | 25.6 |
| 7/02/2014 | 41.5 | 0.1 | 41.6 | 17/07/2014 | 19.8 | 5.7 | 25.5 |
| 26/04/2014 | 28.1 | 2.0 | 30.1 | 10/07/2014 | 19.8 | 5.7 | 25.5 |
| 13/02/2014 | 25.5 | 0.4 | 25.8 | 25/06/2014 | 3.8 | 5.6 | 9.4 |
| 29/09/2014 | 25.0 | 0.3 | 25.4 | 7/06/2014 | 2.1 | 5.4 | 7.5 |
| 23/10/2014 | 25.0 | 0.4 | 25.4 | 11/07/2014 | 19.8 | 5.4 | 25.2 |
| 1/02/2014 | 24.9 | 0.0 | 24.9 | 29/06/2014 | 19.8 | 4.9 | 24.7 |
| 20/04/2014 | 21.1 | 1.7 | 22.9 | 30/06/2014 | 19.8 | 4.8 | 24.6 |
| 25/02/2014 | 20.7 | 0.0 | 20.7 | 31/08/2014 | 19.8 | 4.8 | 24.6 |