APPENDIX 5

Noise and Blasting Impact Assessment

Inspired people | Dedicated team
Quality outcomes

Holcim (Australia) Pty Ltd

NOISE AND BLASTING IMPACT ASSESSMENT

Teven Quarry Project

November 2014

Holcim (Australia) Pty Ltd

NOISE AND BLASTING IMPACT ASSESSMENT

Teven Quarry Project

November 2014

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
Holcim (Australia) Pty Ltd

Project Director:	**John Merrell**
Project Manager:	**Gabrielle Allan**
Technical Director:	**Tim Procter**
Report No.	**3230/R02/FINAL**
Date:	**November 2014**

umwelt

Newcastle

75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 Introduction

Holcim (Australia) Pty Ltd (Holcim Australia) operates the Teven Quarry, an existing hard rock quarry located at Stokers Lane, Teven, approximately eight kilometres north-west of Ballina (refer to **Figure 1.1**). Teven Quarry has been producing construction and road building materials since the 1940s and has approval to continue operation until 2056.

Due to increasing demand for quarry products associated with current and future major construction projects, for example road upgrade works, in the region and significant forecast population growth, Holcim Australia is seeking development consent to increase production from Teven Quarry from the currently approved limit of 265,000 tonnes per annum (tpa) to 500,000 tpa, as well as extend the hours of operations for product transport and add additional processing options to site infrastructure. This proposal is referred to as the Teven Quarry Project (the Project). No change to the existing approved quarry footprint or disturbance area are proposed as part of the Project. Further detail of the proposed Project is provided in **Section 2.0**.

Approval for the Project is being sought under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Part 4, Division 4.1 of the EP&A Act provides a framework for the assessment and approval of development classified as 'State Significant' in NSW. The Project satisfies the criteria for State Significant Development listed in Schedule 1 of the *State Environmental Planning Policy (State and Regional Development) 2011* as it involves production of 500,000 tpa of saleable product from a resource exceeding 5 million tonnes. The Minister for Planning and Environment (DP&E) is the approval authority for all projects assessed as State Significant Development.

An Environmental Impact Statement (EIS) has been prepared for the Project to accompany a Project Application. This Noise and Blasting Impact Assessment (NIA) has been prepared by Umwelt (Australia) Pty Limited (Umwelt) as part of the EIS for the Project. The NIA has been undertaken in accordance with the NSW Environment Protection Authority (EPA) NSW *Industrial Noise Policy* (INP) (EPA 2000) with the objective of addressing the key issues relating to noise as required by the DP&E Director-General's Requirements for the Project (refer to **Section 3.1**).

Image Source: Google Earth (2012)

0 1.0 2.0 4.0km
1:75 000

Legend

Project Area

FIGURE 1.1

Locality Plan

2.0 Project Description

Holcim Australia proposes to increase production at the Teven Quarry from the currently approved 265,000 tpa to 500,000 tpa. This will be achieved by maximising use of the existing fixed crushing and screening plant (approximately 350,000 tpa capacity) and adding an in-pit mobile plant to cater for periods of peak demand (approximately 150,000 tpa capacity). Holcim Australia also proposes the addition of new processing options/equipment which will add value to the products produced on site, including the addition of:

- a mobile pugmill; and
- allowance for recycling of surplus concrete from local approved concrete batching facilities in the region for re-use as product.

To accommodate the needs of future major construction projects, for example road upgrades, Holcim Australia is also seeking to extend the hours of operation of the Teven Quarry for a limited range of activities, including:

- truck loading and product transport;
- stockpile management; and
- maintenance.

The proposed extended operating hours would allow the above activities to operate up to 10.00 pm Monday to Friday on a campaign basis (i.e. only when required to meet the needs of a particular project). No blasting, quarrying, crushing or screening would be undertaken during the proposed extended hours of operation.

Holcim Australia is also seeking to standardise the existing hours of operation for the remaining site activities with the currently accepted day-time period, that is, between 7.00 am and 6.00 pm Monday to Saturday.

The proposed Project does not involve any change to the existing approved extraction limit boundary or depth of the Teven Quarry.

A summary of the key components of the proposed Project compared to the existing approved operations is provided in **Table 2.1**.

Table 2.1 – Comparison of Existing Operations and Proposed Project

Project Component	Currently Approved	Proposed Project
Quarry life	Quarry operations permitted until 2056	30 years from date of approval.
Limits of production	200,000 tonnes per annum in 1995, increasing annually by 1.5% to 495,974 tonnes per annum in 2056.	500,000 tonnes per annum.
Quarry footprint	Shown on **Figure 2.1**.	No change
Overburden management	Shown on **Figures 2.2** and **2.3**.	No change
Hours of operation	Blasting: 9.00 am – 3.00 pm Monday to Friday All other activities: 7.00 am – 5.00 pm Monday to Friday 7.00 am – 4.00 pm Saturday	Blasting: No change All other activities: 7.00 am – 6.00 pm Monday to Saturday Extended hours for product loading and transport, stockpile management and maintenance: 6.00 pm to 10.00 pm Monday to Friday
Transport	Road transport at current approved production level	Road transport at proposed production level
Employment	8 Full Time Equivalent positions	11 Full Time Equivalent positions
Infrastructure	Fixed primary, secondary and tertiary crushing and screening plant	Retain all existing plant plus new: Mobile crushing and screening plant; and Mobile pug mill.
Site Access	Off Stokers Lane	No change
Concrete recycling for re-use as product	Not currently undertaken	Commence recycling of up to 10,000 tonnes per annum of clean surplus concrete material on site using existing and proposed processing infrastructure for re-use as product.

2.1 Project Design Process to Minimise Noise Impacts

Potential noise impacts associated with the Project were a key consideration in the design of the Project. Noise modelling was completed on an iterative basis throughout the design of the Project to develop the Project so that, as far as practicable, noise impacts associated with the Project were minimised. There was consideration of project alternatives during the iterative project design, noise modelling and assessment process including:

- the investigation of operational scenarios that considered different machine utilisation levels during the day-time that would achieve the Project production schedule and minimise noise impacts;
- investigation of noise attenuation operations required such that the addition of the new plant and equipment would not increase the noise impacts of the overall development;

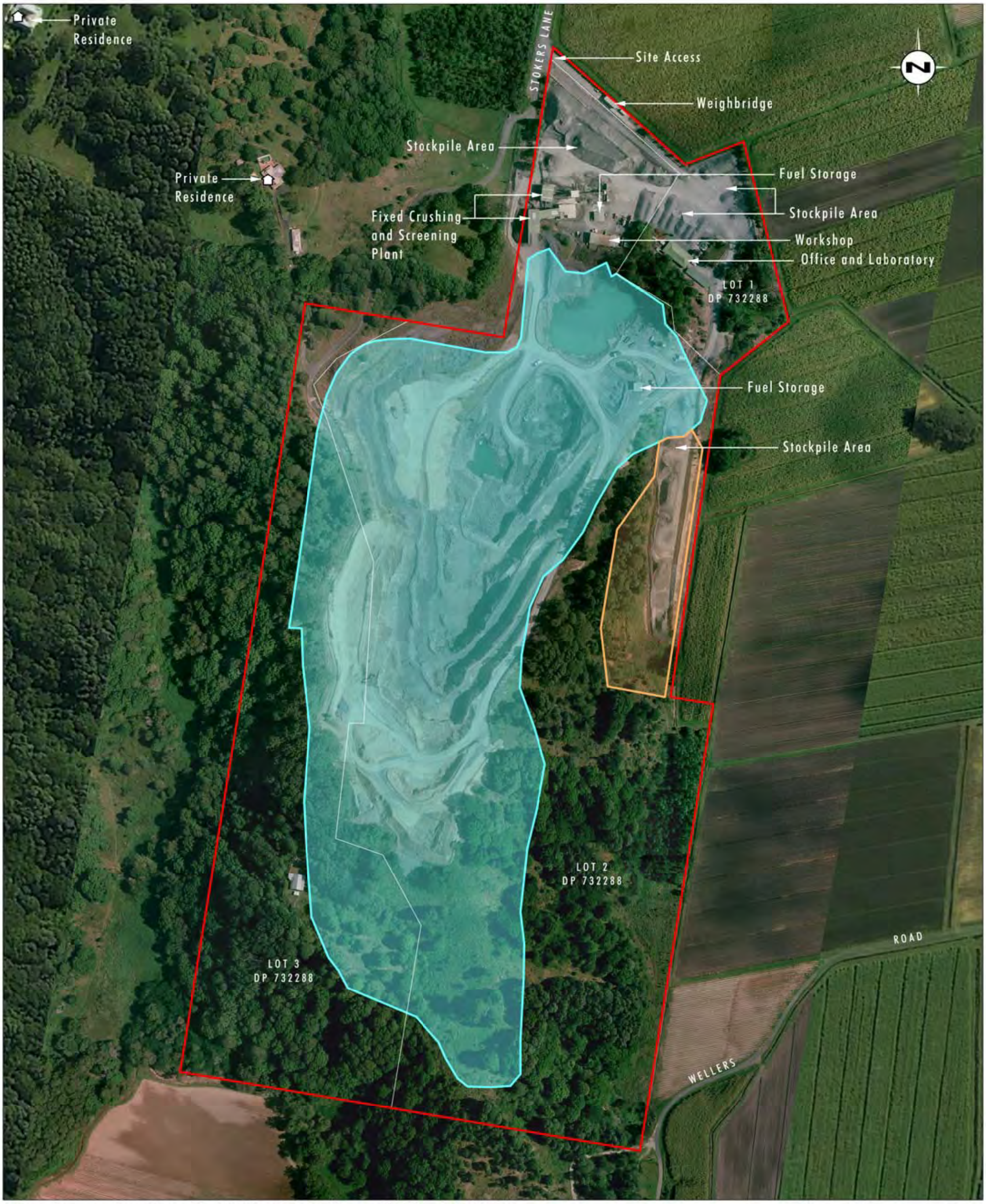


Image Source: Google Earth (2013), Holcim (Australia) Pty Ltd (2014)
Data Source: Holcim (Australia) Pty Ltd (2014)

0 50 100 200m
1:5 000

Legend
- Project Area
- Extraction Limit Boundary
- Stockpile Area
- Private Residence

FIGURE 2.1

Teven Quarry Existing Operations

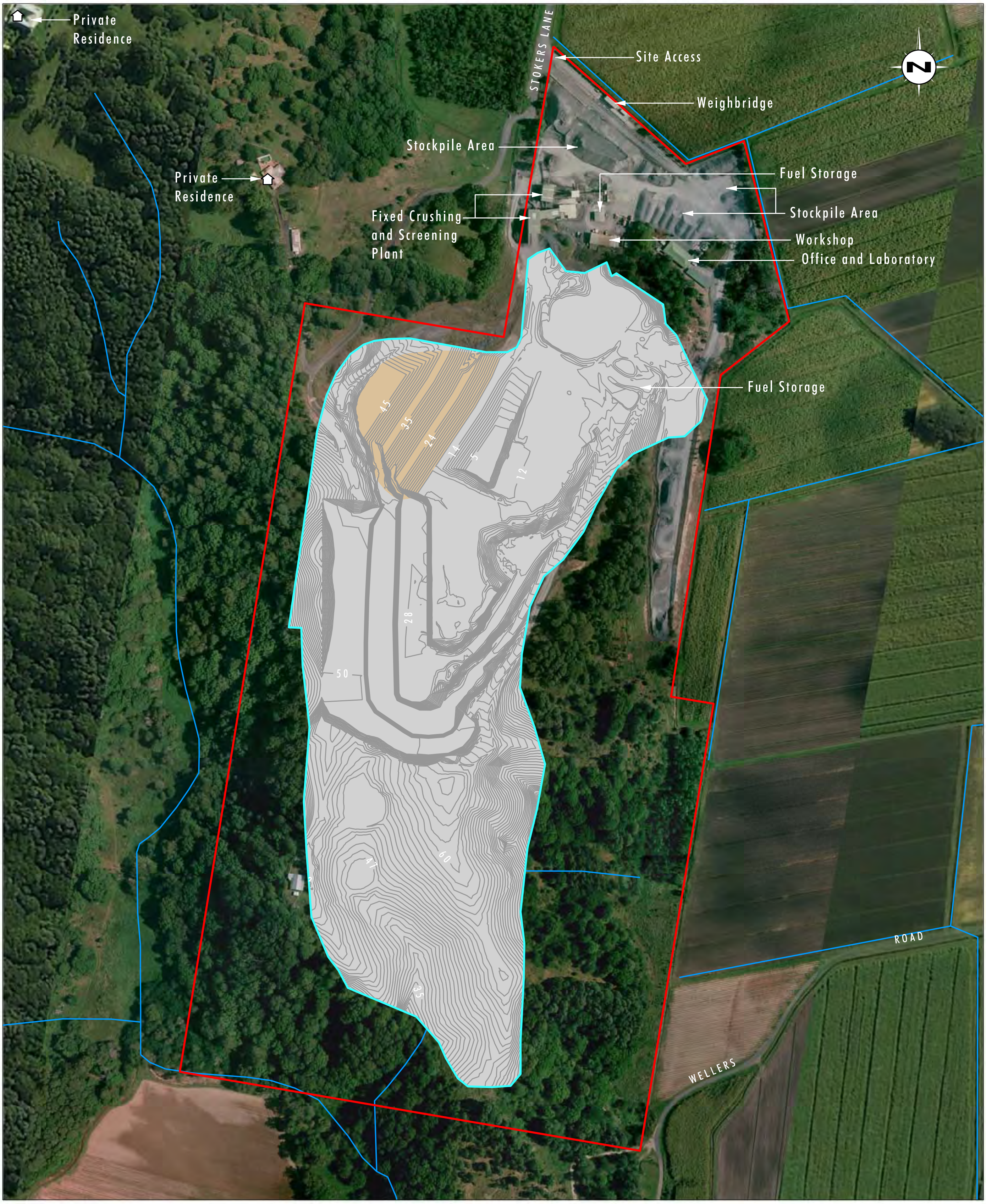


Image Source: Google Earth (2013), Holcim (Australia) Pty Ltd (2014)
Data Source: Holcim (Australia) Pty Ltd (2014)

0 50 100 200m
1:5 000

Legend
- Project Area
- Extraction Limit Boundary
- Western Overburden Emplacement Area
- Private Residence
- Drainage Line

FIGURE 2.2

Teven Quarry Year 1 Indicative Quarry Plan

File Name (A4): R02/3230_028.dgn
20140522 12.59

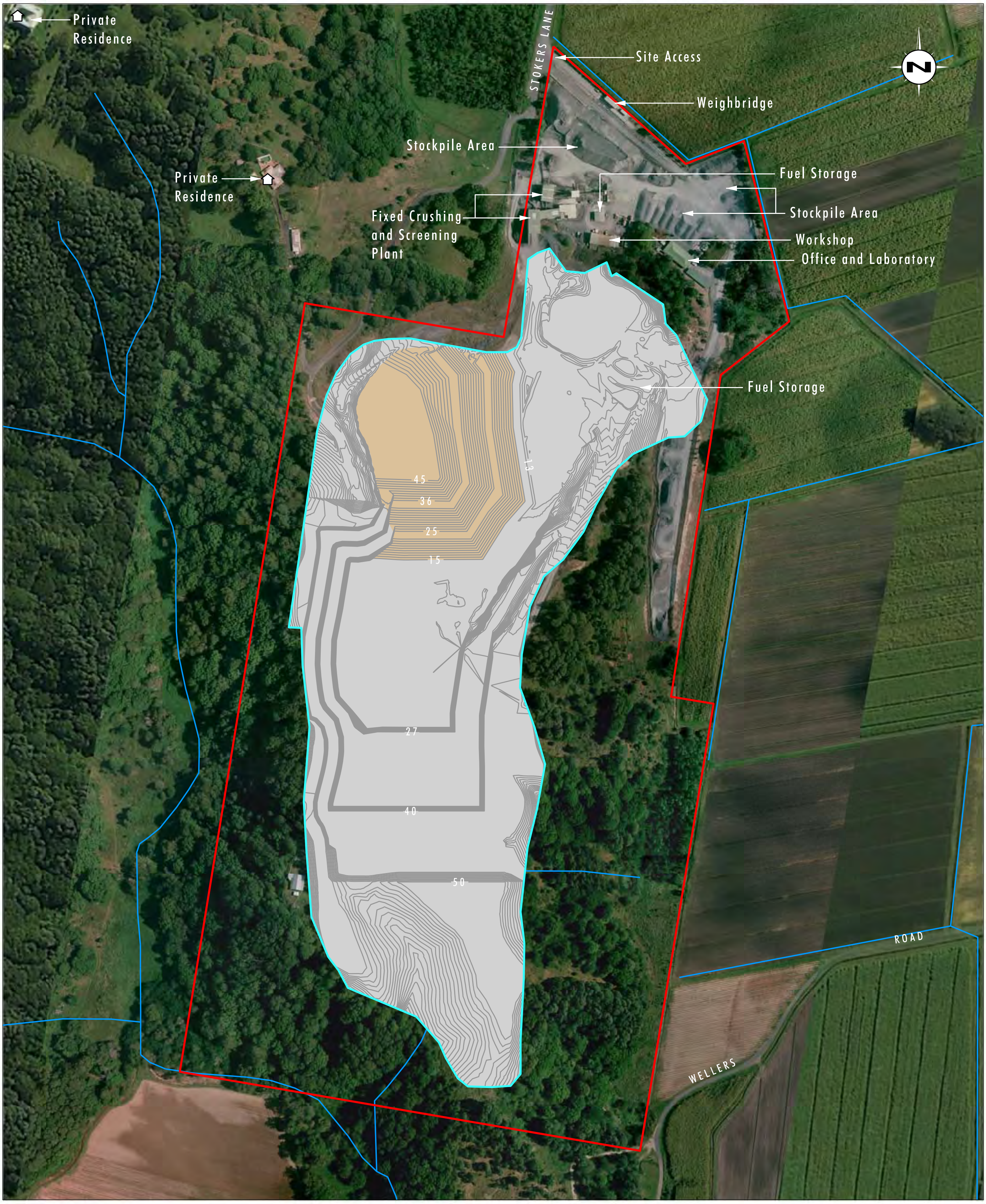


Image Source: Google Earth (2013), Holcim (Australia) Pty Ltd (2014)
Data Source: Holcim (Australia) Pty Ltd (2014)

Legend

- Project Area
- Extraction Limit Boundary
- Western Overburden Emplacement Area
- Private Residence
- Drainage Line

FIGURE 2.3

Teven Quarry Year 11 Indicative Quarry Plan

File Name (A4): R02/3230_029.dgn
20140522 13.00

- investigation of alternative locations for the mobile crushing plant to minimise the transmission of noise from the new plant to the surrounding environment;
- investigation of operational alternatives for the Project under adverse meteorological conditions during the evening period, including managing product dispatch activities and restricting activities in exposed locations; and
- investigation of the use of product stockpiles as noise barriers during the evening period.

This process sought to minimise the extent of potential noise affectation on private properties and residences, and to enable consideration of all reasonable and feasible noise control measures in the project design and optimisation process.

In addition to the identification of appropriate noise controls incorporated into Project design, this assessment process also considered the use of adaptive management (refer to **Section 7.0**) to noise that focuses on implementing appropriate operational controls and management strategies to proactively manage potential noise impacts associated with the operation. As outlined in **Section 7.0**, in addition to the extensive noise controls factored into the noise model (refer to **Section 5.0**), Holcim Australia is committed to an adaptive approach to noise management at Teven Quarry as this is an effective and proactive management tool to minimise potential noise impacts over the life of the Project.

3.0 Assessment Methodology

3.1 Director-General's Requirements

The Department of Planning and Environment (DP&E) has issued Director-General's Requirements (DGRs) for the Project that identify noise impacts as a key issue for consideration in the EIS for the Project. In regard to noise and blasting, the DGRs specify that the EIS must include quantitative assessment of potential:

- construction (refer to **Section 4.6**), operational (refer to **Section 6.1**), transport and off-site road noise impacts (refer to **Sections 6.2**);
- reasonable and feasible mitigation measures (refer to **Sections 2.1**, **5.2**, **6.1** and **8.1**), including evidence that there are no such measures available other than those proposed (refer to **Section 2.1** and **5.2**); and
- monitoring (refer to **Section 7.3**) and management measures (refer to **Section 7.1**).

The DGRs specify that this assessment should be undertaken in accordance with the following policies and guidelines:

- *NSW Industrial Noise Policy* (INP) (EPA 2000); and
- *NSW Road Noise Policy* (DECCW 2011).

The following guidelines have been used, in addition to those mentioned above, to undertake the NIA for the Project:

- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration [The Australian and New Zealand Environment Conservation Council (ANZECC) 1990];
- *Interim Construction Noise Guideline* (DECC 2009); and
- INP (EPA 2000) Application Notes (as at May 2014).

3.2 Noise Impact Assessment Methodology

3.2.1 Section 10 of the Industrial Noise Policy

The DGRs require the proposal be assessed in accordance with the INP (EPA 2000). Section 10 – Applying the Policy to Existing Industrial premises of the INP (EPA 2000) outlines a methodology for the assessment of a project where a company proposes to upgrade or modify its existing operations. This methodology is also applicable to a proposal for the continuation of an existing operation. As outlined in **Section 1.0**, the NIA includes both the continuation of operations at Teven Quarry and the proposed increase in production capacity of the quarry.

The INP (EPA 2000) identifies four triggers for the application of Section 10. These are:

1. the site becomes the subject of serious and persistent noise complaints;
2. there is a proposal to upgrade and/or expand the site;

3. the site has no formal consent or licence conditions and management wish to clarify their position; or

4. management chooses to initiate a noise reduction program.

Using theses triggers as a guide, the methodology for the preparation of the NIA has taken into account:

1. The Project is not the subject of serious and persistent noise complaints from the community or EPA.

2. An EIS and supporting studies will be required to enable the proposed increase in production capacity (refer to **Section 2.0**). While the operations will remain substantially the same, the Project will include changes in operational aspects, additional plant and equipment and an extension to operating hours to cater for peak project demands.

3. The original development consent for Teven Quarry was granted in 1995 prior to the publishing of the Industrial Noise Policy in 2000. While a noise goal for the quarry was included within EPL 3293 in July 2007 as part of a NSW EPA noise reduction program, the quarry does not currently operate under a contemporary set of noise related consent or licence conditions. As noted in Point 2 above, the Project will include additional plant and equipment and an extension to operating hours. As a result, it will be necessary to establish new, achievable project-specific noise goals for the Project.

4. The expectation of the INP (EPA 2000) is that new consent or licence noise limits obtained for an upgrade or expansion of an existing operation would reconcile the application of feasible and reasonable noise control measures with the economic, social and environmental considerations of the Project. Teven Quarry implemented a noise reduction program under the guidance of the NSW EPA from March 2006 to February 2008. As part of the noise reduction program, Teven Quarry implemented a range of noise control measures and technologies including:

    - enclosure of the primary crusher, including a partial enclosure around the primary dump hopper;
    - enclosure of Screen No. 1;
    - enclosure of Screen No. 2;
    - enclosure of the secondary crushers; and
    - installation of rubber lining to the primary feed bin.

    Additional noise mitigation and management measures were also implemented during 2012 to 2014 including:

    - installation of a new primary crusher with enhanced noise attenuation;
    - upgrade of noise attenuation of exhaust systems on quarry haul trucks;
    - extension of the enclosure of the primary dump hopper; and
    - entering into negotiations with the nearest noise affected resident to obtain a commercial agreement.

The historical approach taken to Teven Quarry's management of noise has incorporated the application of new and proven noise control measures/technologies in concert with the management of economic, social and environmental impacts. This methodology has formed the basis for the detailed design process for the Project (refer to **Section 2.0**) and the identification of any additional reasonable and feasible noise mitigation measures for the Project (refer to **Section 7.0**).

There has been a significant change in noise policy and objectives since the existing approval was granted in 1995. Accordingly, a comprehensive assessment of the existing noise environment and definition of refined noise impact assessment goals has been undertaken as part of the NIA in order to assess the Project in accordance with contemporary requirements and expectations.

Section 10 of the INP (EPA 2000) notes that in establishing revised project-specific noise levels (PSNL) for the Project:

- the PSNLs are not applied as mandatory noise limits;
- the PSNLs supply the initial target levels and drive the process of assessing all feasible and reasonable control measures;
- achievable noise limits result from applying all feasible and reasonable noise control measures; and
- for sites with limited mitigation measures the achievable noise limits may sometimes be above the PSNLs.

3.2.2 Deriving Noise Limits

The INP (EPA 2000) provides a framework and methodology for deriving limit conditions for consent and Environment Protection Licence (EPL) conditions. Using this policy the EPA regulates premises that are scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act).

The specific INP (EPA 2000) objectives are:

- to establish noise criteria that would protect the community from excessive intrusive noise and preserve the noise amenity for specific land uses;
- to use the criteria as the basis for deriving PSNLs;
- to promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;
- to outline a range of mitigation measures that could be used to minimise noise impacts;
- to provide a formal process to guide the determination of feasible and reasonable noise limits for consent or licence conditions that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and
- to carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the POEO Act.

The INP (EPA 2000) is designed for large and complex industrial sources and outlines processes designed to strike a feasible and reasonable balance between the operation of industrial activities and the protection of the community from noise levels that are intrusive or unpleasant.

Where the PSNLs are predicted to be exceeded, Section 1 of the INP (EPA 2000) notes that:

> Where project-specific noise levels are exceeded, proponent assesses the level of impact by comparing resultant noise levels against the project-specific noise levels (for example, noise exceeds project-specific noise levels by X dB, number of people affected, likely impacts on activities, % of time impact occurs) and factoring-in economic and social benefits from the development.

The NIA has modelled the predicted noise impacts at the nearest sensitive receivers to the Project under significant meteorological conditions for the locality as required by the INP (EPA 2000). The resulting predicted noise impacts have been used to satisfy one of the underlying principles of the noise criteria in the INP (EPA 2000), in that:

> The criteria in this document (Section 2) have been selected to protect at least 90 per cent of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90 per cent of the time. Provided the criteria in this document are achieved, then it is unlikely that most people would consider the resultant noise levels excessive.

3.2.3 Assessment Approach

In accordance with the DGRs (refer to **Section 1.2**) and Section 10 of the INP (EPA 2000) the NIA has:

- identified the noise sensitive locations, such as residential properties, likely to be affected by activities associated with the Project and determined existing background noise levels at the respective noise sensitive locations (refer to **Section 4.0** and **Appendix C**);

- determined PSNLs from intrusiveness and amenity based measurement of the existing background and ambient noise levels. As per the INP (EPA 2000) requirements for an existing industrial operation, the ambient noise levels that form the basis of the PSNLs have been determined excluding noise from the source under investigation (refer to **Section 4.0** and **Appendix C**);

- identified all noise sources from the Project and determined the expected noise levels and noise characteristics (e.g. tonality and impulsiveness) likely to be generated from the noise sources (refer to **Section 5.0**);

- identified the times of operation of the development and for all noise producing activities (refer to **Sections 2.0** and **5.0**);

- considered the influence of existing meteorological conditions such as wind and temperature inversions in the prediction models so as to provide a true representation of actual noise levels (refer to **Sections 4.0** and **5.0**). This has been achieved by:

    - determining the noise levels at the most sensitive locations under the significant meteorological conditions required by the INP (EPA 2000); and

    - providing noise contours for day-time and evening periods predicted under worst case significant meteorological conditions.

- assessed the effect of relevant noise mitigation measures incorporated into the predictive modelling. **Section 2.0** discusses the project alternatives and noise control measures that were investigated, **Section 5.0** outlines those measures that were incorporated into the noise model of the Project and **Section 7.0** discusses the noise management and monitoring practices that will be incorporated into the Project;

- compared the predicted noise levels with the appropriate PSNLs (refer to **Section 6.1**);
- discussed the findings from the predictive modelling and, where relevant PSNLs have not been met, recommend additional mitigation measures (refer to **Section 6.1**);
- quantified the residual level of noise impact where relevant noise criteria cannot be met after application of all feasible and cost effective (i.e. reasonable) mitigation measures, where relevant (refer to **Section 8.0**); and
- provided details of a proposed noise monitoring program (refer to **Section 7.0**).

A glossary of terms and abbreviations used in this report is provided in **Appendix A**.

A detailed summary of the INP (EPA 2000) assessment methodology used for this NIA is provided in **Appendix B**.

3.2.4 Computer-based Modelling Software

The computer-based modelling software package Environmental Noise Model (ENM) was used to predict the noise levels likely to be produced by the Project within the surrounding environment. ENM is recognised and accepted by the EPA as a computer modelling program suited to predicting noise impacts from industrial noise sources.

The ENM noise models were based on machine and plant sound power level (SWL) data collected by Umwelt from the existing Teven Quarry operations, other Holcim Australia operations, and Umwelt's library of SWL levels. Digital terrain maps of the region surrounding the Project Area were prepared by Umwelt and quarry plans provided by Holcim Australia.

The details of the noise sources, quarry plans and receiver locations are presented in **Section 5.0** and **Appendix E**.

The NIA was based on the noise levels predicted by the ENM model of the proposed operations for the Project. The assessment of the predicted noise levels against the PSNL was then undertaken in accordance with the INP (EPA 2000) (refer to **Section 6.0**). The assessment of reasonable and feasible mitigation measures was undertaken in accordance with the DGRs (refer to **Sections 2.1**, **5.2**, **6.1** and **8.1**).

3.3 Blasting Impact Assessment

Explosives are used in extractive and quarry operations for resource extraction which is achieved by drilling holes in a pre-defined pattern considering angle, depth and spacing. These holes are then filled with an emulsion-type explosive charge and the charge initiated with the aid of primers and detonators. Detonation is undertaken using a delayed firing technique to ensure the sequential firing of each hole and to blast efficiency and reduce its environmental impacts.

Blasting can have impacts on surrounding residential receivers and structures (including buildings) with regard to airblast (overpressure) and ground vibration.

Blasting emissions criteria are presented in **Section 4.8**. The methodology for predicting ground vibration and blasting levels associated with the Project is presented in **Section 5.6**.

This methodology typically involves the analysis of site blasting monitoring data or the use of generic ground vibration and airblast prediction calculations in accordance with industry standards. The results of the blasting assessment are presented in **Section 6.4**. It is noted that blasting practices and times of operation will not change from the existing approved blasting activities due to the Project.

4.0 Existing Acoustic Environment and Assessment Criteria

4.1 Existing Background Noise Levels

An assessment of the existing noise environment in the area surrounding the Project Area was undertaken from 26 July 2013 up to 12 August 2013 using three Acoustic Research Laboratories EL-215 noise loggers. Attended noise monitoring was used to confirm source identification at the noise logging locations.

The locations of the background noise monitoring sites provided in **Table 4.1** and are shown on **Figure 4.1**. The details of the background noise monitoring program using the noise loggers are given in **Table 4.1**.

Table 4.1 – Background Noise Monitoring Locations

Monitoring Location	Description
N1	217 Leadbeatters Lane, Teven
N2	433 Teven Road, Teven
N3	168 Wellers Road, Teven

The monitoring data from the background noise monitoring program includes, but is not limited to, ambient background and statistical noise levels for each 15 minute interval recorded as $L_{A1,15 minute}$, $L_{A10,15 minute}$, $L_{Aeq,15 minute}$ and $L_{A90,15 minute}$.

The results of the background noise monitoring program have been used to determine the assessment background levels (ABLs), rating background level (RBLs) and mean $L_{Aeq, period}$ (where 'period' equals day, evening or night) noise levels in the region surrounding the Project Area. Depending on operational conditions within the Project Area as well as the surrounding activities and the meteorological conditions at the time of monitoring, the background noise monitoring results include noise contributions from a number of rural, and road noise sources as well as, at times, the existing Teven Quarry.

The assessment of the existing noise environment using the background noise monitoring results, reported as the RBL and the measured Mean $L_{Aeq, period}$ are presented in **Table 4.2**. The ABLs, RBLs, Mean $L_{Aeq, period}$ noise levels and supporting raw monitoring data are provided in **Appendix C**. Where practical, the contribution from the existing Teven Quarry operation has been removed from the assessment of the existing noise environment.

During the monitoring program, data affected by rain or wind speeds in excess of 5 m/s was excluded in accordance with Section 3.4 of the INP (EPA 2000). Meteorological data for this purpose was obtained from the Bureau of Meteorology Automatic Weather Station 058198 located approximately 6 kilometres to the east of the Project Area at Ballina Airport.

The existing noise environment at N1 – 217 Leadbeatters Lane shows little to no influence from road traffic noise or from the existing Teven Quarry operations. The existing noise environment at N2 – 433 Teven Road is influenced by road traffic noise from Teven Road. The existing noise environment at N3 – 168 Wellers Road shows the influence of local noise sources specifically insects (cicadas) and frogs.

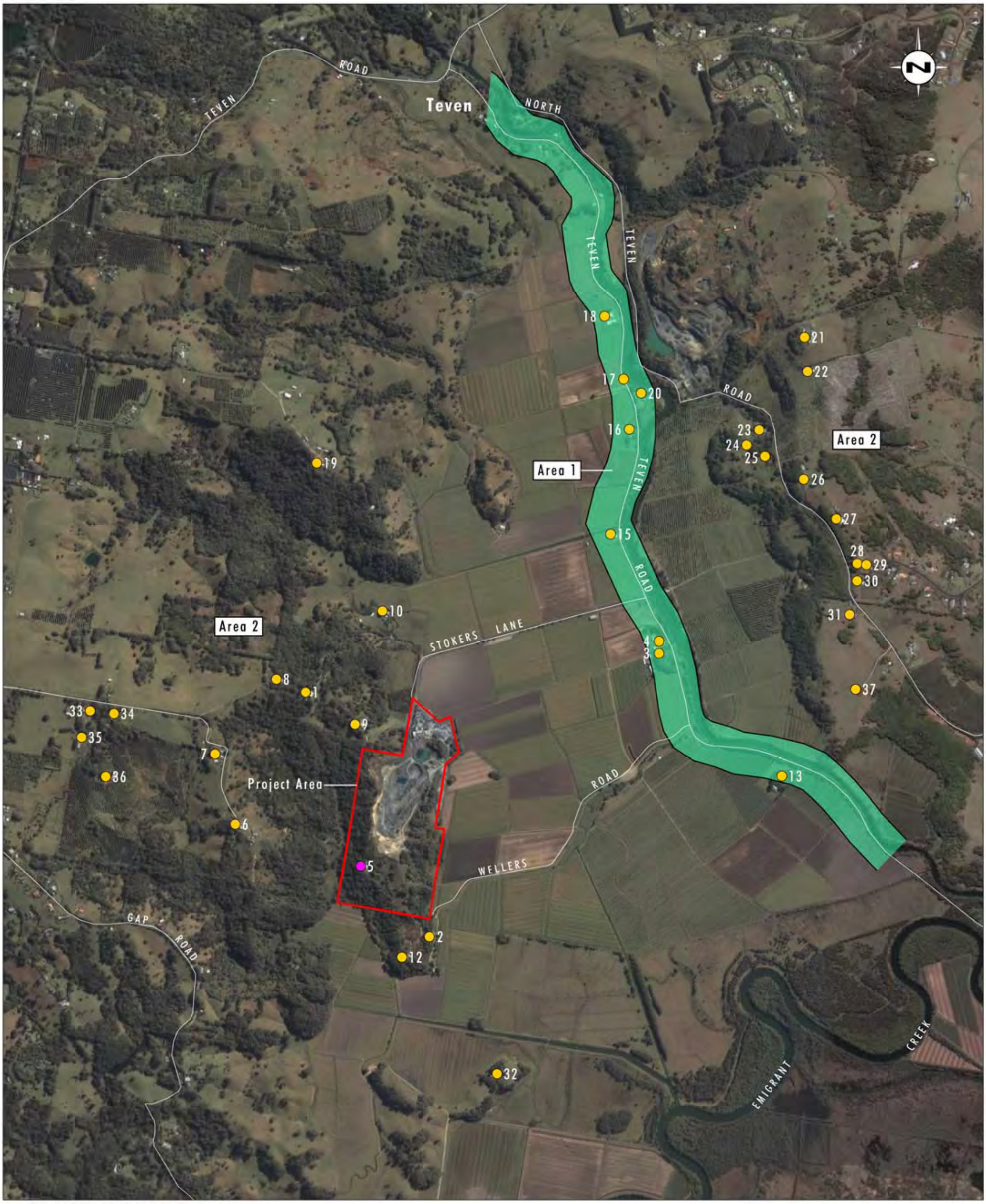


Image Source: Google Earth (2014)
Data Source: Holcim (2014)

0 0.25 0.5 1.0km
1:25 000

Legend

- Project Area
- Residential Receiver Location
- Subject to Commercial Agreement Receiver Location

FIGURE 4.1

Sensitive Receivers and Noise Monitoring Locations

Table 4.2 – Background Noise Monitoring Results, RBL and Mean $L_{Aeq, period}$, dB(A)

Monitoring Location	Time Period	RBL [1]	Mean $L_{Aeq, period}$
N1 – 217 Leadbeatters Lane, Teven	Day	31.8	45.5
	Evening	30.5	36.2
	Night	30.0 (28.5)	36.2
N2 – 433 Teven Road, Teven	Day	32.5	55.8
	Evening	30.0	47.7
	Night	30.0 (27.9)	42.8
N3 – 168 Wellers Road, Teven	Day	36.0	41.3
	Evening	38.0	44.0
	Night	37.3	40.4

Note 1: Where the RBL is less than 30 dB(A) the RBL is set at 30 dB(A). The values in the parentheses are the actual RBL determined from the monitoring data.

4.2 Intrusiveness and Amenity Criteria

4.2.1 Intrusiveness Criteria

The results from the background noise monitoring program presented in **Table 4.2** and **Appendix C** show that the RBL in the rural areas surrounding the Project Area are generally between 32 to 36 dB(A) during the day-time, 30 to 38 dB(A) during the evening and less than 30 to 37 dB(A) during the night-time.

The intrusiveness of an industrial noise source is generally considered acceptable if the noise from the source (represented by $L_{Aeq, 15minute}$), does not exceed the RBL by more than 5 dB. **Table 4.3** details the Intrusiveness Criteria for each of the background noise monitoring locations.

Table 4.3 – Intrusiveness Criteria, dB(A)

Monitoring Location	Time Period	Rating [1] Background Noise Level	Intrusiveness Criteria $L_{Aeq, 15 minute}$
N1 – 217 Leadbeatters Lane, Teven	Day	32	37
	Evening	31	36
	Night	30	35
N2 – 433 Teven Road, Teven	Day	33	38
	Evening	30	35
	Night	30	35
N3 – 168 Wellers Road, Teven	Day	36 [2]	41
	Evening	38	41 (43) [3]
	Night	37	41 (42) [3]

Note 1: Where the measured RBL in the region surrounding the Project Area is at or below 30 dB(A) the corresponding Intrusiveness Criteria has been set be 35 dB(A). This is the minimum possible Intrusiveness Criterion under the INP (EPA 2000).

Note 2: Attended monitoring identified that noise from the existing Teven Quarry operations was contributing to the existing environmental noise levels.

Note 2: Where the day time is quieter than the evening set the evening at the daytime level and where the evening is quieter than the night time set the night tome at the evening /daytime level.

The assessment of the night-time and evening RBL take into consideration the recommendations of the EPA Application Note for the assessment of the Intrusiveness Criteria (refer to **Appendix B**).

4.2.2 Amenity Criteria

The Amenity Criteria is determined by comparing the existing ambient noise levels resulting from industrial noise sources with the recommended acceptable ambient noise levels for the respective noise amenity areas (refer to **Table 3.1**). The ambient noise levels in the region surrounding the Project Area are dependent on the proximity of the respective properties to existing industrial and farming activities and to other features such as rivers and roads. The ambient noise level is also affected by insects, birds and local traffic.

Based on the descriptions outlined in the Section 2 of the INP (EPA 2000) the acoustic environment in the vicinity of the Project Area is typically rural and therefore the Rural assessment criteria (refer to **Appendix B**) has been adopted for those receivers nearest the Project Area.

The assessment of Amenity Criteria considered the recommendations of the EPA Application Note for the assessment of the Amenity Criteria in high traffic noise areas (refer to **Appendix B**). The monitoring data from the noise monitoring program does not trigger the high traffic noise area criteria.

Table 4.4 details the Amenity Criteria developed for each of the background noise monitoring locations.

Table 4.4 – Determination of the Amenity Criteria, dB(A)

Monitoring Location	Type of Receiver[1]	Time Period	Recommended Acceptable Noise Level	Mean $L_{Aeq, period}$	Modification[2] to ANL due to existing industrial noise	Amenity Criteria[4] $L_{Aeq, period}$
N1 – 217 Leadbeatters Lane, Teven	Rural	Day	50	46	Nil	50
		Evening	45	36	Nil	45
		Night	40	36	Nil	40
N2 – 433 Teven Road, Teven	Rural	Day	50	56	Nil	50
		Evening	45	48	Nil	45
		Night	40	43	Nil	40
N3 – 168 Wellers Road, Teven	Rural	Day	50	41	up to 38[3]	50
		Evening	45	44	Nil	45
		Night	40	40	Nil	40

Note 1: Rural areas have an acoustic environment that is dominated by natural sounds, having little or no road traffic (INP (EPA 2000)).

Note 2: Modification to ANL to account for existing level of industrial noise to give maximum L_{Aeq} noise levels for noise from new sources alone, as per Table 2.2 of the INP (EPA 2000).

Note 3: Attended monitoring identified that noise from the existing Teven Quarry operations was contributing to the existing environmental noise levels.

Note 4: Where there is no existing industrial noise influence and the high traffic noise criteria is not triggered at the receiver location, the Amenity Criteria is set to the Recommended Acceptable Noise Level (INP (EPA 2000)). Where the measured mean $L_{Aeq, period}$ noise levels is affected by industrial noise sources the acceptable noise level is modified in accordance with Table 2.2 of the INP (EPA 2000)

.

4.3 Project-specific Noise Levels

4.3.1 Determination of Project-specific Noise Levels

Evaluation of the noise levels monitored in the rural environment surrounding the Project Area has resulted in PSNLs that are based on a combination of the Intrusiveness and Amenity Criteria. The day-time, evening and night-time PSNLs for each monitoring locations are presented in **Table 4.5**. The assessment criteria for each sensitive receiver are detailed in **Appendix D**.

Table 4.5 – Project-Specific Noise Levels, dB(A)

Monitoring Location	Time Period	Intrusiveness Criteria LAeq, 15 minute	Amenity Criteria LAeq, period	PSNL
N1 – 217 Leadbeatters Lane, Teven	Day	37	50	37 $L_{Aeq,15min}$
	Evening	36	45	36 $L_{Aeq,15min}$
	Night	35	40	35 $L_{Aeq,15min}$
N2 – 433 Teven Road, Teven	Day	38	50	38 $L_{Aeq,15min}$
	Evening	35	45	35 $L_{Aeq,15min}$
	Night	35	40	35 $L_{Aeq,15min}$
N3 – 168 Wellers Road, Teven	Day	41	50	41 $L_{Aeq,15min}$
	Evening	41	45	41 $L_{Aeq,15min}$
	Night	41	40	41 $L_{Aeq,15min}$ 40 $L_{Aeq, night}$

4.3.2 Residential Receivers

34 residences in the region surrounding the Project Area have been grouped into localities or areas that have similar representative background noise levels. These areas have been defined giving consideration to the relative location of other noise sources (such as industrial and road traffic). Attended monitoring undertaken at monitoring location N3 indicated the influence of existing operations from Teven Quarry with the RBLs ranging from 36 to 38 dB(A) depending on the time of day. In accordance with Section 3 of the INP (EPA 2000), the noise impacts from Teven Quarry have been excluded from the final PSNLs by utilising the more conservative PSNLs from background noise monitoring location N1. The defined areas are presented in **Figure 4.1** and form two distinct areas:

- Area 1 consists of rural residential receivers located in the proximity of Teven road. The background noise level at these residences is likely to be influenced by existing levels of road traffic noise on Teven Road.

- Area 2 which comprises all other rural residential receivers in the vicinity of the Project.

The PSNLs determined for each defined area in the region surrounding the Project Area are presented in **Table 4.6.**

Table 4.6 – Residential Receiver PSNL, dB(A)

Receiver Description	Time Period	PSNL [1]
Area 1 – Residences located in proximity of Teven Road	Day	38 $L_{Aeq,15min}$
	Evening	35 $L_{Aeq,15min}$
	Night	35 $L_{Aeq,15min}$
Area 2 – All other residential receivers	Day	37 $L_{Aeq,15min}$
	Evening	36 $L_{Aeq,15min}$
	Night	35 $L_{Aeq,15min}$

Note 1: The most conservative of the alternatives available has been used to set the PSNL

4.4 Sleep Disturbance Criteria

The INP Application Notes state that the sleep disturbance criteria is normally assessable for the night time period only (10.00 pm to 7.00 am). As the Project does not seek to operate from 10.00 pm to 7.00 am, sleep disturbance criteria are not applicable.

4.5 Cumulative Noise Criteria

The INP (EPA 2000) addresses potential cumulative noise impacts from existing and proposed developments in an area by ensuring that appropriate noise emission criteria and consent limits are established with a view to maintaining acceptable amenity noise levels for residential receivers (refer to **Table 3.1**). The INP (EPA 2000) objective is that the combined noise levels from industrial noise sources should not exceed the specified 'acceptable' noise levels appropriate for the locality and land use.

In relation to industrial noise sources, the acceptable cumulative industrial noise criteria applying to the rural areas in the region surrounding the Project Area from the combined operation of the Project and other industrial sources in the region surrounding the Project Area are outlined in **Table 4.7**. The cumulative noise levels is measured as the $L_{Aeq, period}$ noise level (where 'period' equals day, evening or night) from industrial noise sources.

Table 4.7 – Cumulative Noise Goals based on Amenity Level, dB(A)

Period	Acceptable Cumulative Noise Level L_{Aeq} period	Maximum Cumulative Noise Level L_{Aeq} period
Day	50	55
Evening	45	50
Night	40	45

4.6 Construction Noise Criteria

Construction activities such as those associated with the upgrade and modifications to the quarry infrastructure area to accommodate the additional mobile plant are considered to generate minor noise impacts that would be less than the noise generated by the general activities considered in the operational noise assessment. Therefore, an assessment of the construction noise levels is not required.

4.7 Road Traffic Noise Criteria

The NSW Road Noise Policy (RNP) (DECCW 2011) sets out criteria for road traffic noise through the provision of a framework that addresses traffic noise issues associated with new developments, new or upgraded road developments or planned building developments.

The primary access route to the Project will continue to be via the southern route from Stokers Lane, south along Teven Road and then onto the Bruxner and Pacific Highways. The secondary access route to the Project will continue to be via the northern route from Stokers Lane, north along Teven Road and then access Tintenbar Road to cater for local deliveries. **Table 4.8** outlines the road traffic noise criteria for the Project along Teven Road and Stokers Lane. Under the road category definitions provided in Table 2 of the RNP, Teven Road is considered a sub-arterial road as it provides a connection between arterial and local roads. Stokers Lane is defined as a local road by the RNP.

Table 4.8 – Road Noise Criteria, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria dB(A)	
		Day (7.00 am – 10.00 pm)	Night (10.00 pm – 7.00 am)
Freeway/arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq, 15 hour}$ 60 (external)	$L_{Aeq, 9 hour}$ 55 (external)
Local Roads	Existing residences affected by noise by additional traffic on existing local roads generated by land use developments	$L_{Aeq, 1 hour}$ 55 (external)	$L_{Aeq, 1 hour}$ 50 (external)

Source: NSW Road Noise Policy (DECCW 2011)

Section 3.4 of the RNP notes that when assessing noise impacts and the effectiveness of feasible and reasonable mitigation measures, an increase of up to 2 dB represents a minor impact that is considered barely perceptible to the average person.

4.8 Blasting Emissions Criteria

The EPA has established guidelines for blasting based on the impacts on human comfort levels. The guidelines have been adapted from the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC 1990). The guidelines are defined in terms of impact on airblast (pressure), measured in dB(Linear) (dBL), and ground vibration, measured as peak particle velocity (PPV), and are presented in **Table 4.9**.

Table 4.9 – Blasting Emissions Criteria for Residential Receivers

Blasting Impact	Recommended 95th Percentile Maximum Level [1]	Maximum Level
Airblast (dB Linear Peak) [1]	115	120
Ground Vibration (mm/s) [2]	5	10

Source: Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC 1990).

Note 1: This level may be exceeded on up to 5 per cent of the total annual number of blasts.

Note 2: It is recommended by ANZECC that a level of 2 mm/s be considered as a long term regulatory goal.

5.0 Noise Modelling Parameters

5.1 Noise Modelling

Section 6 of the INP (EPA 2000) requires noise level predictions to take into account all significant noise sources that may reasonably be expected when the plant or facility in question is fully operational. As discussed in **Section 3.4**, the computer-based modelling software package ENM was used to predict the contributed noise levels from the proposed operations at the nearest potentially affected receivers for two conceptual stages of quarry development. The conceptual representative quarry stage plan for Year 1 and Year 11 has been selected as they are considered to represent the potential worst case impacts of the proposed quarry progression.

ENM calculates noise levels at either specified receiver locations (single point calculation) or generates noise level contours over a defined area (contour calculation). The single point calculation feature of ENM was used to assess the noise impacts from operational requirements of the Project (refer to **Section 3.4**), the proposed equipment fleets (refer to **Section 5.2**), and 6 combinations of wind speed, wind direction and temperature gradients considered representative of the meteorological conditions of the region (refer to **Section 5.4**).

The results presented in **Section 6.0** represent the likely contributed noise levels for each of the two conceptual stages modelled, per receiver.

5.2 Operational Noise Levels

5.2.1 Modelling Scenarios

ENM noise models were run for the preferred operational scenarios of the Project for Year 1 and Year 11 of the conceptual quarry development. The conceptual quarry plans and equipment locations used in the noise models are shown in **Appendix E**.

The assumptions used in modelling the operational phase of the Project include the following:

- all acoustically significant plant and equipment operating simultaneously in accordance with the conceptual quarry plans and production schedule to achieve maximum production levels;
- mobile noise sources, such as front-end loaders, excavators, product trucks and haul trucks modelled at typical locations and assumed to operate in repetitive cycles; and
- noise attenuation equipment is in place and operational.

Details of the type and location of the mobile equipment in each model are presented in **Appendix E**.

5.2.2 Operational Noise Sources

Noise source models representative of the acoustically significant plant and equipment proposed for use in each of the conceptual quarry stages were developed for ENM. Representative SWLs for the plant and equipment were collected by Umwelt from Teven Quarry, other Holcim Australia operations or equivalent quarrying operations.

It is anticipated that during the life of the quarry, equipment replacement programmes will result in a progressive improvement in the SWLs of the respective equipment. However, a conservative approach has been taken that assumes the SWLs will be maintained over the life of the quarry. The SWLs of the quarry equipment and associated infrastructure modelled for Year 1 and Year 11 of the Project are presented in **Appendix E**.

5.2.3 Control Measures

As discussed in **Section 2.0**, there was extensive consideration of project alternatives during the iterative project design and assessment process. This included investigations into operating different equipment during different time periods with the objective of reducing or managing the noise impacts from the Project.

Prior to the finalisation of the Project design, a range of options were investigated to eliminate, control or manage the noise impacts from the Project. In establishing the feasible and reasonable noise control measures that could be incorporated into the Project, a comprehensive range of noise control measures were considered for the management of operational activities under particular operational scenarios and meteorological conditions, in order to achieve specific noise outcomes. This included:

- the provision of additional sound attenuation on some plant and equipment;
- investigating operational alternatives for the Project, including limiting operations under adverse meteorological conditions and restricting activities in exposed locations;
- the management of mobile machines during adverse weather conditions in exposed locations; and
- identifying activities that could be restricted during times of adverse noise propagating meteorological conditions.

Those controls that were found to be reasonable and feasible in relation to providing an effective control of potential impacts have been incorporated into the Project design and specifically assessed as part of the NIA. Control measures that have been considered as a standard part of the Project are discussed in detail in **Section 7.0**. The specific control measures that have been incorporated into the noise models of the Project include:

- the maintenance of product stockpiles in strategic locations, where practicable, along the northern edge of the Project site shielding product trucks and product loading equipment;
- the use of broad band reversing alarms instead of beeper style alarms on all mobile equipment; and
- the management of mobile machines during adverse weather conditions when wind conditions or inversion conditions enhance the noise propagation towards sensitive receiver locations. In order to control/eliminate noise impacts this would likely include:
    - ensuring the sales loader operates behind the product stockpile during adverse weather conditions in the evening period;
    - moving quarrying activities to locations deeper in the quarry pit during adverse weather conditions; and
    - shut down of some equipment during adverse weather conditions if required.

These noise control measures have been incorporated into the management strategies and noise modelling for the Project.

5.3 Road Traffic Noise

5.3.1 Modelling Scenarios

The road noise impacts associated with traffic movements generated by the Project were modelled using the *US Federal Highway Administration (FHWA) Traffic Noise Model (TNM) Version 2.5 Look-Up Tables* (U.S. Department of Transportation 2004). TNM is a highway traffic noise prediction and analysis model used to analyse highway geometries including vehicle speeds, vehicle type, setback distances and the effectiveness of barriers.

The transport routes for the Project as currently utilised by Teven Quarry are:

- Route 1 (Primary Transport Route) – Stokers Lane, south along Teven Road to Bruxner Highway and then west towards Lismore or east to the Pacific Highway (for trips north or south) or to Ballina (east) via River Street (Old Pacific Highway); and

- Route 2 (Secondary Transport Route) – Stokers Lane, north along Teven Road to Tintenbar Road and then north along Tintenbar Road.

An assessment of road traffic noise impacts due to the project has been evaluated for noise sensitive receivers located on Stokers Lane and Teven Road. Set back distances from the centreline of the road are listed in **Table 5.1**.

Table 5.1 – Traffic Noise Assessment Properties

Receiver Location	Set Back Distance[1]
R10	280 m to Stokers Lane
R3	45 m to Teven Road
R4	30 m to Teven Road
R13	55 m to Teven Road
R15	20 m to Teven Road
R16	10 m to Teven Road
R17	10 m to Teven Road
R18	35 m to Teven Road
R20	60 m to Teven Road

Note 1: Set back distance is defined as the distance between the centre line of the road and the building facade, and was estimated based on aerial photography.

5.3.2 Traffic Noise Sources

Currently approximately 70 per cent of product trucks travel on Route 1 and 30 per cent on Route 2. As part of the Project, Holcim Australia is proposing to utilise Route 1 for all product trips to the Pacific Highway, including future upgrade works to the north, with Route 2 utilised for local deliveries only. Route 1 is therefore anticipated to carry 95 per cent of product truck movements associated with the Project.

Heavy vehicle traffic movements from the quarry will increase as a result of the proposed increase in production. At a production rate of 500,000 tpa, the Project is expected to generate 70 light vehicle movements per day (35 in/35 out) and 146 product truck movements per day (73 truck loads). This represents an increase of approximately 10 light vehicle movements (5 in/5 out) and 68 haulage vehicle movements (34 truck loads) per day on current levels.

The traffic volumes in the traffic study undertaken for the Project (Transport and Urban Planning 2014), shown in **Tables 5.2** and **5.3**, have been used as the basis for the road traffic noise assessment. The following information was used in the assessment of the road traffic noise:

- the existing and the Project road traffic noise impacts have been modelled;
- AM and PM peak traffic volumes for Stokers Lane and daytime traffic volumes for Teven Road, both with and without the Project, were derived from TAUP 2014 and used to estimate traffic noise impacts;
- the daytime traffic volumes for Teven Road, both north and south of Stokers lane, are based on the daytime road noise assessment period of 7.00 am to 10.00 pm;
- the daytime traffic volumes for Teven Road, both north and south of Stokers lane, are based on ADT values and assume little to no traffic on Teven Road during the night time road noise assessment period;
- the peak AM period is considered to be between 7.00 am and 9.00 am while the peak PM period is considered to be between 3.00 pm and 5.00 pm; and
- the predictions are based on an average speed on Stokers Lane of 60 km/h and an average speed on Teven Road of 80 km/h.

Table 5.2 – Estimated Peak Day Time 1hr Two-way Traffic Volumes

Vehicle classification	Current Traffic Volumes		Predicted Project Traffic	
	AM	PM	AM	PM
Stokers Lane				
Light	13	5	16	8
Heavy	16	7	20	11
Total	29	12	36	19

Source: Table 3.7 and Section 4.1 of Transport and Urban Planning, Teven Traffic Impact Assessment, 2014

Table 5.3 – Estimated Day Time 15hr Two-way Traffic Volumes

Vehicle classification	Current Traffic Volumes[1]	Predicted Project Traffic[1]
Teven Road – North of Stokers Lane		
Light	490	467
Heavy	203	187
Total	693	662
Teven Road – South of Stokers Lane		
Light	514	539
Heavy	246	330
Total	760	869

Source: Transport and Urban Planning, Teven Traffic Impact Assessment, 2014

Note 1: Based on 5day ADT so overestimates day time traffic contribution

5.4 Meteorological Conditions

The modelling approach taken with respect to meteorology (refer to **Appendix B**) was to analyse representative meteorological data for the region surrounding the Project Area and determine the percentage of occurrence of inversions and/or wind effects. The noise impacts were then modelled meteorological conditions identified as being significant by the criteria outlined in sections 5.2 and 5.3 of the INP (EPA 2000). This approach takes account of the influence of local meteorological conditions on the propagation of the noise from the Project to the entire region surrounding the Project Area.

Meteorological data was sourced from the Bureau of Meteorology Automatic Weather Station 058198 located approximately 6 kilometres to the east of the Project Area at Ballina Airport. The data used for modelling consists of the period from 12 May 2010 to 27 August 2013. The detailed analysis of the meteorological data is presented in **Appendix F** and summarised in **Table 5.4**.

Table 5.4 –Noise Modelling Meteorological Conditions

Season/Period	Day	Evening
Summer	Calm	Calm ENE 3 m/s
Autumn	Calm	Calm WSW 3 m/s
Winter	Calm	Calm Inversion (no D/F [1]) W 3 m/s
Spring	Calm	Calm NNE 3 m/s

5.4.1 Wind

As noted in the INP (EPA 2000), wind has the potential to increase the noise impacts upon a receiver when it is light and stable and blows from the direction of the noise source towards the receiver. As the strength of the wind increases the noise produced by the wind begins to obscure the noise from most industrial and transport sources. Adverse meteorological conditions created by wind speeds above 5 m/s can also skew the noise predictions. The cut off wind speed is based around the principles documented in the INP (EPA 2000). That is, cut off wind speed would be when the noise produced by the wind begins to obscure the noise from the Project. As a result, when considering the wind effects on the Project, wind speeds above 5 m/s were excluded from the analysis.

The windroses in **Appendix F** indicate the presence of prevailing seasonal wind conditions that create vectored source-to-receiver winds. However, the analysis of the meteorological data for the day-time period indicates the prevailing seasonal wind conditions do not create vectored wind up to 3 m/s for more than 25 per cent of the time and that the vectored component is associated with prevailing winds from 3 to 5 m/s in strength. Therefore, in accordance with the INP (EPA 2000), the only day-time meteorological condition that needs to be assessed is calm conditions.

5.4.2 Temperature Inversion

Temperature inversions are generally determined based on the occurrence of atmospheric stability classes, with moderate to strong inversions corresponding to atmospheric stability categories E, F to G respectively.

Based on the analysis of the meteorological data presented in **Appendix F**, temperature inversions are a significant characteristic of the area occurring for more than 30 per cent of the total night-time (i.e. the evening and night-time periods) during winter. To account for this, a meteorological scenario was included in the noise modelling with a temperature inversion that had a corresponding lapse rate to atmospheric stability category F.

5.5 Receiver Locations

The privately owned residential/rural receivers that could potentially be affected by the Project are shown on **Figure 4.1**. The description of each receiver location used for the Single Point Calculations in ENM and the applicable project-specific noise criteria are presented in **Appendix D**.

Location R005, a vacant residential building, located on land leased by Holcim Australia does not require PSNLs.

5.6 Ground Vibration and Airblast Impact Prediction Methodology

The prediction of ground vibration and airblast impacts typically involves the development of site laws for the Project to assess the impacts of blasting on residential and other sensitive receivers in proximity to the Project. Monitoring data collected during previous blasting activities was analysed and used in conjunction with industry and Australian standards to develop the site laws for the Project.

The development of ground vibration and airblast site laws are subject to the guidance of the OEH and ANZECC which provide for the inherent variability associated with the impacts of blasting emission by allowing the definition of site laws with a five percent exceedance probability. They also provide a definitive maximum criterion above which emissions are in breach of the site laws.

Holcim Australia maintain a blast monitor both at the Teven Quarry site located next to the weigh bridge and at 144 Stokers Lane, Teven, NSW (receiver R011), refer to **Figure 4.1**.

5.6.1 Ground Vibration Site Law

The methodology outlined in the *Blasting Guide* (Orica 2012) was used to determine the median Peak Vector sum (PVS) (50%) ground vibration site law.

The PVS (50%) is defined as:

$$PVS\ (mm/s)\ (50\%) = 1140\ (SD)^{-1.6}$$

Where SD (scaled distance) is defined as:

$$SD\ (m.kg^{0.5}) = D/(MIC^{0.5})$$

MIC is the maximum explosive charge mass (kilograms) detonated per delay at any 8 millisecond interval and D is the distance between charge and receiver.

5.6.2 Airblast Site Law

The methodology outlined in the *ICI Blasting Guide* (ICI 1995) was used to determine the 95th percentile airblast site law, which may be exceeded on up to 5 per cent of the total annual blasts. The airblast site law is defined by the peak airblast level (SPL) measured in dB(Lin).

The SPL 5 per cent is defined as:

$$SPL,\ dB(Lin)\ (5\%) = -24 \log (SD) + 165.3$$

Where SD (scaled distance) is defined as:

$$SD\ (m.kg^{-0.33}) = D/MIC^{0.33}$$

6.0 Noise Predictions

6.1 Operational Noise Levels

6.1.1 Predicted Operational Noise Levels

ENM's Single Point calculation feature was used to determine noise levels from the Project at the nearest residential receiver locations identified in **Section 5.5**, under the meteorological conditions described in **Section 5.4** for the schedule of equipment (or their equivalent) that Teven Quarry proposes to use described in **Section 5.0** and **Appendix E**. The predicted operational noise levels for the two operational stages modelled, Year 1 and Year 11 are presented in detail in **Tables 6.1** to **6.3** below.

Table 6.1 presents a summary of the day time predicted operational noise levels for Year 1 and Year 11. **Table 6.2** and **Table 6.3** presents a summary of the evening predicted operational noise levels for Year 1 and Year 11 respectively. **Figures 6.1**, **6.2, 6.3** and **6.4** presents the noise level contours predicted under day time and evening calm neutral conditions for Year 1 and Year 11.

Table 6.1 –Predicted Day time Operational Noise Levels, dB(A)

Receiver Location	PSNL	Year 1 Calm Neutral	Year 11 Calm Neutral
R001 - Area 1	37	36	35
R002 - Area 1	37	33	33
R003 - Area 2	38	37	36
R004 - Area 2	38	36	36
R006 - Area 1	37	32	32
R007 - Area 1	37	29	30
R008 - Area 1	37	30	30
R009 - Area 1	37	45	45
R010 - Area 1	37	35	35
R012 - Area 1	37	24	26
R013 - Area 2	38	30	30
R015 - Area 2	38	35	35
R016 - Area 2	38	31	31
R017 - Area 2	38	30	30
R018 - Area 2	38	27	27
R019 - Area 1	37	33	33
R020 - Area 2	38	30	30
R021 - Area 1	37	32	32
R022 - Area 1	37	28	28
R023 - Area 1	37	29	29
R024 - Area 1	37	30	30
R025 - Area 1	37	30	30
R026 - Area 1	37	30	30
R027 - Area 1	37	30	30
R028 - Area 1	37	31	31
R029 - Area 1	37	30	30

Table 6.1 – Predicted Day time Operational Noise Levels, dB(A) (cont)

Receiver Location	PSNL	Year 1 Calm Neutral	Year 11 Calm Neutral
R030 - Area 1	37	31	31
R031 - Area 1	37	32	32
R032 - Area 1	37	25	25
R033 - Area 1	37	23	24
R034 - Area 1	37	27	23
R035 - Area 1	37	24	24
R036 - Area 1	37	26	26
R037 - Area 1	37	32	32

Note: Predicted noise levels include low frequency modifying factors where required by section 4 of the INP (EPA 2000).

Table 6.2 – Predicted Year 1 Evening Operational Noise Levels, dB(A)

Receiver Location	PSNL	Calm Neutral	3 m/s from the NNE	3 m/s from the ENE	3 m/s from the WSW	3 m/s from the W	F Class Stability with no drainage flow
R001 - Area 1	36	20	21	25	17	16	23
R002 - Area 1	36	20	32	25	18	20	25
R003 - Area 2	35	29	25	24	35	30	32
R004 - Area 2	35	29	25	24	35	30	32
R006 - Area 1	36	15	19	20	10	11	17
R007 - Area 1	36	14	16	19	9	9	16
R008 - Area 1	36	18	19	24	14	13	21
R009 - Area 1	36	28	29	31	25	25	29
R010 - Area 1	36	29	26	30	29	27	33
R012 - Area 1	36	12	17	14	10	11	14
R013 - Area 2	35	16	14	11	25	25	23
R015 - Area 2	35	25	20	20	34	32	30
R016 - Area 2	35	21	14	15	29	27	27
R017 - Area 2	35	18	12	13	25	23	24
R018 - Area 2	35	12	7	8	20	18	20
R019 - Area 1	36	23	21	24	23	22	27
R020 - Area 2	35	19	13	13	27	25	26
R021 - Area 1	36	19	16	16	25	23	22
R022 - Area 1	36	21	17	17	26	25	24
R023 - Area 1	36	22	19	19	29	27	26
R024 - Area 1	36	23	20	20	29	28	27
R025 - Area 1	36	23	20	20	29	28	26
R026 - Area 1	36	22	19	18	28	27	26
R027 - Area 1	36	23	20	19	28	27	26
R028 - Area 1	36	24	21	20	28	28	26
R029 - Area 1	36	23	20	19	28	27	26

Table 6.2 – Predicted Year 1 Evening Operational Noise Levels, dB(A) (cont)

Receiver Location	PSNL	Calm Neutral	3m/s from the NNE	3m/s from the ENE	3m/s from the WSW	3m/s from the W	F Class Stability with no drainage flow
R030 - Area 1	36	23	21	20	28	28	26
R031 - Area 1	36	24	22	21	29	29	27
R032 - Area 1	36	19	29	24	17	22	27
R033 - Area 1	36	10	12	15	5	5	12
R034 - Area 1	36	12	17	19	7	7	18
R035 - Area 1	36	9	11	14	5	5	12
R036 - Area 1	36	10	17	26	5	5	15
R037 - Area 1	36	24	21	20	29	29	27

Note: Predicted noise levels include low frequency modifying factors where required by section 4 of the INP (EPA 2000).

Table 6.3 – Predicted Year 11 Evening Operational Noise Levels, dB(A)

Receiver Location	PSNL	Calm Neutral	3 m/s from the NNE	3 m/s from the ENE	3 m/s from the WSW	3 m/s from the W	F Class Stability with no drainage flow
R001 - Area 1	36	30	21	25	17	16	23
R002 - Area 1	36	20	32	25	18	20	25
R003 - Area 2	35	29	25	24	35	35	32
R004 - Area 2	35	29	25	24	35	35	32
R006 - Area 1	36	15	19	20	10	11	17
R007 - Area 1	36	14	16	19	9	9	16
R008 - Area 1	36	18	19	24	14	13	21
R009 - Area 1	36	28	29	31	25	25	29
R010 - Area 1	36	29	26	30	29	27	33
R012 - Area 1	36	12	17	14	10	11	14
R013 - Area 2	35	16	14	11	25	25	23
R015 - Area 2	35	25	20	20	34	32	30
R016 - Area 2	35	21	14	15	29	27	27
R017 - Area 2	35	18	12	13	25	23	24
R018 - Area 2	35	12	7	8	20	18	20
R019 - Area 1	36	23	21	23	23	22	27
R020 - Area 2	35	19	13	13	27	25	26
R021 - Area 1	36	19	16	16	25	23	22
R022 - Area 1	36	21	17	17	26	25	24
R023 - Area 1	36	22	19	19	29	27	26
R024 - Area 1	36	23	20	20	29	28	27
R025 - Area 1	36	23	20	20	29	28	26
R026 - Area 1	36	22	19	18	28	27	26
R027 - Area 1	36	23	20	19	28	27	26
R028 - Area 1	36	24	21	20	28	28	26

Table 6.3 – Predicted Year 11 Evening Operational Noise Levels, dB(A) (cont)

Receiver Location	PSNL	Calm Neutral	3 m/s from the NNE	3 m/s from the ENE	3 m/s from the WSW	3 m/s from the W	F Class Stability with no drainage flow
R029 - Area 1	36	23	20	19	28	27	26
R030 - Area 1	36	23	21	20	28	28	26
R031 - Area 1	36	24	22	21	29	29	27
R032 - Area 1	36	19	29	24	17	22	27
R033 - Area 1	36	10	12	15	5	5	12
R034 - Area 1	36	12	17	29	7	7	18
R035 - Area 1	36	9	11	14	5	5	12
R036 - Area 1	36	10	17	26	5	5	15
R037 - Area 1	36	24	21	19	29	29	27

Note: Predicted noise levels include low frequency modifying factors where required by section 4 of the INP (EPA 2000).

An analysis of the predicted noise level results for the inclusion of 'modifying factors' was conducted in accordance with Section 4 of the INP (EPA 2000) and the INP Application Notes (refer to **Appendix B**). Tonal noise, impulsive noise, intermittent noise during the night time and single event duration noise as defined by the INP (EPA 2000) were not found to be a feature of the Project. Therefore modification factors for the noise impacts listed above were not required to be applied to the predicted noise levels.

Some receivers were found to meet the conditions required for the addition of a low frequency noise modifying factor under certain noise enhancing meteorology conditions. Low frequency modifying factors have been included in the results presented in **Tables 6.1** to **6.3**. Analysis of the predicted noise levels found that the predicted low frequency noise levels were generally close to the threshold of hearing and therefore unlikely to be intrusive or cause annoyance.

6.1.2 Summary of Findings

The number of potential exceedances of the project-specific noise criterion for the Project (refer to **Tables 6.1** to **6.3**) is summarised in **Table 6.4**. The potential exceedances identified in **Table 6.2** are inclusive of the control measures discussed in **Section 5.0**.

Table 6.4 – Summary of Predicted Noise Impacts

Season/Period	Year 1	Year 11
Day-time		
No. Properties > PSNL to PSNL+2	0	0
No. Properties > PSNL+2 to PSNL+5	0	0
No. Properties > PSNL+5	1	1
Maximum Noise Level at R009 (PSNL of 37dB(A))	45	45
Evening		
No. Properties > PSNL	0	0

During day-time the Project will achieve the day-time target PSNL at all residential receiver locations except Receiver R009. The modelled scenario of the day-time activities includes the maximum simultaneous operation of all noise generating equipment on the Project site,

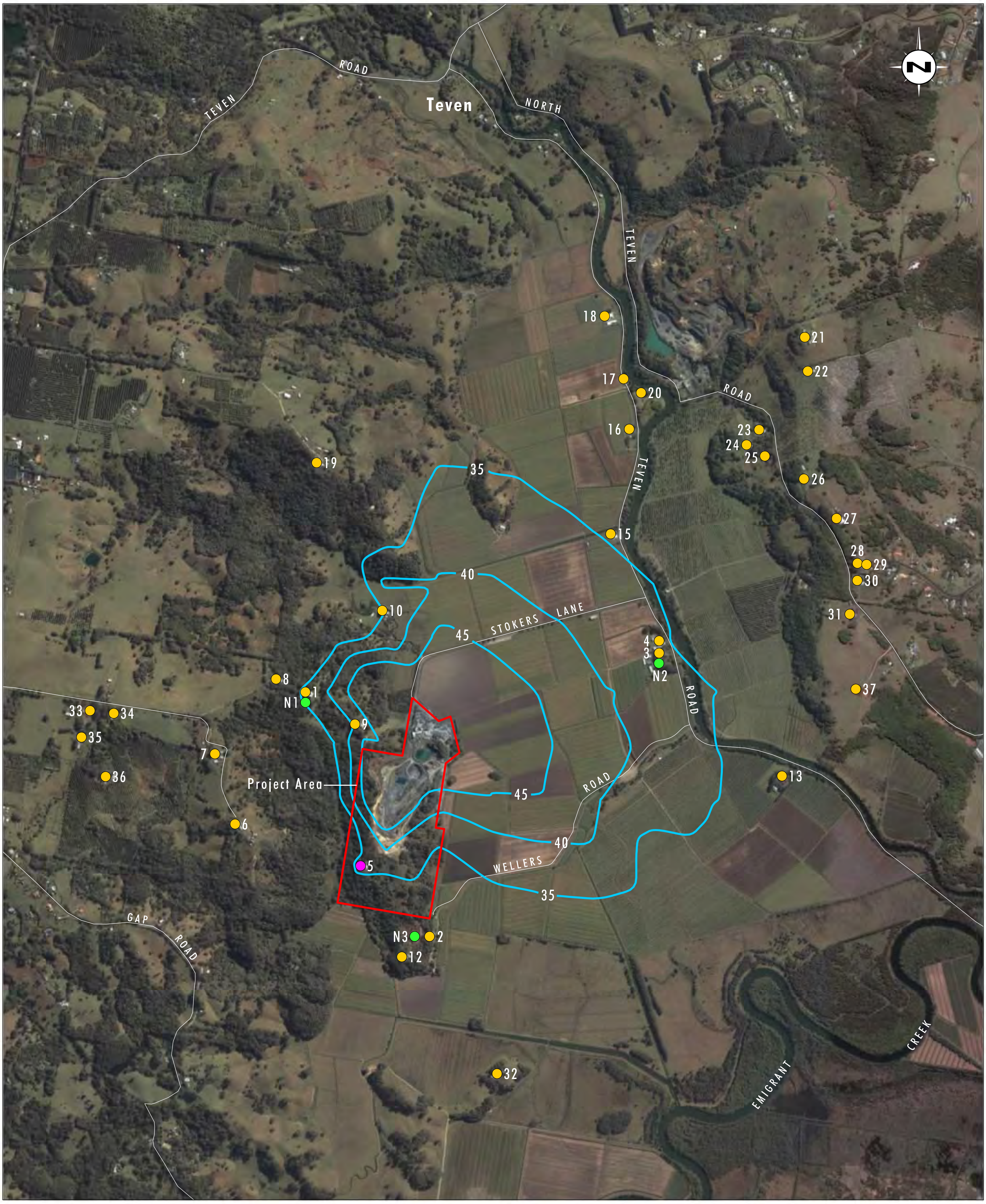


Image Source: Google Earth (2014)
Data Source: Holcim (2014)

Legend

- Project Area
- Residential Receiver Location
- Subject to Commercial Agreement Receiver Location
- Noise Monitoring Location
- Stage 2 Daytime Calm - Noise Contour

FIGURE 6.1

Predicted Noise Impact Contours - Year 1 Daytime Calm

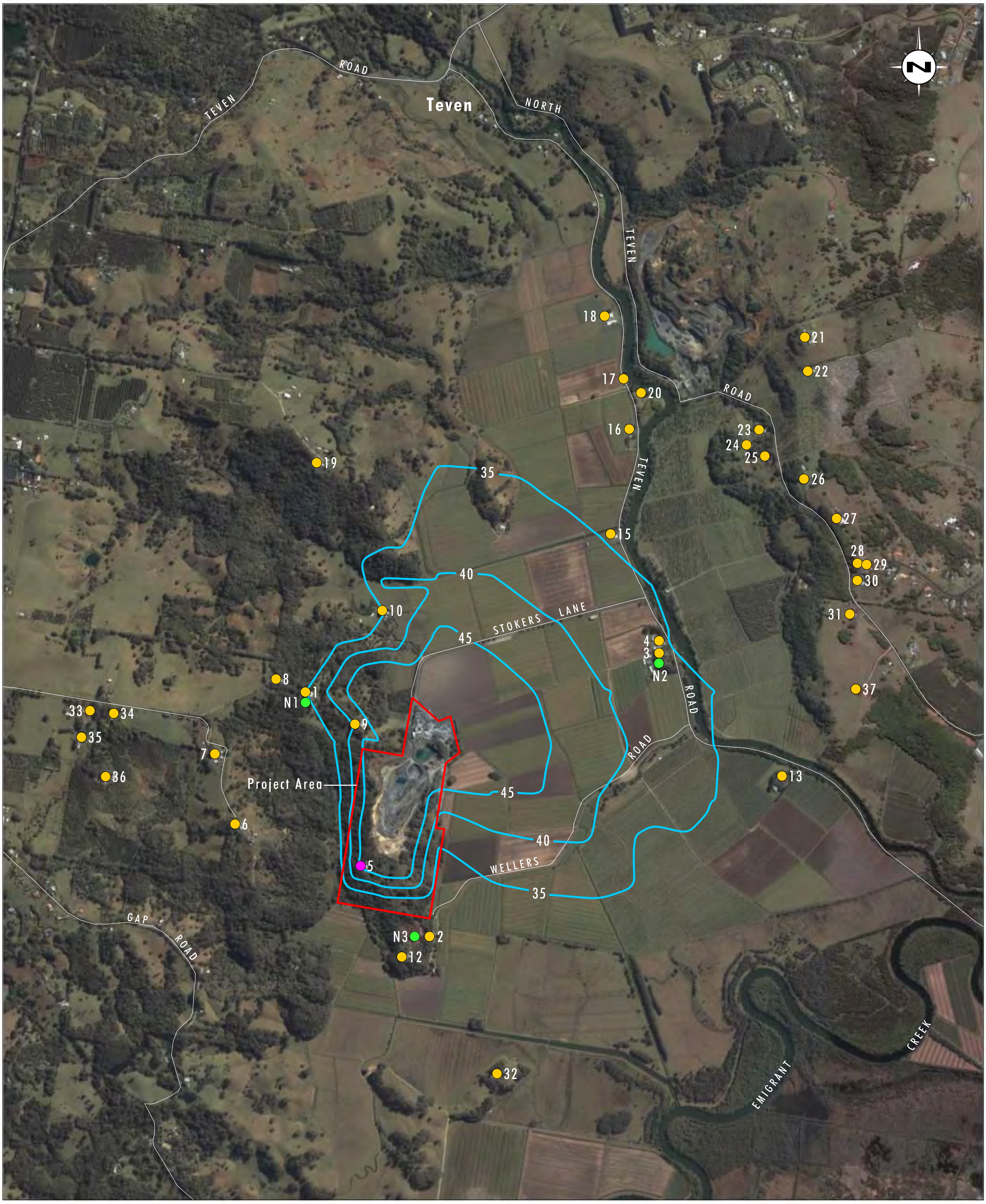


Image Source: Google Earth (2014)
Data Source: Holcim (2014)

0 0.25 0.5 1.0km
1:25 000

Legend

- Project Area
- Residential Receiver Location
- Subject to Commercial Agreement Receiver Location
- Noise Monitoring Location
- Stage 10 Daytime Calm - Noise Contour

FIGURE 6.2

Predicted Noise Impact Contours - Year 11 Daytime Calm

File Name (A4): R02/3230_031.dgn
20141112 13.15

umwelt

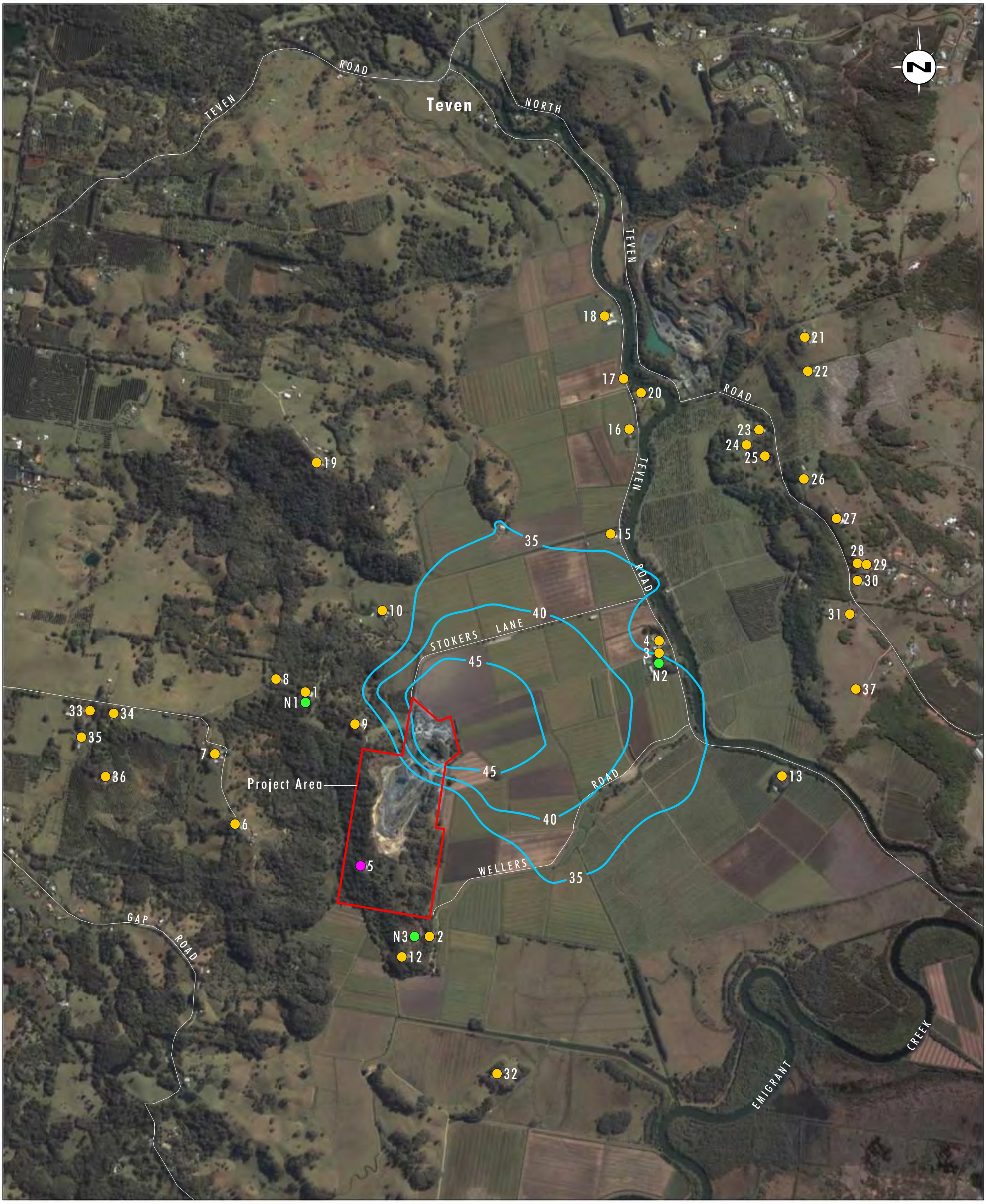


Image Source: Google Earth (2014)
Data Source: Holcim (2014)

0 0.25 0.5 1.0km
1:25 000

Legend

- Project Area
- Residential Receiver Location
- Subject to Commercial Agreement Receiver Location
- Noise Monitoring Location
- Stage 2 Evening with winds from WSW at 3m/s - Noise Contour

FIGURE 6.3

Predicted Noise Impact Contours - Year 1 Evening with winds from the WSW at 3m/s

File Name (A4): R02/3230_032.dgn
20141112 13.18

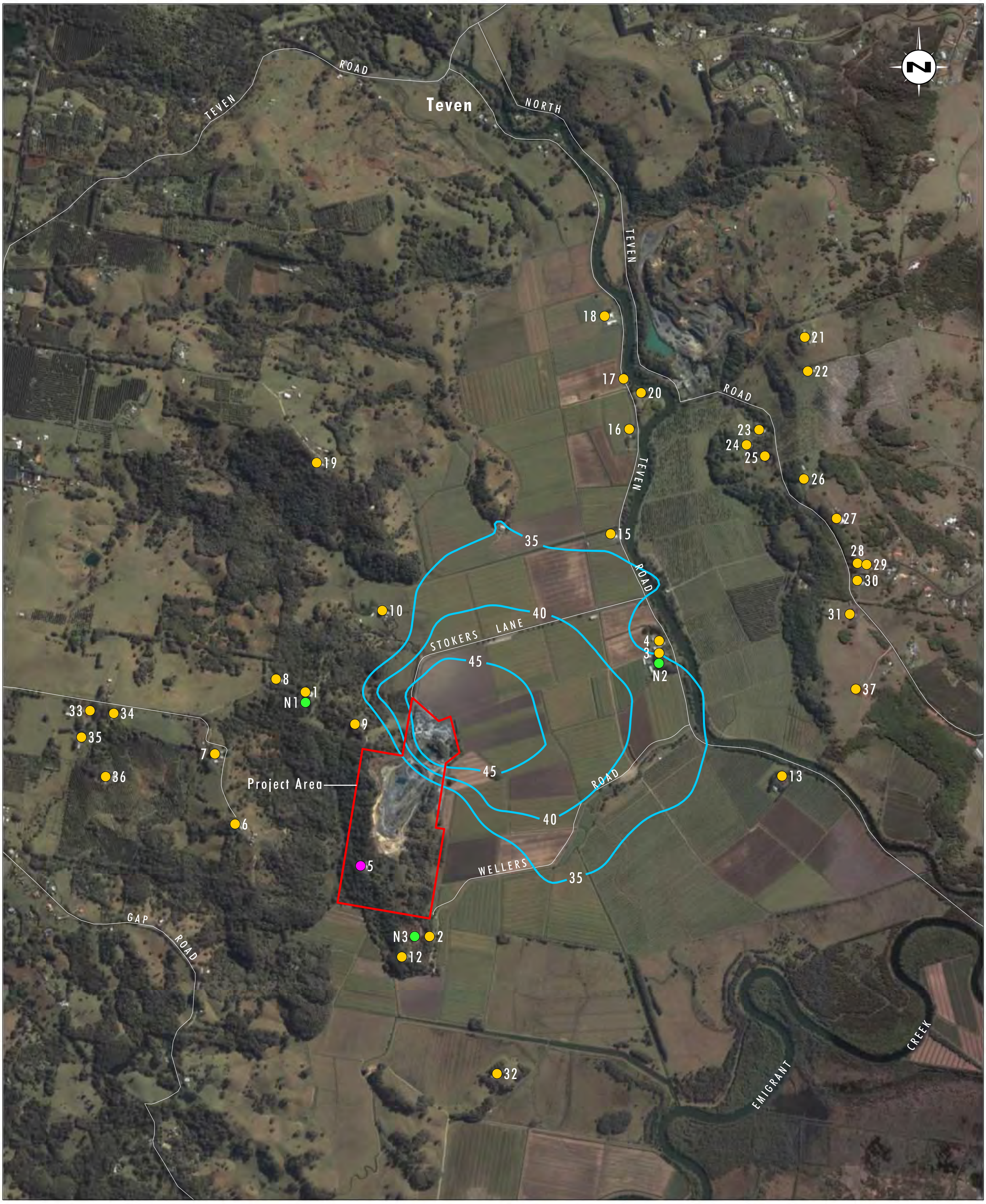


Image Source: Google Earth (2014)
Data Source: Holcim (2014)

0 0.25 0.5 1.0km
1:25 000

Legend

- Project Area
- Residential Receiver Location
- Subject to Commercial Agreement Receiver Location
- Noise Monitoring Location
- Stage 10 Evening with winds from the WSW at 3m/s - Noise Contour

FIGURE 6.4

Predicted Noise Impact Contours - Year 11 Evening with winds from the WSW at 3m/s

including the mobile crushing plant and pug mill which are proposed to be operated on a campaign basis only during periods of maximum production for the Project.

During the evening period the Project will achieve the evening target PSNL at all residential receiver locations.

6.2 Cumulative Noise Impact Assessment

The Project is located in an area generally consisting of rural and rural residential developments. Potential sources of industrial noise within the vicinity of the Project include:

- Boral Teven Quarry located on North Teven Road 2.5 kilometres to the north-east; and
- Tuckombil Quarry located on Gap Road Alstonville 3.2 kilometres to the west.

However, it is unlikely that these sources of industrial noise will cumulatively add to noise emissions from the Project due to the combined effects of:

- the relative locations of the sensitive receivers to the Project and the cumulative noise sources in the surrounding region; and
- the relative direction of significant meteorology for the area that is unlikely to enhance the propagation of noise from more than one operation at a time.

Due to the above reasons, it is unlikely that the cumulative noise impact assessment criteria will be exceeded due to the Project and noise contribution from the relevant surrounding industrial operations. This was confirmed by attended noise monitoring, undertaken as part of the NIA at the nearest sensitive receivers. During the noise monitoring program no other sources of industrial noise were identified at the monitoring locations.

As the Project is predicted to meet the project specific noise goals, it has been assumed that the Project will also meet the cumulative noise criteria. To ensure that this is the case, when required, attended noise monitoring will be undertaken to confirm the industrial noise source(s) contributing to the cumulative noise levels.

6.3 Road Traffic Noise Assessment

The predicted road traffic noise impacts at closest receivers for the existing and proposed Project and the relevant assessment criteria are presented in **Table 6.5** for one hour duration criteria and **Table 6.6** for 15 hour daytime criteria.

Table 6.5 – Predicted Noise Impacts – Stokers Lane, dB(A)

Receiver Location	Existing		Project at Peak Production		Criteria $L_{Aeq,(1 hour)}$	
	Peak AM	Peak PM	Peak AM	Peak PM	AM [1]	PM [1]
R10	39.3	35.7	40.3	37.5	55	55

Note 1: Day time, local road one hour duration criteria, NSW Road Noise Policy, OEH 2011

Table 6.6 – Predicted Noise Impacts – Teven Road, dB(A)

Receiver Location	Existing	Project at Peak Production	Relative Increase	Criteria[1] $L_{Aeq,(15\ hour)}$
R3	54.4	55.6	1.2	60
R4	59.6	60.8	1.2	60
R13	52.8	54.0	1.2	60
R15	63.4	63.0	-0.4	60
R16	63.4	63.0	-0.4	60
R17	63.4	63.0	-0.4	60
R18	55.6	55.3	-0.3	60
R20	52.1	51.7	-0.4	60

Note 1: Day time, sub-arterial road 15 hour duration criteria, NSW Road Noise Policy, OEH 2011

The predicted existing and Project road traffic noise impacts presented in **Tables 6.5** and **6.6** for receivers R10, R3, R13, R18 and R20 are below the relevant road traffic noise criteria. The predicted existing and Project road traffic noise impacts for receiver R4, R15, R16 and R17 are above the relevant road traffic noise criteria and therefore the relative increase criteria of 2 dB need to be considered. The road traffic noise levels at receivers R15, R16 and R17 are predicted to decrease due to the Project (due to the rerouting of haulage traffic to the south). The predicted increase in road traffic noise levels at receivers R3, R4 and R13 are considered negligible by the RNP at 1.2 dB.

6.4 Predicted Blast Emission Levels

The impacts of blasting associated with the Project have been predicted at the nearest sensitive receiver to the Project. Ground vibration levels have been predicted using the site law developed using the methodology outlined in the *Blasting Guide* (Orica 2012) and AS 2187.2 – 2006 (ANZECC 2006).

The predicted ground vibration and airblast levels at the nearest residential receiver location as a result of the Project's blasting activities are summarised in **Table 6.7**. These predictions reflect the worst case airblast and vibration levels potentially experienced at the nearest residential receiver location as a result of the Project and are based on both the historical maximum MIC values and the limiting MIC values.

The results presented in **Table 6.7**, indicate that the predicted ground vibration levels from a maximum 35 kilogram MIC would comply with the ANZECC and EPA criteria at the nearest residential receivers for Year 11 of the Project. However, at this MIC, a minor exceedance of 1 dB of the ANZECC and EPA air blast criteria could be expected at residential receiver R002. For the worst case potential blasting distance of 190 metres, the limiting MIC is 5 kilograms, due to potential airblast overpressure.

In accordance with Teven Quarry's existing practice, the permissible MIC for each blast will be calculated based on the specific location in which it will occur and on the blasting site law. Holcim Australia will design all blasts to comply with the ANZECC and EPA ground vibration and air blast criteria.

The blasting site law will be constantly updated using site-specific blast monitoring data. This process will provide Teven Quarry with flexibility to design blasts to best meet production requirements while complying with relevant criteria for residential receivers.

Table 6.7 – Predicted Blasting Emissions at Residential

Receiver Location	Distance (m)	MIC (kg)	Predicted Blasting Level		Blasting Emissions Criteria	
			SPL (dBL)	PVS (mm/s)	SPL (dBL)	PVS (mm/s)
R002 – (Lot 2 DP617131, 168 Wellers Road, Teven)	350[1]	35	116	1.7	115	5
R002 – (Lot 2 DP617131, 168 Wellers Road, Teven)	190[2]	5[3]	116	0.9	115	5

Note 1: Distance measured for Year 11 from edge of furthest extent of quarry wall, i.e. the closest distance blasting could possibly take place to the Receiver for Year 11 of the quarry.

Note 2: Distance measured for final landform edge of furthest extent of quarry wall, i.e. the closest distance blasting could possibly take place to the Receiver.

Note 3: Limiting MIC value due to potential airblast overpressure.

7.0 Management and Monitoring Framework

Section 7 of the INP (EPA 2000) notes that, when predicted noise levels exceed the PSNLs a range of strategies should be considered to reduce the noise impact on offsite receivers. Specifically for this project, the DGRs require evidence that there are no additional reasonable and feasible mitigation measures available for inclusion as a part of the Project. The three main strategies used to identify reasonable and feasible noise control and mitigation strategies are:

- **Controlling noise at the source** – There are three approaches to controlling noise generated by the source: source elimination; Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA).

- **Controlling the transmission of noise** – There are two approaches: the use of barriers and land-use controls which attenuate noise by increasing the distance between source and receiver.

- **Controlling noise at the receiver** – There are two approaches: negotiating an agreement with the landholder and acoustic treatment of dwellings to control noise.

7.1 Management of Operational Noise Levels

As outlined in **Section 2.0**, the identification and assessment of reasonable and feasible noise controls have been considered throughout the project design process and incorporated into detailed noise modelling (refer to **Section 5.0**). The incorporation of these reasonable and feasible controls has reduced the predicted noise impacts of the Project as far as practicable.

Holcim Australia commits to the implementation of the reasonable and feasible controls outlined in **Section 5.2.3** which have been factored into the noise model, over the life of the Project. These controls include:

- the maintenance of product stockpiles in strategic locations, where practicable, along the northern edge of the Project site shielding product trucks and product loading equipment;

- the use of broad band reversing alarms instead of beeper style alarms on all mobile equipment; and

- the management of mobile machines during adverse weather conditions when wind conditions or inversion conditions enhance the noise propagation towards sensitive receiver locations. In order to control/eliminate noise impacts this would likely include:

  - ensuring the sales loader operates behind the product stockpile during adverse weather conditions in the evening period;
  - moving quarrying activities to locations deeper in the quarry pit during adverse weather conditions; and
  - shut down of some equipment during adverse weather conditions if required.

To ensure the ongoing effective operation of these noise control measures, Holcim Australia is committed to:

- regular inspection and maintenance of noise attenuation systems; and

- implementation of a process for periodic review of noise performance of equipment. This process will be outlined in a Noise Management Plan to be prepared for the Project (refer to **Section 7.3**)

Following the implementation of these reasonable and feasible controls, only one property (R009) exceeds the target PSNL. This predicted exceedance is by more than 5 dB during the day-time period. Holcim Australia is currently negotiating a purchase agreement with the landholder of R009.

If during the course of operations, individual residential receivers are found to exceed their PSNLs, in addition to the management of operational noise levels outlined above, additional management procedures that can be implemented include:

- prompt response to any issues of concern raised by community;
- additional targeted noise monitoring on-site and within the community; and
- refinement of on-site noise mitigation measures and plant operating procedures where practical, specific to the transmission of noise to the affected receiver.

7.2 Additional Management Options during Periods of Adverse Conditions

Although not required to be assessed by the INP as part of the NIA (as they are not prevailing conditions and occur infrequently), there are a range of adverse meteorological conditions that could enhance the propagation of noise to receivers surrounding the Project area. Typically these adverse conditions occur less than 20 per cent of the time.

To assist in the management of noise emissions from the Project during these periods of adverse weather conditions when wind conditions enhance noise propagation towards sensitive receiver locations, a number of additional management and mitigation options have been identified relating to the management (use and placement) of mobile machines and attenuation of existing equipment. The need for implementation of these additional management options will be assessed as part of the recommended noise monitoring program (refer to **Section 7.4.1**), or in response to community complaints (refer to **Section 7.3.2**). Examples of management options could include:

- the noise attenuation of existing operations such that the addition of the new plant and equipment does not increase the noise impacts of the overall development. This could include:
  - the attenuation of the front end loaders working in and around the product stockpiles; and
  - attenuation of the tertiary crushing and screening plant.
- moving front end loader operations off elevated areas or away from exposed locations;
- restricting the dumping of overburden in exposed locations; and/or
- re-scheduling drilling in exposed locations for periods when the weather conditions do not enhance the noise impacts.

7.3 Noise Management Plan

Teven Quarry will develop and implement a Noise Management Plan (NMP). The NMP will detail the implementation of environmental management controls to be utilised to manage potential noise impacts associated with site operations. The NMP will, at a minimum, include:

- noise objectives and targets consistent with the Development Consent and EPL;
- noise mitigation measures, referencing relevant operating procedures with documented controls. The suitability of the noise management controls is to be assessed on an annual basis as part of ongoing review of operational risks to the Project;
- provision of general noise awareness training for operational staff, which identifies site specific objectives and targets for noise management, potential noise impacts, environmental commitments for Teven Quarry and obligations in respect of noise management;
- noise monitoring processes to be implemented over the life of the Project to provide for ongoing noise performance monitoring and determination of compliance with relevant noise criteria provided in the Project Approval and EPL (refer to **Section 7.3**);
- mechanisms for stakeholder consultation;
- complaint handling processes including maintenance of a Community Contact Line which will be in operation during operating hours; and
- a roles and responsibilities matrix, with responsibilities being clearly defined through all levels within the operation.

7.3.1 Change Management Process

During the operational phase of the Project, a change management process will be implemented in order to assess the potential noise impacts associated with operational changes at Teven Quarry. The change management process will be implemented at a minimum, in the following instances:

- when significant changes are made to the number of equipment or type of equipment utilised on site providing for evolving technology and equipment changes, to ensure the potential risk of noise criteria being exceeded is minimised; and
- prior to the purchase or rental of equipment which through either size or volume of equipment has the potential to result in exceedances of noise criteria.

The change management process is to consider the existing noise performance at Teven Quarry and is to include a review of the existing noise performance of the operation. Where considered necessary, noise modelling of the predicted noise emissions from the operation may be undertaken to confirm that compliance with the relevant statutory approval will be maintained following the proposed change.

7.3.2 Incident Investigation and Response

In the event that an exceedance of the noise impact assessment criteria is identified, Teven Quarry will notify the relevant government agencies and report within the statutory timeframes and liaise with any affected landowners.

If a non-compliance is identified or a request for installation for noise impact mitigation measures is received, corrective or preventative actions will be implemented. A review of the effectiveness of the corrective/preventative action will be conducted at a specified interval following the implementation of the corrective action.

7.4 Monitoring Requirements

7.4.1 Noise and Blast Monitoring Program

Teven Quarry will undertake a noise monitoring program on an annual basis comprising of day time operations and if/when undertaken, evening operations. Noise monitoring locations will be developed based on suitability and available land access, however, would ideally assess noise impacts at a number of the nearest sensitive receivers (for example, R001, R002, R003/R004, R010). The monitoring program will include:

- attended noise monitoring to measure ambient noise levels in the surrounding region and determination of the quarry's contribution to measured noise levels;
- comparison of the attended noise monitoring results with predicted noise levels from the Project noise models of the quarry under similar meteorological conditions, and relevant consent and EPL noise limits; and
- comparison of blast monitoring results with predicted vibration and airblast levels against the site laws developed for the Project and revise the site laws as required; and
- assessment of performance of noise control measures and recommendations for additional measures if required.

It is recommended that monitoring of ground vibration and airblast levels continue to be undertaken during each blasting event, as well as recording the precise location of each blast, to allow further refinement of the ground vibration site law. This will provide a more precise predictive tool for ongoing prediction of blasting impacts on structural receivers as quarrying progresses. It is also recommended that as the quarry progresses south, Holcim Australia should investigate the relocation or installation of a blast monitor to cover sensitive receivers to the south of the quarry (R002/R0012).

The monitoring program would also be used to assess the performance of all quarrying machinery as a whole. Equipment selection will be governed by the noise performance of the quarry not necessarily on individual items of equipment.

7.4.2 Reporting

The monitoring results should be reviewed to assess compliance with the NIA predictions and criteria outlined in the Development Consent and EPL. The results will be reported in accordance with the requirements of the Development Consent and EPL.

A summary of the noise monitoring and blasting monitoring results will be reported in the Annual Review for the operation.

8.0 Conclusion

8.1 Operational Noise Levels

Umwelt has undertaken a NIA to assess the potential noise impacts associated with the Project. The NIA included a detailed assessment of the existing noise environment surrounding the Project Area, assessment of the local meteorological conditions and modelling of two worst case stages of quarry development. The assessment of the noise impacts was undertaken in accordance with the NSW *Industrial Noise Policy* (INP), (EPA 2000).

During day-time the Project will achieve the day-time target PSNL at all residential receiver locations except Receiver R009. Holcim Australia is currently negotiating a purchase agreement with the landholder of R009.

During the evening period the Project will achieve the evening target PSNL at all residential receiver locations.

8.2 Cumulative Noise

The cumulative noise impact assessment for the areas surrounding the Project indicates that the cumulative noise impacts assessment criteria will not be exceeded based on the Project and the relevant surrounding industrial noise sources (refer to **Section 6.2**).

8.3 Road Traffic Noise

The predicted existing and Project road traffic noise impacts are generally below the road traffic noise criteria. The predicted existing and Project road traffic noise impacts for receivers that are above the relevant road traffic noise criteria are below the 2 dB trigger nominated in the NSW *Road Noise Policy* (DECCW 2011).

8.4 Blasting Assessment

The blasting impact assessment indicated that the predicted airblast and ground vibration levels associated with the Project can comply with the relevant criteria at the nearest residential receivers when the limiting MIC is applied. Holcim Australia will design all blasts to comply with the ANZECC and OEH ground vibration and airblast criteria.

8.5 Recommendations

The following recommendations are made in relation to the ongoing management, monitoring and reporting of noise emissions associated with the Project:

- the reasonable and feasible **noise mitigation and management measures** outlined in **Section 7.1** be implemented for the Project;
- a **noise management plan** be prepared and implemented for the Project as discussed in **Section 7.3**.

- a **noise and blast monitoring program** be undertaken annually, incorporating:
  - attended noise monitoring to measure ambient noise levels in the surrounding region and determination of the quarry's contribution to measured noise levels;
  - comparison of the attended noise monitoring results with predicted noise levels from the Project noise models of the quarry under similar meteorological conditions, and relevant consent and EPL noise limits;
  - comparison of blast monitoring results with predicted vibration and airblast levels against the site laws developed for the Project and revise the site laws as required; and
  - assessment of performance of noise control measures and recommendations for additional measures if required.
- ongoing **monitoring of ground vibration and airblast levels** be undertaken during each blasting event as well as recording the precise location of each blast, to allow further refinement of the ground vibration site law;
- as the quarry progresses south, Holcim Australia should investigate the **relocation or installation of a blast monitor** to cover sensitive receivers to the south of the quarry (R002/R0012); and
- until peak airblast and peak vibration data is recorded in conjunction with blast locations, it is recommended that **MIC is limited to 95 per cent** of the maximum calculated MIC.

9.0 References

Australian and New Zealand Environment Conservation Council 1990. *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration.*

Australian Standard AS1055-1989. *Acoustics – Description and Measurement of Environmental Noise, Part 1 General Procedures.*

Australian Standard AS2922-1987. *Ambient Air – Guide for the siting of sampling units*.

Australian Standard AS 2187.2 – 2006. *Explosives – Storage and Use – Use of explosives.*

Department of Climate Change 2009. *Interim Construction Guideline.*

Department of Environment, Climate Change & Water 2011. *NSW Road Noise Policy*.

ICI 1995, *Blasting Guide*.

NSW Environment Protection Authority 2000. *New South Wales Industrial Noise Policy.*

Office of Environment and Heritage 2011. NSW Road Noise Policy.

Orica Group of Companies 2012, *Orica Blasting Guide.*

Transport and Urban Planning 2014. *Traffic Assessment for Teven Quarry at Stokers Lane, Teven*.

United States of America Department of Transportation 2004. *US Federal Highway Administration Traffic Noise Model Version 2.5 Look-Up Tables.*

APPENDIX A

Glossary of Terms and Abbreviations

Appendix A – Glossary of Terms and Abbreviations

1/3 Octave	Single octave bands divided into three parts.
Octave	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
ABL	Assessment background level - A single-figure background noise level representing each assessment period – day, evening and night (that is, three assessment background levels are determined for each 24 hr period of the monitoring period). It is determined by taking the lowest 10th percentile of the L_{90} level for each assessment period.
Ambient Noise	The noise associated with a given environment. Typically a composite of sounds from many sources located both near and far where no particular sound is dominant.
A Weighting	A standard weighting of the audible frequencies designed to reflect the response of the human ear to noise.
dB(A), dBA	Decibels A-weighted.
dB(Z), dB(L)	Decibels Linear or decibels Z-weighted.
Decibel (dB)	The units of sound level and noise exposure measurement where a step of 10 dB is a ten-fold increase in intensity or sound energy and actually sounds a little more than twice as loud.
Hertz (Hz)	The measure of frequency of sound wave oscillations per second - 1 oscillation per second equals 1 hertz.
L_{A10}	The percentile sound pressure level exceeded for 10 per cent of the measurement period with 'A' frequency weighting calculated by statistical analysis. Typically used to assess the impact of an existing operation on a receiver area and is referred to as the cumulative noise levels at the receiver attributable to the noise source.
L_{A90}	Background Noise Level. The percentile sound pressure level exceeded for 90 per cent of the measurement period with 'A' frequency weighting calculated by statistical analysis.
L_{Amax}	The maximum of the sound pressure levels recorded over an interval of 1 second.
$L_{A1,1minute}$	The measure of the short duration high-level noises that cause sleep arousal. The noise level is measured as the percentile sound pressure level that is exceeded 1 per cent of measurement period with 'A' frequency weighting calculated by statistical analysis during a measurement time interval of 1 minute.
$L_{Aeq,t}$	Equivalent continuous sound pressure level - The value of the sound pressure level of a continuous steady noise that, a measurement interval of time (t), has the same mean square sound pressure as the sound under consideration whose level varies with time. Usually measured in dB with 'A' weighting.

L_{An} Percentile level - A measure of the fluctuation of the sound pressure level which is exceeded 'n' per cent of the observation time.

PSNL Project-specific noise levels - The target noise levels for a particular noise generating facility based on the most stringent of the intrusive criteria or amenity criteria.

RBL Rating background level - The overall single figure background level representing each assessment period over the whole monitoring period determined by taking the median of the ABLs found for each assessment period.

SPL (dBA) Noise: Sound pressure level - The basic measure of noise loudness. The level of the root-mean-square sound pressure in decibels given by:

$$SPL = 10.\log10\ (p/po)^2$$

where p is the rms sound pressure in pascals and po is the sound reference pressure at 20 μPa. decibels.

SWL Sound power level - a measure of the energy emitted from a source as sound and is given by:

$$SWL = 10.\log10\ (W/W_o)$$

where W is the sound power in watts and W_o is the sound reference power at 10^{-12} watts.

APPENDIX B

Industrial Noise Policy Assessment Methodology

Appendix B – Industrial Noise Policy Assessment Methodology

Industrial Noise Policy

Responsibility for the control of noise emissions in New South Wales (NSW) is vested in Local Government and the Office of Environment and Heritage (OEH). The NSW Environmental Protection Authority (EPA) *Industrial Noise Policy* (INP), 2000, provides a framework and methodology for deriving limit conditions for consent and licence conditions. Using this policy the OEH regulates premises that are scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act).

The specific INP (EPA 2000) objectives are:

- to establish noise criteria that would protect the community from excessive intrusive noise and preserve the noise amenity for specific land uses;
- to use the criteria as the basis for deriving project-specific noise levels;
- to promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;
- to outline a range of mitigation measures that could be used to minimise noise impacts;
- to provide a formal process to guide the determination of feasible and reasonable noise limits for consent or licence conditions that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and
- to carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the POEO Act.

The INP (EPA 2000) is designed for large and complex industrial sources and outlines processes designed to strike a feasible and reasonable balance between the operation of industrial activities and the protection of the community from noise levels that are intrusive or unpleasant.

The application of the INP (EPA 2000) involves the following processes:

- determining the project-specific noise levels (PSNL) from intrusiveness and amenity based measurement of the existing background and ambient noise levels. For existing industrial operations, the underlying level of noise present in the ambient noise, should be determined excluding the noise source under investigation;
- predicting or measuring the noise levels produced by the development; and
- comparing the predicted noise levels with the project-specific noise levels and assessing the impacts.

Where the project-specific noise levels are predicted to be exceeded the INP (EPA 2000) provides guidelines on the assessment of feasible and reasonable noise mitigation strategies, including:

- ‘weighing up’ the benefit of the development against the social and environmental costs resulting from the noise impacts;
- establishment of achievable and agreed noise limits for the development in consultation with the consent authority; and
- undertaking performance monitoring of environmental noise levels to determine compliance with the consent and licence conditions.

Industrial Noise Policy Assessment Methodology

There are two criteria to consider when establishing project-specific noise levels for the assessment of industrial noise sources. These criteria are:

- **The intrusive noise criterion**, which is based on the background noise level plus 5 dB. The background noise level, or Rating Background Level (RBL), is determined in accordance with Section 3 of the INP (EPA 2000) and is based on the use of noise monitoring data or INP default RBLs (refer to INP (EPA 2000)), to establish the assessable background noise levels.
- **The noise amenity criterion**, which is based on the recommended noise levels in the INP (EPA 2000) for prescribed land use. The recommended acceptable and maximum ambient noise levels are outlined in Table 2.1 of the INP (EPA 2000). Table 2.2 of the INP (EPA 2000) outlines the requirements for developments where the existing noise level from industrial noise sources is close to the acceptable noise level.

The relevant Tables in Section 2 of the INP relating to the amenity criteria relevant to the Project are presented in **Table B.1** and **Table B.2**.

Table B.1 – Amenity Criteria – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq Noise Level	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50 dB(A)	55 dB(A)
		Evening	45 dB(A)	50 dB(A)
		Night	40 dB(A)	45 dB(A)
	Suburban	Day	55 dB(A)	60 dB(A)
		Evening	45 dB(A)	50 dB(A)
		Night	40 dB(A)	45 dB(A)
	Urban	Day	60 dB(A)	65 dB(A)
		Evening	50 dB(A)	55 dB(A)
		Night	45 dB(A)	50 dB(A)
	Urban/Industrial Interface - for existing situations only	Day	65 dB(A)	70 dB(A)
		Evening	55 dB(A)	60 dB(A)
		Night	50 dB(A)	55 dB(A)

Table B.1 – Amenity Criteria – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources (cont.)

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended LAeq Noise Level	
			Acceptable	Recommended Maximum
Area specifically reserved for passive recreation	All	When in use	50 dB(A)	55 dB(A)
Active recreation area (School playground, golf course)	All	When in use	55 dB(A)	60 dB(A)
Commercial premises	All	When in use	65 dB(A)	70 dB(A)
Industrial premises	All	When in use	70 dB(A)	75 dB(A)

Source: Table 2.1, INP (EPA 2000).

Note: 1. For Monday to Saturday, Daytime 7.00 am – 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time 10.00 pm - 7.00 am. On Sundays and Public Holidays, Daytime 8.00 am - 6.00 pm; Evening 6.00 pm - 10.00 pm; Night-time, 10.00 pm - 8.00 am.

Note: 2. The LAeq index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

Table B.2 – Modification to Acceptable Noise Level (ANL) to Account for Existing Levels of Industrial Noise

Total Existing LAeq Noise Level from Industrial Noise Sources	Maximum LAeq Noise Level for Noise from New Sources Alone, dB
≥ Acceptable noise level plus 2 dB	If existing noise level is likely to decrease in future acceptable noise level minus 10 dB If existing noise level is unlikely to decrease in future existing noise level minus 10 dB
Acceptable noise level plus 1 dB	Acceptable noise level minus 8 dB
Acceptable noise level	Acceptable noise level minus 8 dB
Acceptable noise level minus 1 dB	Acceptable noise level minus 6 dB
Acceptable noise level minus 2 dB	Acceptable noise level minus 4 dB
Acceptable noise level minus 3 dB	Acceptable noise level minus 3 dB
Acceptable noise level minus 4 dB	Acceptable noise level minus 2 dB
Acceptable noise level minus 5 dB	Acceptable noise level minus 2 dB
Acceptable noise level minus 6 dB	Acceptable noise level minus 1 dB
< Acceptable noise level minus 6 dB	Acceptable noise level

Source: Table 2.2, INP (EPA 2000).

Note: 1. ANL = recommended acceptable LAeq noise level for the specific receiver.

In assessing the noise impacts from industrial sources at residential receivers both the intrusive and amenity criteria are considered. For each period (day, evening and night) the most stringent of either the intrusive or amenity criteria becomes the limiting criterion and forms the project-specific noise level for the industrial source.

If the existing ambient noise level is close to the acceptable noise level, a new source must be controlled to preserve the amenity of the surrounding area. If the overall noise level from the industrial source already exceeds the acceptable noise level for the affected area, the L_{Aeq} noise level from a new source should meet the conditions set out in **Table B.2** above.

Industrial Noise Policy Project-Specific Criteria

The INP (EPA 2000) states that the criteria outlined in Tables 2.1 and 2.2 (refer to **Tables B.1** and **B.2** above) have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP (EPA 2000) are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

Table B.3 presents the methodology for assessing noise levels which may exceed the INP (EPA 2000) project-specific noise assessment criteria.

Table B.3 – Noise Impact Assessment Methodology

Assessment Criterion	**Project-Specific Criteria**	**Noise Management Zone**	**Noise Affectation Zone**
Intrusive	Rating background level plus 5 dB	≤ 5 dB above project-specific criteria	≥ 5 dB above project-specific criteria
Amenity	INP based on existing industrial level	≤ 5 dB above project-specific criteria	≥ 5 dB above project-specific criteria

For the purposes of assessing the potential noise impacts the project-specific, management and affectation criteria are further defined in the following sections.

Project-Specific Criteria

Most people in the broader community would generally consider exposure to noise levels that achieve the project-specific criteria to be acceptable.

Noise Management Zone

Depending on the degree of exceedance of the project-specific criteria (1 dB to 5 dB) noise impacts in this zone could range from negligible to moderate. It is recommended that management procedures be implemented including:

- prompt response to any issues of concern raised by community;
- noise monitoring on-site and within the community;
- refinement of on-site noise mitigation measures and plant operating procedures where practical;
- consideration of acoustical mitigation at receivers; and
- consideration of negotiated agreements with property holders.

Noise Affectation Zone

Exposure to noise levels corresponding to this zone (more than 5 dB above project-specific criteria) may be considered unacceptable by some property holders and implementation of the following measures may be required:

- discussions with relevant property holders to assess concerns and provide solutions;
- implementation of acoustical mitigation at receivers; and
- negotiated agreements with property holders.

Assessing Intrusiveness Criteria

The EPA has provided a number of application notes to assist industry and acoustical consultants with interpretation and use of the INP (EPA 2000). The application notes applicable to the Project, reproduced below, were obtained from the EPA web site during May 2014. The EPA web site is:

http://www.epa.nsw.gov.au/noise/applicnotesindustnoise.htm

Identifying Which of the Amenity or Intrusive Criteria Apply
(see INP Section 2.4)

The INP notes that the Project-Specific Noise Levels (PSNL) are the more stringent of either the amenity or intrusive criteria. This is not necessarily just a matter of comparing the magnitude of the amenity criteria to the intrusive criteria because different time periods apply (intrusive criteria uses 15 minutes while the amenity criteria are over the day, evening or night period).

For example, where the same number applies to both the amenity and intrusive criteria, the intrusive criteria would typically be more stringent because it is determined over a much shorter period.

Where the predicted amenity noise level is lower than the intrusive level for the proposed development, the proponent needs to ensure that both levels will be satisfied. In this situation, noise limits specified in the licence conditions will include both the intrusive and amenity noise levels predicted to be achieved by the proposal to ensure that the community is protected from intrusive noise impacts at all times.

Assessing Background Noise Levels
(see INP Section 3.1)

To determine the Rating Background Level (RBL) and existing industry-contributed L_{Aeq}, the measurement of ambient noise levels should be undertaken in the absence of noise from the development under consideration.

When the RBL for Evening or Night Is Higher Than the RBL for Daytime
(see INP Section 3.1)

The results of long term unattended background noise monitoring can sometimes determine that the calculated Rating Background Level (RBL) for the evening or night period is higher than the RBL for the daytime period. These situations can often arise due to increased noise from, for example, insects or frogs during the evening and night in the warmer months or due to temperature inversion conditions during winter. The objective of carrying out long-term background noise monitoring at a location is to determine existing background noise levels that are indicative of the entire year.

In determining project-specific noise levels from the RBLs, the community's expectations also need to be considered. The community generally expects greater control of noise during the more sensitive evening and night-time periods than the less sensitive daytime period. Therefore, in determining project-specific noise levels for a particular development, it is generally recommended that the intrusive noise level for evening be set at no greater than the intrusive noise level for daytime. The intrusive noise level for night-time should be no greater than the intrusive noise level for day or evening. Alternative approaches to these recommendations may be adopted if appropriately justified.

Tonality - Sliding Scale Test
(see INP Section 4.2)

The sliding scale test for tonality outlined in Section 4 of the INP uses a linear (z-weighted) spectrum (that is, no frequency weighting on each of the octave or third octave bands).

Duration Correction
(see INP Section 4.2)

Section 4 of the INP provides guidance on the use of modifying factors to account for certain characteristics of a noise source. The duration factors in Table 4.2 are intended to increase the criterion that is acceptable, whereas the modifying factor corrections in Table 4.1 are intended to increase the measured or predicted level.

Determining What Weather Conditions Should Be Used When Predicting Noise
(see INP Section 5)

Background

The INP intends that the noise levels used in assessing noise impacts at the consent stage include the effects of any weather conditions that are a feature of the area when the development operates. This means that the effects of weather conditions such as temperature inversions and wind on the noise level experienced at sensitive receivers should be adequately assessed at the consent stage.

Wind can enhance noise propagation compared with calm conditions (where there is no wind). When a wind blows, friction causes the air to move more slowly close to the ground than at higher altitudes. This phenomenon of wind speed increasing with height is termed 'wind shear'. The increase in noise occurs because sound waves from the source are bent through this 'wind shear' back towards the ground.

Unlike temperature inversions, wind can enhance propagation during any time of the day, evening or night. Wind does not increase noise in all directions and can also reduce noise. For example, wind blowing from the south to the north (termed a 'southerly' wind) increases noise to the north of an industrial premise and also reduces noise to the south of that premise.

In some instances, where one or more significant weather conditions have been identified as part of a noise assessment, noise levels from the industrial premises under only these significant weather conditions have been assessed, but noise levels under calm conditions have not.

The INP describes in Section 5 when weather is 'significant' (i.e. it occurs more than 30 per cent of the relevant time period) and how to apply this in the noise assessment. This approach may result in noise levels at some receivers being underestimated, as in the southerly prevailing wind scenario described above.

Recommended approach

This application note clarifies that in all cases at each receiver:

- noise levels from the premises under calm conditions as well as any significant weather conditions as defined in the INP should be predicted or measured; and

- the highest of the noise levels from Step 1 is to be used in the assessment for that receiver.

The intent of the INP is not to require that these conditions should be applied exclusively where the significant weather conditions act to reduce noise at a sensitive receiver.

For example, where a significant prevailing wind of speed less than 3 metres per second increases noise levels at a receiver to the north of a development (compared with those predicted under calm conditions), the noise levels predicted under that prevailing wind should be used at that receiver. For receiver(s) to the south of the same development, if the noise levels predicted under calm wind conditions are higher than those predicted under the significant prevailing wind, the noise levels predicted under calm wind conditions should be used at the southern receiver(s).

The EPA has previously accepted (and will accept) noise predictions based on modelling noise emissions using long term weather data, as it can present a higher level of analysis than that required under the INP.

How Calm is Defined
(see INP Section 5.1)

In the assessment of wind effects, the INP requires the assessment of wind speeds of up to 3 metres per second where these speeds are a feature of the area (they occur for 30 per cent of the time or more) but does not specify the minimum wind speed that needs to be assessed. The calm condition is typically represented by wind speeds less than or equal to 0.5 metres per second as this is likely to be the lower limit of measurement.

Presenting Predicted Noise Impacts
(see INP Section 6.3)

In carrying out noise impact predictions for a particular development, predicted noise levels for calm conditions as well as any significant adverse weather conditions should generally be provided. It is particularly useful to provide predicted noise impacts for calm weather conditions where predicted noise impacts under adverse weather conditions exceed the project-specific noise levels. This allows for a better understanding of potential noise impacts from the development.

Noise Impact Assessment for the Modification of Existing Industrial Premises
(see INP Section 10)

<u>Background</u>

Section 10 of the INP outlines the application of the policy to existing industrial premises.

As well as being used to assess noise emissions from new industrial premises, the INP is also applied to situations where existing industrial premises are modified, expanded or upgraded.

Where a modification is proposed, the noise level targets for the premises (termed Project Specific Noise Levels) are to be determined firstly excluding any noise from the subject premises. The noise from the existing premises is then assessed against these targets to determine if there is a need to consider noise mitigation for existing operations. The predicted noise level from the proposed modification is then assessed, both in isolation and in combination with noise from the existing premises.

The total noise emissions from the modified premises should ideally not exceed the Project Specific Noise Levels. If the existing premises cannot achieve these targets, the allowable noise emissions from the proposed modification will be set so that the modification does not significantly increase the existing noise emissions.

Recommended approach

This application note outlines these processes together with the degree of information required to support a proper assessment of modifications to an existing industrial premises.

A noise impact assessment for the modification of existing industrial premises should include, as a minimum:

- existing noise criteria contained in consents, approvals or licences, that are applicable to the premises;

- Project Specific Noise Levels (PSNLs) for the premises determined in accordance with the INP and relevant application notes (see, for example, Appendix A4 of the INP). Note: care should be taken to exclude noise from the existing premises when quantifying background and existing industrial noise levels (further guidance is in the INP in Section 11.1.2);

- where application of the INP results in a PSNL more stringent than existing noise criteria, the PSNL should be adopted for noise assessment purposes. Note: the INP acknowledges that the PSNL is a goal sought to be achieved through the application of feasible and reasonable noise mitigation measures and is not necessarily applied as a statutory limit by default;

- measured or predicted noise levels from the existing premises at noise sensitive receiver locations;

- predicted noise contribution from the proposed modification, in isolation, at noise sensitive receiver locations; and

- cumulative noise levels from the entire premises (i.e. combined level from existing and proposed modification) compared to the PSNL.

Where noise from the existing premises exceeds the PSNL

Where it can be determined that noise from the existing premises alone is currently exceeding the PSNL, a preliminary analysis of potential noise mitigation measures, and conceptual noise reductions, needs to be undertaken for the existing premises. Note: this does not mean that in all circumstances noise mitigation to existing premises will be required as part of a modification. Decisions of this nature will be determined on a case-by-case basis, taking into account various factors, for example, feasible and reasonable mitigation options, the absolute level of noise and existing measures of community impact, including complaints.

Once the conceptual mitigated level of noise performance of the existing premises (i.e. what can be achieved) has been determined, the contribution noise level goal for the modification can be determined. The noise level goal for the modification should be set at least 10 dB below the PSNL, or where it has been determined that the existing premises cannot achieve the PSNL, it should be set at least 10 dB below the conceptual mitigated noise performance of the existing premises.

This approach is designed to ensure that noise from the modification does not become the limiting factor in noise from the entire premises potentially meeting the PSNL.

Using Appendix D

Appendix D of the INP provides a rough guide for predicting the increase in noise due to inversion effects. The data provided is based on simple calculations performed using the Environmental Noise Model (ENM), assuming flat ground and no barriers.

The use of this Appendix may underestimate the effects of temperature inversions where a barrier or intervening topography is present. For detailed noise impact assessments, a more thorough analysis of noise impacts under temperature inversions is expected. Where a noise model such as SoundPlan or ENM is used to determine noise impacts from a development under calm conditions or during wind conditions, the model should also be used to determine potential noise impacts under inversion conditions, rather than using Appendix D.

Sleep Disturbance

Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development. The INP does not specifically address sleep disturbance from high noise level events.

Research on sleep disturbance is reviewed in the NSW Road Noise Policy. This review concluded that the range of results is sufficiently diverse that it was not reasonable to issue new noise criteria for sleep disturbance.

From the research, the EPA recognised that the current sleep disturbance criterion of an L_{A1}, (1 minute) not exceeding the L_{A90}, (15 minute) by more than 15 dB(A) is not ideal. Nevertheless, as there is insufficient evidence to determine what should replace it, the EPA will continue to use it as a guide to identify the likelihood of sleep disturbance. This means that where the criterion is met, sleep disturbance is not likely, but where it is not met, a more detailed analysis is required.

The detailed analysis should cover the maximum noise level or L_{A1}, (1 minute), that is, the extent to which the maximum noise level exceeds the background level and the number of times this happens during the night-time period. Some guidance on possible impact is contained in the review of research results in the NSW Road Noise Policy. Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur;
- time of day (normally between 10.00 pm and 7.00 am); and
- whether there are times of day when there is a clear change in the noise environment (such as during early morning shoulder periods).

The L_{A1}, (1 minute) descriptor is meant to represent a maximum noise level measured under 'fast' time response. The EPA will accept analysis based on either L_{A1}, (1 minute) or L_{A}, (Max).

APPENDIX C

Assessment of Existing Noise Environment

Appendix C – Assessment of Existing Noise Environment

Industrial Noise Policy Methodology

Introduction

The NSW Industrial Noise Policy (INP), (EPA 2000) and supporting Application Notes documents the procedures used to assess the noise from industrial noise sources scheduled under the *Protection of the Environment Operations Act 1997*. The first step in the application of the INP involves:

- Determining the project-specific noise levels for intrusiveness and amenity based on the measurement of the existing background and ambient noise levels.

The methodologies for determining the assessment criteria and the monitoring programs required to provide the necessary data are outlined in the INP and is based around the evaluation of the background noise levels and amenity noise levels.

Background Noise Levels

The underlying ambient noise level is referred to as the background noise level and is represented by the $L_{A90,\ 15\ minute}$ descriptor. The intrusiveness of an industrial noise source is generally considered acceptable if the predicted $L_{AEq,\ 15\ minute}$ from the noise source does not exceed the background noise level by more than 5 dB when measured in the absence of the source. The background noise level, or Rating Background Level (RBL), is determined in accordance with Section 3 of the INP and is the median value of the Assessment Background Levels (ABL) determined for the monitoring period.

Amenity Noise Levels

To control and/or limit the increase in industrial noise levels, the EPA has identified recommended acceptable and maximum ambient noise levels for typical receiver areas and land uses. The INP represents the existing ambient noise level by the $L_{Aeq,\ period}$ descriptor where the periods is the day, evening and/or night during which the proposed development will operate. The INP suggests a minimum measurement period of one week is required in order to obtain sufficient data to determine the existing L_{Aeq} noise levels. The assessment of the existing L_{Aeq} noise levels is then used to determine the amenity criteria which are designed to control the overall impact from industrial noise sources.

Transportation Noise Levels

The INP notes that transportation noise should also be included in the assessment of the noise environment when traffic is constant and continuous, and it can be demonstrated that the existing noise is due to transportation-related sources. The INP notes specifically that this is only applicable where the industrial noise level is 10 dB below the existing combined noise level.

Weather Conditions

The INP notes that noise monitoring data should be excluded when the average wind speeds are greater than 5 m/s or when it is raining.

Monitoring Period

The EPA typically require one week's worth of valid data covering the days and times of operation of the proposed development. However the INP also notes that:

- variations due to seasonal changes in weather including the presence and strength of inversions should be considered;
- variations due to wildlife activity and operational activities of other developments should be considered; and
- to meaningfully determine the existing noise environment the duration of monitoring should be determined by taking into account the circumstances of the particular situation.

Background Noise Monitoring Program

The existing noise environment in the area surrounding the Project was assessed using three Acoustic Research Laboratories EL-215 noise loggers. The details of the noise monitoring data used in the assessment of the noise environment are presented in **Table 1**.

The monitoring data from the noise logging units included the 24 hours per day monitoring of:

- ambient background and statistical noise levels for each 15 minute interval recorded as $L_{A1, 15minute}$, $L_{A10, 15minute}$, and $L_{A90, 15minute}$; and
- $L_{AEq, 15minute}$ noise levels for every 15 minute interval recorded.

Table 1 – Background Noise Monitoring Program

Monitoring Location	Description	Monitoring Period
N1	217 Leadbeatters Lane, Teven	14:45 26/07/13 to 21:30 01/08/13
N2	433 Teven Road, Teven	15:15 26/07/13 to 20:00 12/08/13
N3	168 Wellers Road, Teven	15:30 26/07/13 to 23:00 09/08/13

Meteorological Data

Data on meteorological conditions at the time of each monitoring period was collected from the Bureau of Meteorology Automatic Weather Station 058198 located approximately 6km to the east of the Project Area at Ballina Airport.. The meteorological data included:

- ambient temperature at 2 metres;
- wind speed; wind direction and stability class (or sigma-theta);
- humidity; and
- rainfall.

Summary of Background Noise Monitoring Data

A summary of the background noise monitoring data used to determine the existing noise background and amenity noise levels is presented in **Tables 4** to **6**.

Table 4 – Monitoring Location N1, RBL and Mean L_{Aeq}, dB(A)

INP Stats		Day	Evening	Night
Mean L_{Aeq}		**45.5**	**36.2**	**36.2**
RBL		**31.8**	**30.5**	**30.0**
ABL	26 July 2013	-	30.0	27.0
	27 July 2013	30.2	28.5	29.0
	28 July 2013	31.0	28.0	28.0
	29 July 2013	32.5	31.0	29.1
	30 July 2013	33.0	32.5	-
	31 July 2013	-	-	-
	1 August 2013	-	32.1	-
INP Analysis				
RBL		**31.8**	**30.5**	**30.0 (28.5) [1]**
Intrusiveness Criteria		**37**	**36**	**35**
Recommended L_{Aeq}		50	45	40
Mean Measured L_{Aeq} (All Sources)		**45.5**	**36.2**	**36.2**
Estimated Mean L_{Aeq} (Non-industrial)		45.5	36.2	36.2
Estimated Mean L_{Aeq} (Industrial)		<30	<30	<30
Mean $L_{Aeq,industrial}$ minus Recommended L_{Aeq}		<-6	<-6	<-6
Mod Req'd (INP Table 2.2) to ANL[2]		0	0	0
Amenity Criteria[2]		**50**	**45**	**40**
Day time noise level is more than 6 dB below the recommended level therefore set at the recommended level				
Evening noise level is more than 6 dB below the recommended level therefore at the recommended level				
Night time noise level is more than 6 dB below the recommended level therefore at the recommended level				
Project Specific Noise Level		**37 $L_{Aeq,15min}$**	**36 $L_{Aeq,15min}$**	**35 $L_{Aeq,15min}$**

Note: '-' denotes wind or rain effected results excluded in accordance with the INP

Note 1: Where the RBL is less than 30 dB(A) then the RBL is set at 30.0 dB(A).

Note 2: Where there is no existing industrial noise influence and the high traffic noise criteria is not triggered at the receiver location, the Amenity Criteria is set to the Recommended Acceptable Noise Level (INP). Where the measured mean LAeq, period noise levels is affected by industrial noise sources the acceptable noise level is modified in accordance with Table 2.2 of the INP.

Table 5 – Monitoring Location N2, RBL and Mean L_{Aeq}, dB(A)

INP Stats		Day	Evening	Night
Mean L_{Aeq}		**55.8**	**47.7**	**42.8**
RBL		**32.5**	**30.0**	**30.0**
ABL	26 July 2013	-	32.5	28.0
	27 July 2013	32.2	30.0	29.0
	28 July 2013	31.0	33.3	30.6
	29 July 2013	33.0	33.0	30.0
	30 July 2013	34.9	34.0	-
	31 July 2013	-	-	-
	1 August 2013	-	33.8	31.5
	2 August 2013	31.7	31.3	27.5
	3 August 2013	32.5	27.5	26.0
	4 August 2013	32.6	28.0	27.8
	5 August 2013	32.6	27.8	27.8
	6 August 2013	31.5	28.5	28.3
	7 August 2013	32.9	28.3	27.3
	8 August 2013	-	-	-
	9 August 2013	-	32.0	29.0
	10 August 2013	31.7	28.5	26.5
	11 August 2013	30.0	27.5	25.0
	12 August 2013	35.0	-	-
INP Analysis				
RBL		**32.5**	**30.0**	**30.0 (27.9)[1]**
Intrusiveness Criteria		**38**	**35**	**35**
Recommended L_{Aeq}		50	45	40
Mean Measured L_{Aeq} (All Sources)		**55.8**	**47.7**	**42.8**
Estimated Mean L_{Aeq} (Non-industrial)		55.8	47.7	42.8
Estimated Mean L_{Aeq} (Industrial)		<30	<30	<30
Mean $L_{Aeq,industrial}$ minus Recommended L_{Aeq}		<-6	<-6	<-6
Mod Req'd (INP Table 2.2) to ANL[2]		0	0	0
Amenity Criteria[2]		**50**	**45**	**40**
Day time noise level is more than 6 dB below the recommended level therefore set at the recommended level				
Evening noise level is more than 6 dB below the recommended level therefore at the recommended level				
Night time noise level is more than 6 dB below the recommended level therefore at the recommended level				
Project Specific Noise Level		**38 $L_{Aeq,15min}$**	**35 $L_{Aeq,15min}$**	**35 $L_{Aeq,15min}$**

Note: '-' denotes wind or rain effected results excluded in accordance with the INP

Note 1: Where the RBL is less than 30 dB(A) then the RBL is set at 30.0 dB(A).

Note 2: Where there is no existing industrial noise influence and the high traffic noise criteria is not triggered at the receiver location, the Amenity Criteria is set to the Recommended Acceptable Noise Level (INP). Where the measured mean LAeq, period noise levels is affected by industrial noise sources the acceptable noise level is modified in accordance with Table 2.2 of the INP.

Table 6 – Monitoring Location N3, RBL and Mean L_{Aeq}, dB(A)

INP Stats		Day	Evening	Night
Mean L_{Aeq}		**41.3**	**44.0**	**40.4**
RBL		**36.0**	**38.0**	**37.3**
ABL	26 July 2013	-	38.00	37.50
	27 July 2013	36.00	37.75	38.00
	28 July 2013	36.50	38.00	37.50
	29 July 2013	36.50	38.20	37.50
	30 July 2013	36.00	39.25	-
	31 July 2013	-	-	-
	1 August 2013	-	38.50	38.50
	2 August 2013	35.50	38.00	37.00
	3 August 2013	35.50	37.00	37.25
	4 August 2013	36.00	37.25	37.00
	5 August 2013	36.00	36.75	37.00
	6 August 2013	35.50	37.00	37.00
	7 August 2013	35.50	37.00	36.50
	8 August 2013	-	-	-
	9 August 2013	-	38.00	-
INP Analysis				
RBL		**36.0**	**38.0**	**37.3**
Intrusiveness Criteria		**43 (41)[1]**	**43**	**42**
Recommended L_{Aeq}		50	45	40
Mean Measured L_{Aeq} (All Sources)		**41.3**	**44.0**	**40.4**
Estimated Mean L_{Aeq} (Non-industrial)		41.3	44.0	40.4
Estimated Mean L_{Aeq} (Industrial)[2]		<30	<30	<30
Mean $L_{Aeq,industrial}$ minus Recommended L_{Aeq}		<-6	<-6	<-6
Mod Req'd (INP Table 2.2) to ANL[3]		0	0	0
Amenity Criteria[3]		**50**	**45**	**40**
Day time noise level is more than 6 dB below the recommended level therefore set at the recommended level				
Evening noise level is more than 6 dB below the recommended level therefore at the recommended level				
Night time noise level is more than 6 dB below the recommended level therefore at the recommended level				
Project Specific Noise Level		**43 $L_{Aeq,15min}$**	**43 $L_{Aeq,15min}$**	**42 $L_{Aeq,15min}$** **40 $L_{Aeq, night}$**

Note: '-' denotes wind or rain effected results excluded in accordance with the INP

Note 1: Where the day time is quieter than the evening set the evening at the daytime level.

Note 2: Attended monitoring noted the influence of existing Teven Quarry operations on background noise levels at this location but was unable to determine contribution.

Note 3: Where there is no existing industrial noise influence and the high traffic noise criteria is not triggered at the receiver location, the Amenity Criteria is set to the Recommended Acceptable Noise Level (INP). Where the measured mean LAeq, period noise levels is affected by industrial noise sources the acceptable noise level is modified in accordance with Table 2.2 of the INP.

APPENDIX D

Assessment Criteria

Appendix D – Assessment Criteria

Table 1 – Receivers Location and Assessment Criteria, dB(A)

Receiver Location	Applicable Monitoring Data	Project-specific Noise Level [1] (L_{Aeq},15minute/L_{Aeq},period)		
		Day	Evening	Night
R001	Area 1	37/-	36/-	35/-
R002	Area 1	37/-	36/-	35/-
R003	Area 2	38/-	35/-	35/-
R004	Area 2	38/-	35/-	35/-
R005	-	-	-	-
R006	Area 1	37/-	36/-	35/-
R007	Area 1	37/-	36/-	35/-
R008	Area 1	37/-	36/-	35/-
R009	Area 2	38/-	35/-	35/-
R010	Area 1	37/-	36/-	35/-
R011	-	-	-	-
R012	Area 1	37/-	36/-	35/-
R013	Area 2	38/-	35/-	35/-
R014	-	-	-	-
R015	Area 2	38/-	35/-	35/-
R016	Area 2	38/-	35/-	35/-
R017	Area 2	38/-	35/-	35/-
R018	Area 2	38/-	35/-	35/-
R019	Area 1	37/-	36/-	35/-
R020	Area 2	38/-	35/-	35/-
R021	Area 1	37/-	36/-	35/-
R022	Area 1	37/-	36/-	35/-
R023	Area 1	37/-	36/-	35/-
R024	Area 1	37/-	36/-	35/-
R025	Area 1	37/-	36/-	35/-
R026	Area 1	37/-	36/-	35/-
R027	Area 1	37/-	36/-	35/-
R028	Area 1	37/-	36/-	35/-
R029	Area 1	37/-	36/-	35/-
R030	Area 1	37/-	36/-	35/-
R031	Area 1	37/-	36/-	35/-
R032	Area 1	37/-	36/-	35/-
R033	Area 1	37/-	36/-	35/-
R034	Area 1	37/-	36/-	35/-
R035	Area 1	37/-	36/-	35/-
R036	Area 1	37/-	36/-	35/-
R037	Area 1	37/-	36/-	35/-
All other industrial properties[1]	INP [2]	-/70	-/70	-/70
All other commercial properties[1]	INP [2]	-/65	-/65	-/65
All other residential properties	INP [2]	35/-	35/-	35/-

Note "-" indicates that PSNL does not apply as this location is either owned by Teven Quarry or is under a commercial arrangement or is not a private residence.

Note 1: PSNL only applies when property is being used for a commercial or industrial activity.

Note 2: Where PSNLs have not been specifically derived for a receiver the most stringent default condition presented in the INP (DECC, 2000) has been applied.

APPENDIX E

Quarry Plans and Equipment Schedule

Appendix E – Quarry Plans and Equipment Schedule

Introduction

Many of the machines and items of equipment presented in the following Tables are represented as multiple point sources in order to simulate:

- the possible alternate locations of the machine e.g. the use of alternate front end loader locations;
- the same machine doing two different activities e.g. a front end loader pushing (loading) and reversing;
- a number of trucks represented as a continuous circuit; and
- multiple fixed plant items as the equivalent of a single point source.

The sound power levels of the equipment (including acoustic utilisation factors) proposed over the life of the quarry presented in the **Tables 1** to **4** for years 1 and 11 are considered indicative rather than mandatory. The actual performance of the quarry operation will be determined by monitoring the environmental noise levels over the life of the Project. That is, while the representative sound power levels provide a guide to equipment selection, the actual performance of the quarry as a whole will dictate equipment selection criteria.

The ENM models of the staged quarry plans include all the equipment that would be operating in and around the quarry. In addition to the quarrying activities the noise models include:

- existing crushing and screening and conveyor operations;
- proposed portable crusher;
- proposed pug mill; and
- stockpile management and the loading and haulage of product material by road truck within the Project area.

The ENM model of the crushing plant, conveyor systems and mobile equipment working in and around the crushing plant were based on the representative equipment list and topographical layout of the facility. It was assumed that these activities would remain basically unchanged over the life of the quarry.

The representative locations of the equipment within each stage of the mining operation are shown in **Figures E1** and **E2**.

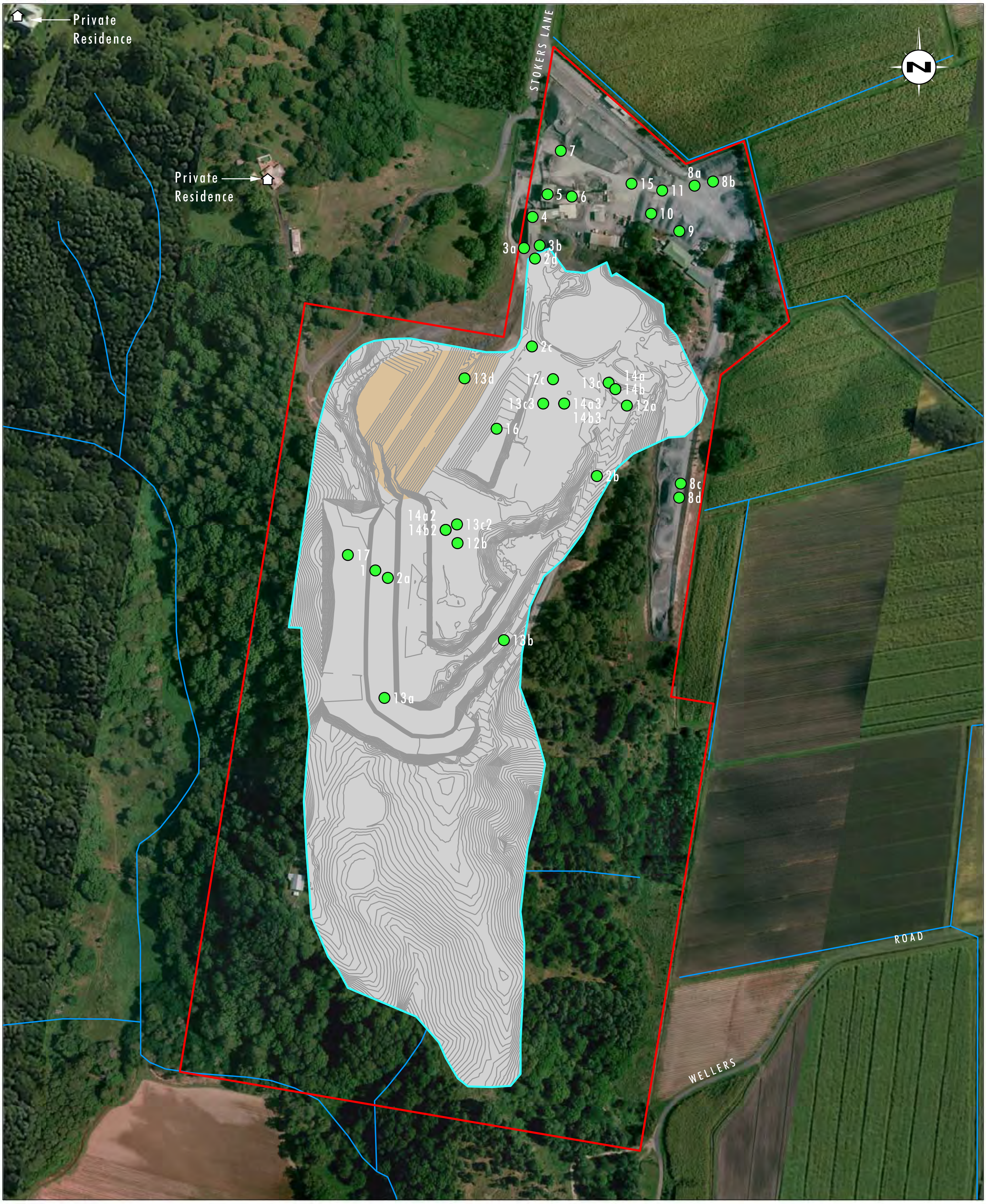


Image Source: Google Earth (2013), Holcim (Australia) Pty Ltd (2014)
Data Source: Holcim (Australia) Pty Ltd (2014)

0 50 100 200m
1:5 000

Legend

- Project Area
- Extraction Limit Boundary
- Western Overburden Emplacement Area
- Private Residence
- Drainage Line
- Noise Source

FIGURE E.1

Year 1 Noise Source Locations

File Name (A4): R02/3230_034.dgn
20140522 12.59

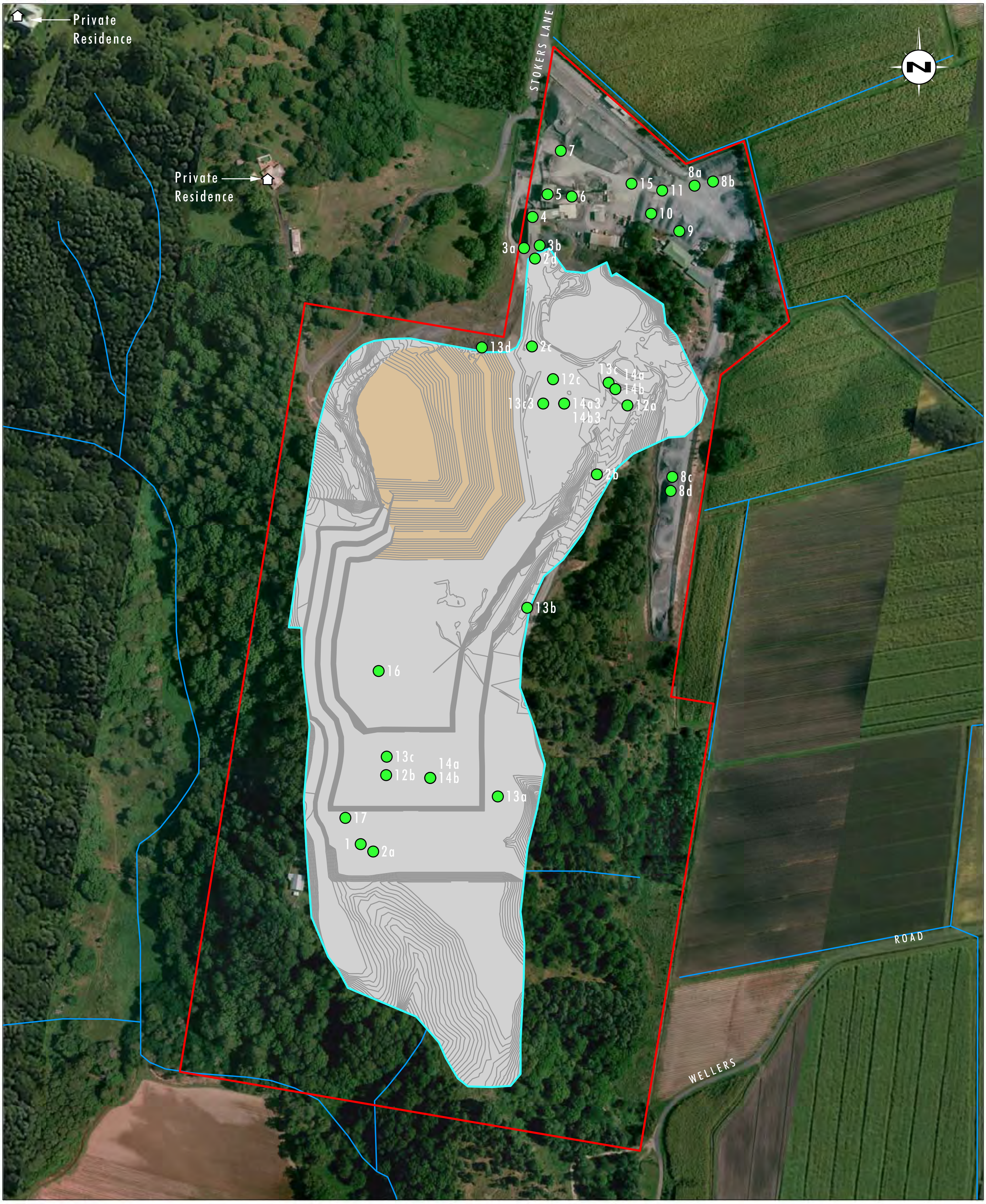


Image Source: Google Earth (2013), Holcim (Australia) Pty Ltd (2014)
Data Source: Holcim (Australia) Pty Ltd (2014)

0 50 100 200m
1:5 000

Legend

- Project Area
- Extraction Limit Boundary
- Western Overburden Emplacement Area
- Private Residence
- Drainage Line
- Noise Source

FIGURE E.2

Year 11 Noise Source Locations

File Name (A4): R02/3230_035.dgn
20140522 13.00

Table 1 - Year 1 Modelled Equipment List - Daytime

Source ID	Equipment Name	Activity	Acoustic Utilisation Factor	SWL, dB(A)	SWL, dB(Z)	Easting, MGA	Northing, MGA	Ground Elevation, m AHD
1	Komatsu Excavator	Digging	100%	94.7	106.9	547540	6809534	40.8
2a	CAT 769C Haul Truck	Load	38%	97.7	104.5	547551	6809528	40.3
2b	CAT 769C Haul Truck	Driving	13%	93	99.8	547746	6809622	20.9
2c	CAT 769C Haul Truck	Driving	13%	93	99.8	547686	6809743	13.0
2d	CAT 769C Haul Truck	Unload	38%	97.7	104.5	547688	6809825	12.2
3a	CAT 988B FEL	Dump - Reverse	50%	105	117.4	547678	6809835	12.5
3b	CAT 988B FEL	Dig - Forwards	50%	103.9	119	547693	6809837	12.6
4	Primary Plant	Running	100%	99.1	114.3	547686	6809864	3.0
5	Secondary Plant	Running	100%	105.3	117.3	547700	6809885	3.0
6	Tertiary Plant	Running	100%	109.4	118.6	547723	6809883	3.0
7	CAT 980C FEL	Dig	100%	110.3	122.7	547712	6809926	3.0
8a	Komatsu FEL	Dig	50%	100	105.8	547837	6809893	2.0
8b	Komatsu FEL	Dump	50%	100.9	105.9	547854	6809897	2.0
10	Pug Mill	Running	100%	103.1	112.6	547797	6809867	2.6
11	Product Truck	Idling	100%	90.2	91	547807	6809889	2.1
15	Product Truck	Idling	100%	90.2	91	547778	6809895	2.4
16	Pump	Pumping	100%	105.1	113.1	547653	6809667	5.0
17	Drill	Drill	100%	101	110.8	547514	6809549	50.6
12c	Portable Crusher	Running	100%	117.6	120.2	547705	6809713	6.0
13c3	CAT 769C Haul Truck	Driving	25%	96	102.8	547696	6809690	6.0
14a3	CAT 988B FEL	Dig	50%	105	117.4	547716	6809690	6.0
14b3	CAT 988B FEL	Dump	50%	103.9	119	547716	6809690	6.0

Table 2 - Year 11 Modelled Equipment List

Source ID	Equipment Name	Activity	Acoustic Utilisation Factor	SWL, dB(A)	SWL, dB(Z)	Easting, MGA	Northing, MGA	Ground Elevation, m AHD
1	Komatsu Excavator	Digging	100%	94.7	106.9	547526	6809279	40.6
2a	CAT 769C Haul Truck	Load	38%	97.7	104.5	547538	6809272	40.6
2b	CAT 769C Haul Truck	Driving	13%	93	99.8	547746	6809624	20.7
2c	CAT 769C Haul Truck	Driving	13%	93	99.8	547686	6809743	13.0
2d	CAT 769C Haul Truck	Unload	38%	97.7	104.5	547688	6809825	12.2
3a	CAT 988B FEL	Dump - Reverse	50%	105	117.4	547678	6809835	12.5
3b	CAT 988B FEL	Dig - Fowards	50%	103.9	119	547693	6809837	12.6
4	Primary Plant	Running	100%	99.1	114.3	547686	6809864	3.0
5	Secondary Plant	Running	100%	105.3	117.3	547700	6809885	3.0
6	Tertiary Plant	Running	100%	109.4	118.6	547723	6809883	3.0
7	CAT 980C FEL	Dig	100%	110.3	122.7	547712	6809926	3.0
8a	Komatsu FEL	Dig	50%	100	105.8	547837	6809893	2.0
8b	Komatsu FEL	Dump	50%	100.9	105.9	547854	6809897	2.0
10	Pugmill	Running	100%	103.1	112.6	547797	6809867	2.6
11	Product Truck	Idling	100%	90.2	91	547807	6809889	2.1
15	Product Truck	Idling	100%	90.2	91	547778	6809895	2.4
16	Pump	Pumping	100%	105.1	113.1	547543	6809441	15.0
17	Drill	Drill	100%	101	110.8	547512	6809304	40.2
12c	Portable_Crusher_Loc_c	Running	100%	117.6	120.2	547705	6809713	6.0
13c3	CAT 769C Haul Truck	Driving	25%	96	102.8	547696	6809690	6.0
14a3	CAT 988B FEL	Dig	50%	105	117.4	547716	6809690	6.0
14b3	CAT 988B FEL	Dump	50%	103.9	119	547716	6809690	6.0

Table 3 - Year 1 Modelled Equipment List - Evening

Source ID	Equipment Name	Activity	Acoustic Utilisation Factor	SWL, dB(A)	SWL, dB(Z)	Easting, MGA	Northing, MGA	Ground Elevation, m AHD
8a	Komatsu FEL	Dig	50%	100	105.8	547837	6809893	2.0
8b	Komatsu FEL	Dump	50%	100.9	105.9	547854	6809897	2.0
10	Pug Mill	Running	100%	103.1	112.6	547797	6809867	2.6
11	Product Truck	Idling	100%	90.2	91	547807	6809889	2.1
15	Product Truck	Idling	100%	90.2	91	547778	6809895	2.4

Table 4 - Year 11 Modelled Equipment List - Evening

Source ID	Equipment Name	Activity	Acoustic Utilisation Factor	SWL, dB(A)	SWL, dB(Z)	Easting, MGA	Northing, MGA	Ground Elevation, m AHD
8a	Komatsu FEL	Dig	50%	100	105.8	547837	6809893	2.0
8b	Komatsu FEL	Dump	50%	100.9	105.9	547854	6809897	2.0
10	Pugmill	Running	100%	103.1	112.6	547797	6809867	2.6
11	Product Truck	Idling	100%	90.2	91	547807	6809889	2.1
15	Product Truck	Idling	100%	90.2	91	547778	6809895	2.4

APPENDIX F

Assessment of Meteorological Data

Appendix F – Assessment of Meteorological Data

Section 5 of the Industrial Noise Policy (INP) (EPA 2000) requires that noise impacts be assessed under weather conditions that would be expected to occur at a particular site for a significant period of time.

The INP (EPA 2000) notes that there are two approaches for the assessment of meteorological effects, such as gradient winds and temperature inversions, on propagating the noise from the source to the receiver. The simple method is to use default conditions outlined in the INP. Alternatively, the local meteorological data can be used to determine weather conditions that would be expected to occur at a particular site for a significant period of time.

Meteorological data for the period May 2010 to August 2013 was sourced from the Bureau of Meteorology Automatic Weather Station 058198 located approximately 6km to the east of the Project Area at Ballina Airport. This data was analysed to determine the frequency of occurrence of prevailing winds and temperature inversions.

This meteorological data was used to determine the prevailing meteorological conditions for the area surrounding the Project as well as for the probability analysis. The prevailing meteorological conditions were used to assess the construction and sleep disturbance noise levels to give an indication of worst-case noise impacts at the residential receivers. Probability analysis used all the meteorological data to determine the percentage occurrence of the operational noise impacts at the residential receivers.

Wind

The INP (EPA 2000) requires that wind effects need to be assessed when wind is considered a feature of the area. Wind is considered a feature of the area where source-to-receiver winds of 3 m/s occur for 30 per cent of the time in any assessment period.

Section 5 of the INP requires that noise impacts be assessed under weather conditions that would be expected to occur at a particular site for a significant period of time.

The collated meteorological data for the May 2010 to August 2013 period was analysed to determine prevailing wind conditions likely to influence the propagation of noise at the project site and is summarised in **Tables 1** to **12**.

Table 1 – Gradient Wind Analysis, Summer - Day

Day						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	2.8%	0.2%	0.8%	1.7%	1.1%	1.0%
NNE		0.1%	0.4%	1.2%	1.9%	3.3%
NE		0.1%	0.3%	1.2%	3.3%	9.1%
ENE		0.1%	0.3%	1.7%	3.2%	3.9%
E		0.1%	0.3%	2.2%	3.4%	2.4%
ESE		0.1%	0.2%	2.0%	3.0%	2.2%
SE		0.1%	0.4%	2.0%	3.2%	2.9%
SSE		0.1%	0.3%	1.7%	3.1%	7.2%
S		0.1%	0.2%	1.0%	1.4%	5.9%
SSW		0.1%	0.3%	1.3%	1.5%	2.8%
SW		0.1%	0.5%	1.9%	0.9%	0.3%
WSW		0.1%	0.6%	1.3%	0.2%	0.2%
W		0.1%	0.6%	0.7%	0.2%	0.2%
WNW		0.1%	0.4%	0.3%	0.1%	0.2%
NW		0.1%	0.4%	0.2%	-	-
NNW		0.3%	0.6%	0.4%	0.1%	-

Table 2 – Gradient Wind Analysis, Summer - Evening

Evening						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	8.9%	0.3%	2.3%	2.4%	1.4%	2.2%
NNE		0.3%	2.2%	7.2%	4.3%	4.2%
NE		0.2%	1.5%	2.5%	1.2%	0.8%
ENE		0.3%	1.3%	2.2%	1.8%	2.4%
E		0.3%	1.9%	3.2%	1.5%	0.8%
ESE		0.2%	1.7%	2.8%	1.7%	0.8%
SE		0.1%	0.6%	3.9%	2.8%	1.2%
SSE		-	0.5%	3.1%	4.2%	3.2%
S		-	0.3%	1.4%	1.1%	3.4%
SSW		0.1%	0.4%	1.1%	0.4%	0.6%
SW		0.1%	1.0%	0.9%	0.3%	0.1%
WSW		0.1%	0.7%	0.3%	0.1%	-
W		0.1%	0.5%	0.2%	-	-
WNW		0.2%	0.2%	0.1%	-	0.1%
NW		0.2%	0.3%	-	0.1%	-
NNW		0.3%	0.4%	0.2%	0.2%	-

Table 3 – Gradient Wind Analysis, Summer - Night

Night						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	25.0%	0.7%	3.6%	3.7%	1.3%	1.3%
NNE		0.3%	1.3%	2.5%	0.9%	0.5%
NE		0.2%	0.7%	0.8%	0.3%	1.1%
ENE		0.1%	0.5%	1.4%	0.8%	1.6%
E		0.1%	0.4%	1.7%	1.0%	1.0%
ESE		-	0.3%	1.3%	1.0%	0.7%
SE		0.1%	0.5%	2.0%	1.5%	0.9%
SSE		0.1%	0.4%	1.5%	1.3%	1.5%
S		0.1%	0.3%	1.1%	0.7%	1.3%
SSW		0.1%	0.5%	1.0%	0.5%	0.8%
SW		0.2%	1.2%	2.9%	1.4%	0.1%
WSW		0.7%	3.8%	5.6%	0.4%	-
W		0.9%	3.5%	2.4%	0.1%	-
WNW		0.4%	0.8%	0.2%	0.1%	-
NW		0.2%	0.5%	0.2%	-	-
NNW		0.4%	1.2%	0.5%	0.1%	-

Table 4 – Gradient Wind Analysis, Autumn - Day

Day						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	6.5%	0.3%	0.8%	0.8%	0.2%	0.1%
NNE		0.1%	0.7%	1.2%	0.5%	0.3%
NE		0.2%	0.5%	1.3%	2.0%	0.8%
ENE		0.1%	0.5%	1.4%	0.9%	0.3%
E		0.1%	0.6%	1.9%	0.9%	0.3%
ESE		0.1%	0.7%	2.4%	1.8%	1.1%
SE		0.1%	0.8%	2.7%	2.7%	2.3%
SSE		0.1%	0.7%	2.6%	2.5%	2.2%
S		0.1%	0.8%	2.1%	2.7%	3.8%
SSW		0.2%	1.0%	2.1%	1.7%	2.6%
SW		0.2%	2.0%	4.5%	2.3%	0.6%
WSW		0.3%	2.3%	5.6%	2.0%	0.6%
W		0.4%	2.4%	3.7%	1.2%	1.1%
WNW		0.3%	1.2%	1.4%	0.9%	0.5%
NW		0.2%	0.9%	0.6%	0.1%	-
NNW		0.2%	0.8%	0.4%	0.1%	-

Table 5 – Gradient Wind Analysis, Autumn - Evening

Evening						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	25.8%	0.7%	3.7%	2.1%	0.4%	0.1%
NNE		0.2%	1.8%	1.9%	0.5%	0.1%
NE		0.3%	0.7%	0.6%	0.2%	-
ENE		0.1%	1.0%	0.9%	0.4%	0.1%
E		-	0.3%	1.0%	0.4%	0.1%
ESE		0.2%	1.0%	2.6%	1.2%	0.4%
SE		0.2%	1.3%	3.6%	2.3%	1.5%
SSE		0.1%	0.3%	1.7%	1.5%	1.5%
S		-	0.5%	1.4%	1.1%	2.2%
SSW		0.1%	0.8%	1.0%	0.4%	0.5%
SW		0.2%	1.3%	2.0%	1.0%	0.4%
WSW		0.5%	2.6%	4.9%	0.5%	0.2%
W		0.7%	3.3%	2.6%	0.6%	0.2%
WNW		0.7%	1.1%	0.8%	0.4%	0.1%
NW		0.6%	1.0%	0.6%	-	-
NNW		0.4%	1.7%	0.6%	-	-

Table 6 – Gradient Wind Analysis, Autumn -Night

Night						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	32.1%	0.4%	1.2%	0.8%	0.2%	0.1%
NNE		0.1%	0.5%	0.4%	0.1%	-
NE		0.2%	0.3%	0.2%	0.1%	-
ENE		0.2%	0.2%	0.2%	0.2%	-
E		-	0.2%	0.5%	0.4%	0.1%
ESE		0.1%	0.3%	1.5%	1.1%	0.3%
SE		0.1%	0.3%	1.1%	1.6%	1.1%
SSE		0.1%	0.2%	0.7%	0.8%	0.9%
S		0.1%	0.3%	0.4%	0.3%	0.8%
SSW		0.2%	0.5%	0.4%	0.3%	0.5%
SW		0.3%	1.4%	2.1%	1.2%	0.5%
WSW		0.5%	4.8%	11.6%	1.9%	0.1%
W		1.0%	5.6%	7.0%	0.7%	0.3%
WNW		0.5%	2.2%	1.4%	0.6%	0.1%
NW		0.4%	1.0%	0.5%	-	-
NNW		0.4%	1.0%	0.4%	-	-

Table 7 – Gradient Wind Analysis, Winter - Day

Day						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	8.7%	0.3%	1.3%	1.5%	1.1%	0.3%
NNE		0.2%	0.6%	1.7%	0.8%	0.4%
NE		0.2%	0.5%	1.0%	0.9%	0.6%
ENE		0.1%	0.4%	0.6%	0.3%	0.1%
E		0.1%	0.4%	1.1%	0.2%	-
ESE		0.1%	0.5%	1.0%	0.4%	0.2%
SE		0.1%	0.6%	1.4%	0.8%	0.9%
SSE		0.1%	0.5%	1.7%	1.1%	1.4%
S		0.1%	0.6%	1.5%	1.9%	3.2%
SSW		0.1%	1.0%	2.1%	2.0%	3.5%
SW		0.2%	1.5%	4.0%	3.5%	1.6%
WSW		0.4%	2.0%	6.4%	3.4%	1.7%
W		0.3%	2.1%	4.7%	2.2%	2.7%
WNW		0.3%	1.1%	2.3%	1.7%	1.6%
NW		0.3%	0.9%	1.6%	0.6%	0.2%
NNW		0.3%	1.0%	1.0%	0.2%	0.1%

Table 8 – Gradient Wind Analysis, Winter - Evening

Evening						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	31.5%	1.1%	5.7%	4.2%	1.0%	0.3%
NNE		0.3%	1.0%	2.0%	0.4%	0.3%
NE		0.2%	0.4%	0.2%	0.2%	0.3%
ENE		0.1%	0.2%	-	-	-
E		-	0.2%	0.1%	-	-
ESE		0.1%	0.1%	0.3%	0.2%	0.2%
SE		-	0.2%	0.8%	1.0%	0.7%
SSE		0.1%	0.1%	0.9%	0.5%	1.1%
S		0.1%	0.3%	0.6%	0.7%	1.6%
SSW		0.2%	0.5%	0.6%	0.5%	1.2%
SW		0.2%	1.0%	2.1%	2.5%	1.2%
WSW		0.4%	2.8%	4.6%	1.0%	0.3%
W		0.8%	3.5%	3.3%	1.2%	1.1%
WNW		1.0%	1.1%	2.0%	1.3%	0.6%
NW		0.6%	1.0%	0.9%	0.1%	-
NNW		1.2%	1.6%	0.4%	-	-

Table 9 – Gradient Wind Analysis, Winter - Night

Night						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	33.6%	0.7%	2.6%	2.1%	0.5%	0.1%
NNE		0.3%	0.5%	0.8%	0.2%	0.2%
NE		0.2%	0.2%	0.1%	-	0.1%
ENE		0.1%	0.1%	-	-	-
E		-	0.1%	0.1%	-	-
ESE		-	-	0.2%	0.2%	0.1%
SE		-	0.1%	0.2%	0.5%	0.8%
SSE		-	-	0.2%	0.3%	0.8%
S		0.1%	0.1%	0.1%	0.2%	0.5%
SSW		0.1%	0.1%	0.2%	0.2%	0.2%
SW		0.2%	0.8%	1.8%	2.0%	0.7%
WSW		0.5%	3.0%	10.1%	3.0%	0.2%
W		0.9%	5.2%	8.6%	1.5%	1.0%
WNW		0.7%	1.9%	2.5%	1.1%	0.7%
NW		0.5%	1.2%	1.2%	0.1%	0.1%
NNW		0.6%	1.3%	0.5%	0.1%	-

Table 10 – Gradient Wind Analysis, Spring - Day

Day						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	3.7%	0.3%	1.2%	2.1%	2.0%	3.0%
NNE		0.1%	0.6%	2.0%	2.6%	6.4%
NE		-	0.4%	1.6%	4.0%	10.0%
ENE		0.1%	0.2%	1.6%	2.4%	1.4%
E		-	0.4%	2.0%	1.5%	0.9%
ESE		-	0.3%	1.9%	1.8%	0.6%
SE		0.1%	0.3%	1.8%	2.3%	1.3%
SSE		-	0.3%	1.6%	2.3%	3.9%
S		-	0.3%	1.0%	1.7%	5.1%
SSW		-	0.5%	1.1%	1.4%	1.7%
SW		0.1%	0.7%	1.8%	0.8%	0.3%
WSW		0.1%	0.8%	1.8%	0.6%	0.3%
W		0.2%	0.9%	1.1%	0.5%	1.6%
WNW		0.1%	0.5%	0.8%	0.6%	0.6%
NW		0.2%	0.5%	0.7%	0.3%	0.2%
NNW		0.3%	1.0%	0.7%	0.1%	0.1%

Table 11 – Gradient Wind Analysis, Spring - Evening

Evening						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	12.9%	1.0%	6.7%	4.7%	4.4%	5.0%
NNE		0.5%	3.3%	8.6%	4.6%	3.8%
NE		0.3%	1.4%	3.2%	0.5%	0.1%
ENE		0.1%	0.8%	1.2%	0.6%	0.1%
E		0.3%	0.8%	1.7%	0.5%	0.4%
ESE		0.2%	0.5%	1.1%	0.6%	0.1%
SE		-	0.6%	2.5%	1.2%	1.2%
SSE		0.1%	0.3%	1.3%	1.2%	1.9%
S		0.1%	0.4%	0.5%	0.9%	1.8%
SSW		0.3%	0.3%	0.6%	0.5%	1.2%
SW		0.1%	0.6%	1.3%	0.3%	0.3%
WSW		0.2%	1.0%	0.7%	0.2%	0.1%
W		0.2%	1.4%	1.2%	0.6%	1.0%
WNW		0.1%	0.4%	0.4%	0.3%	0.1%
NW		0.1%	0.3%	0.3%	-	-
NNW		0.2%	1.2%	0.5%	0.2%	-

Table 12 – Gradient Wind Analysis, Spring - Night

Night						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	34.9%	1.1%	5.9%	4.6%	2.8%	1.4%
NNE		0.3%	1.4%	2.4%	1.2%	0.2%
NE		0.1%	0.4%	0.6%	0.3%	0.1%
ENE		0.1%	0.2%	0.2%	0.3%	0.2%
E		0.1%	0.2%	0.4%	0.6%	0.3%
ESE		-	0.2%	0.8%	0.6%	0.2%
SE		-	0.2%	1.0%	0.6%	0.5%
SSE		0.1%	0.2%	0.6%	0.8%	1.1%
S		0.1%	0.2%	0.5%	0.5%	0.8%
SSW		0.1%	0.2%	0.4%	0.4%	0.5%
SW		0.2%	0.7%	1.7%	1.1%	0.3%
WSW		0.5%	2.5%	4.3%	1.0%	0.1%
W		0.9%	3.5%	3.4%	0.7%	0.5%
WNW		0.4%	1.4%	1.0%	0.5%	0.2%
NW		0.4%	0.7%	0.4%	0.1%	-
NNW		0.6%	1.9%	0.2%	-	-

Wind speed analysis of the prevailing winds has also been conducted and is summarised in **Figures F.1** to **F.4**.

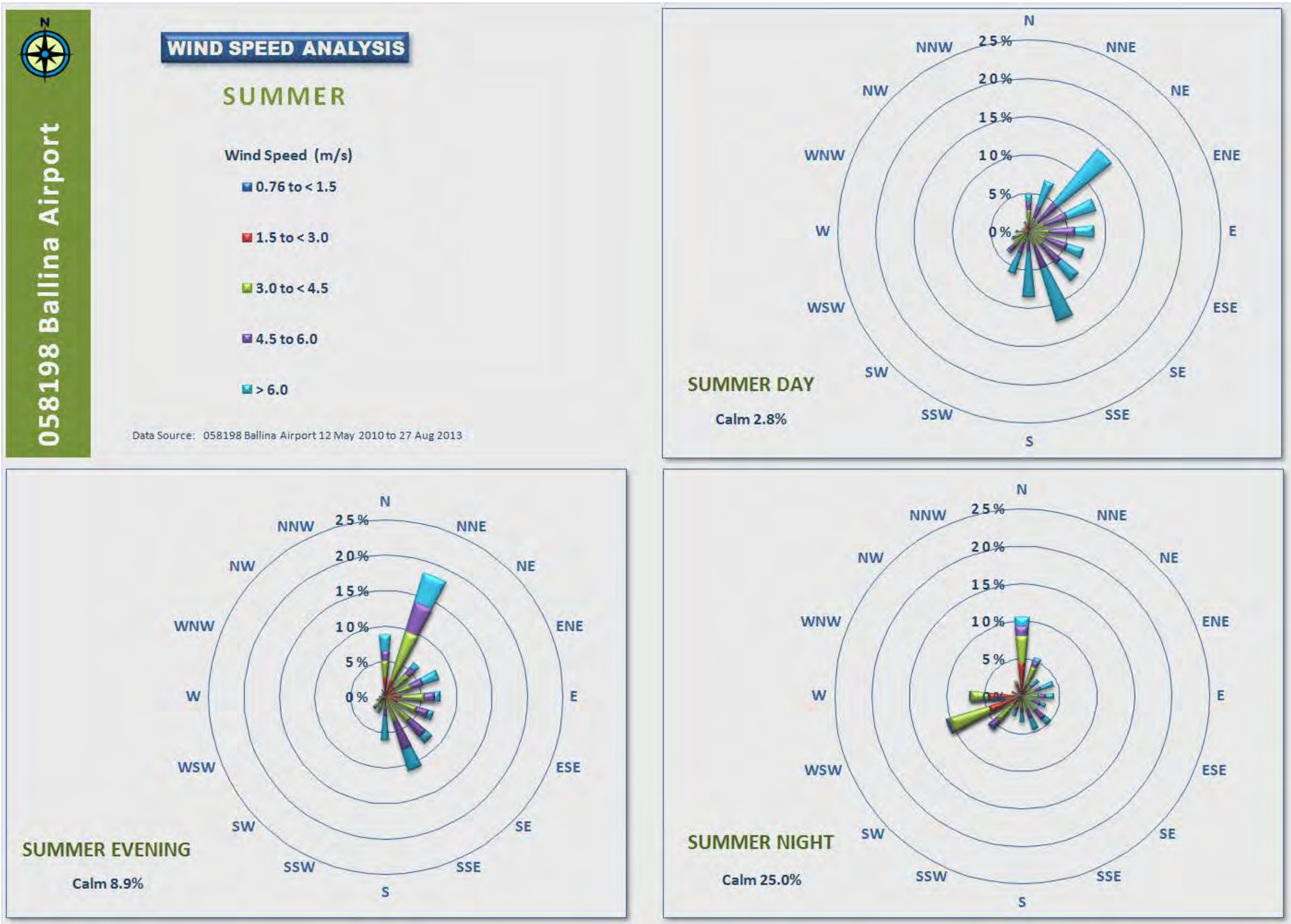
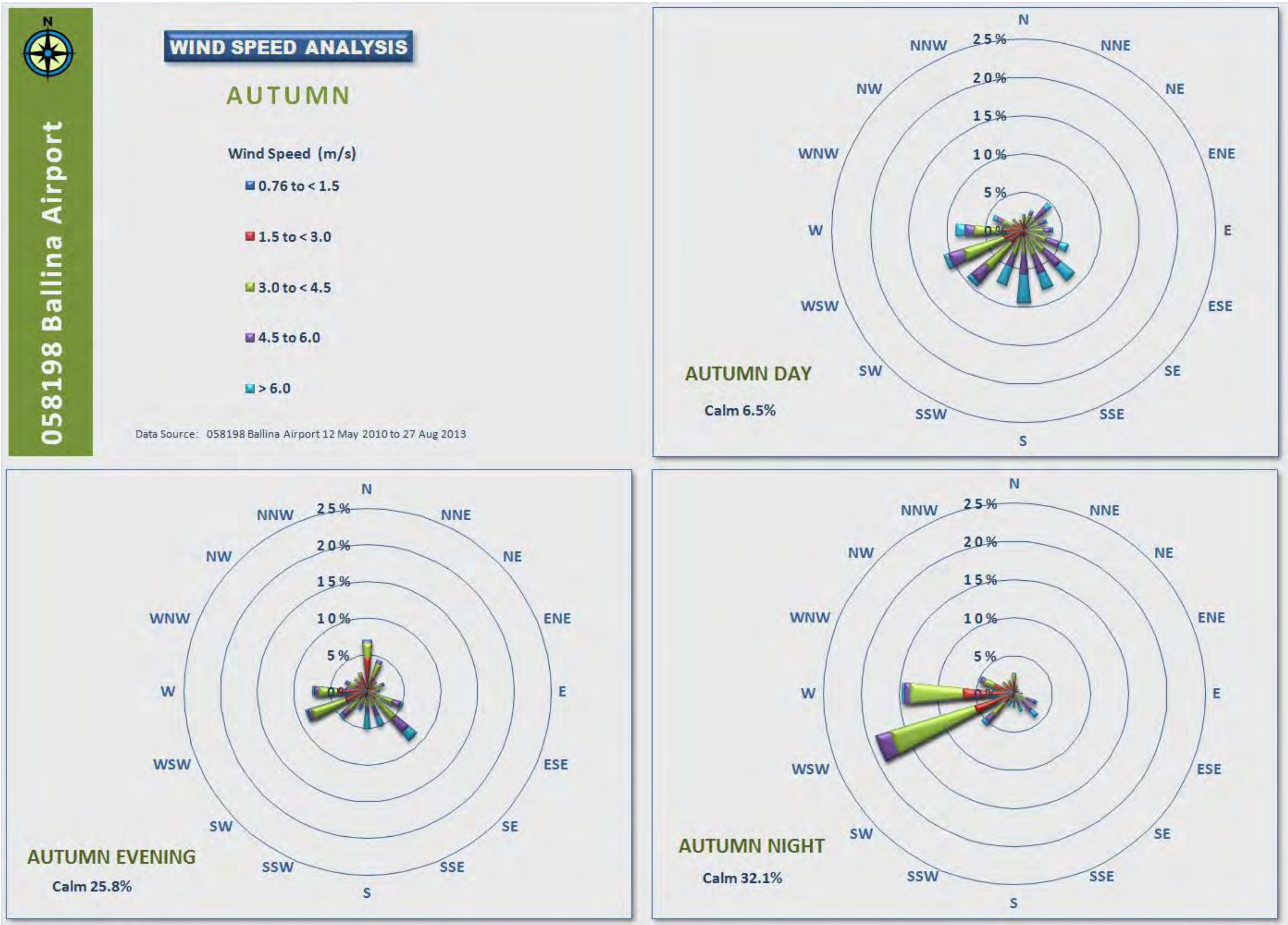


Figure F.1 – Wind Speed Analysis, Summer



FigureF.2 – Wind Speed Analysis, Autumn

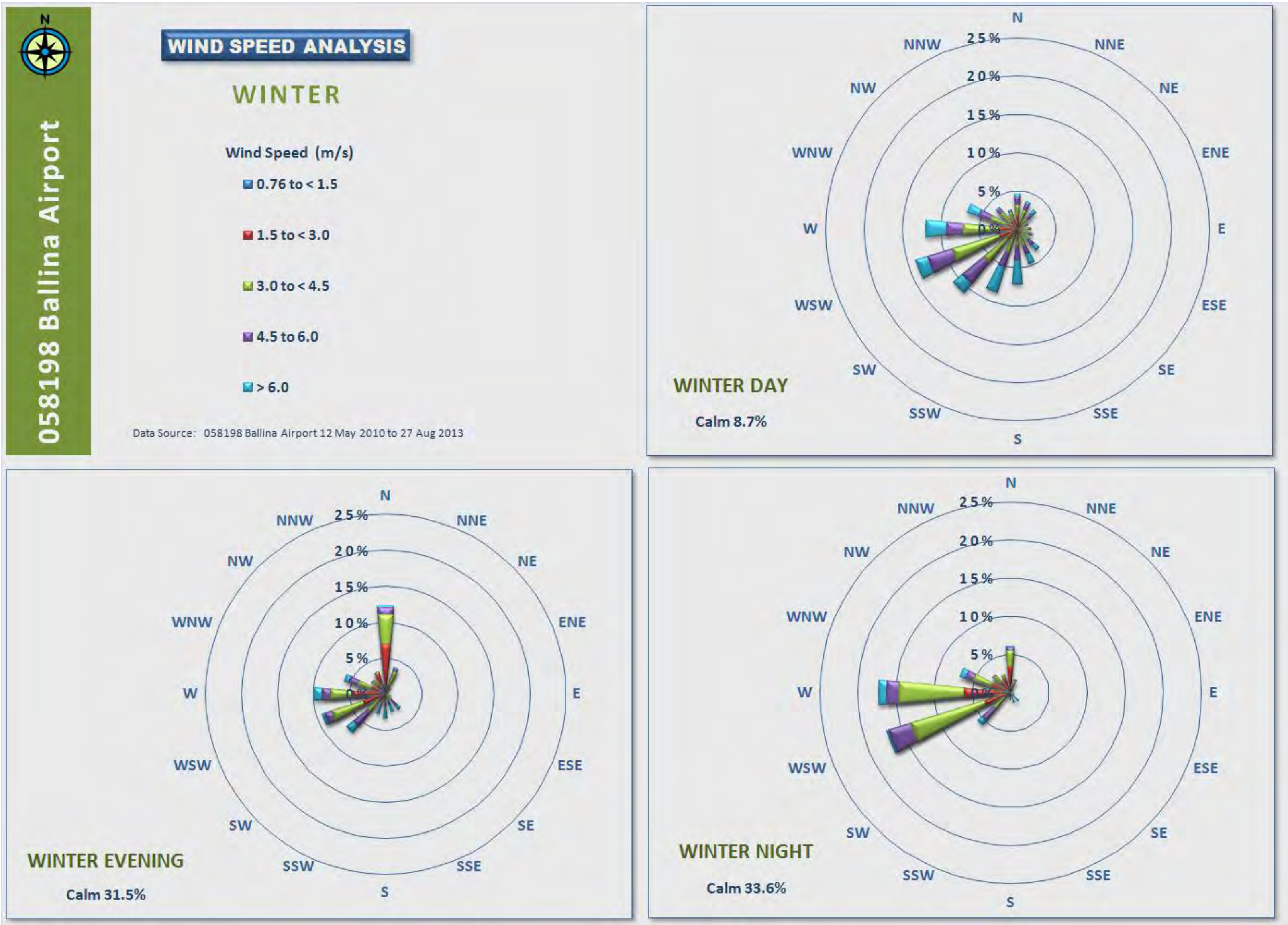


Figure F.3 – Wind Speed Analysis, Winter

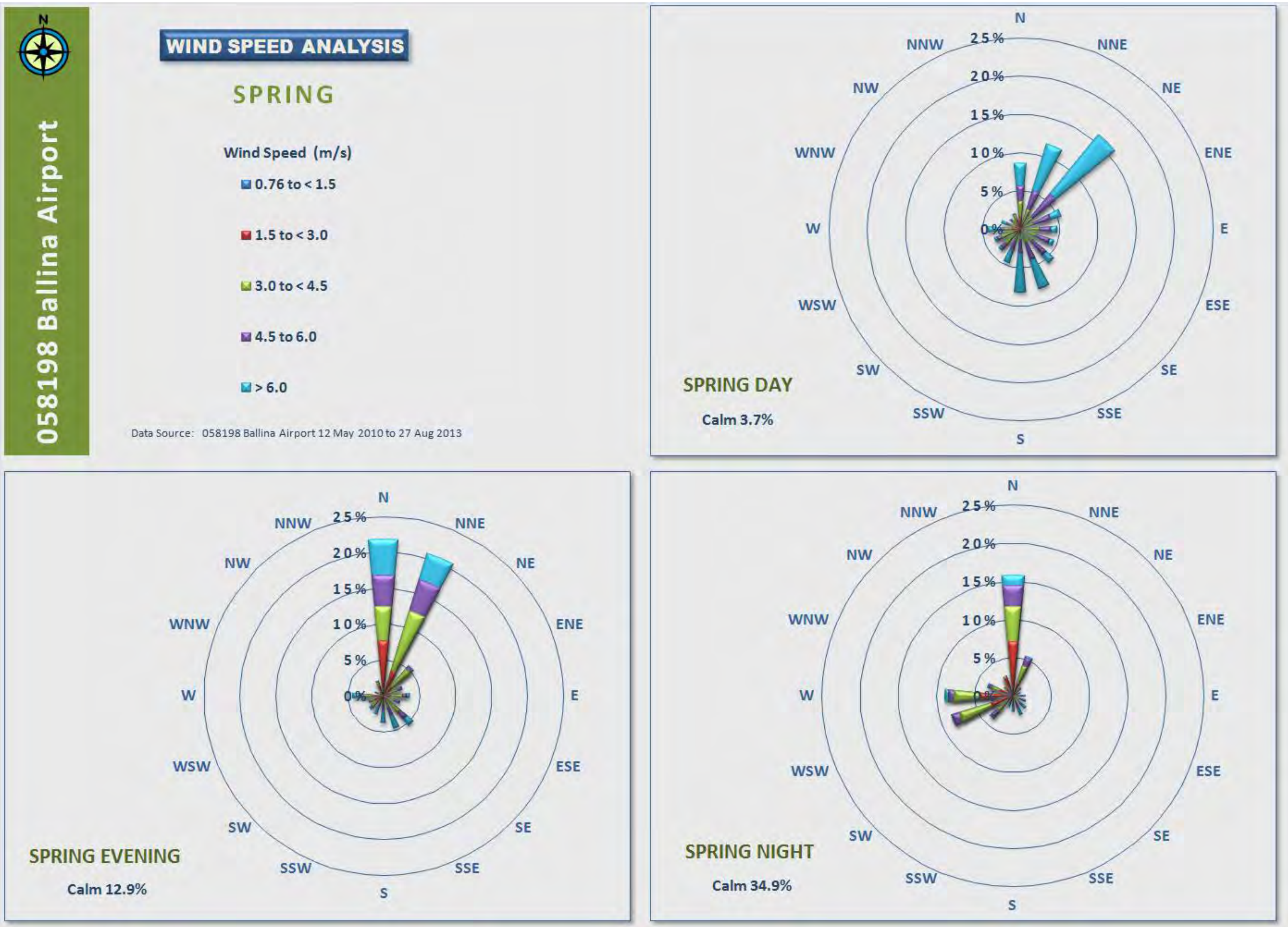


Figure F.4 – Wind Speed Analysis, Spring

Temperature Inversions

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30 per cent of the total night time (i.e. the evening and night-time periods) during winter, or about two nights per week.

Meteorological data was assessed in accordance with INP (EPA 2000) methodology to determine the likelihood of temperature inversions during the winter evening and night time periods. These results of the analysis of the meteorological data for the May 2010 to August 2013 period are presented in **Table 13** and **Table 14**.

Table 13 – Stability Class Wind Analysis, Non Inversion Conditions Winter Evening and Night (6.00 pm to 7.00 am)

Non-Inversion Conditions						
	< 0.76	**0.76 to < 1.5**	**1.5 to < 3.0**	**3.0 to < 4.5**	**4.5 to 6.0**	**> 6.0**
N	4.1%	0.2%	1.1%	2.9%	1.3%	1.0%
NNE		0.1%	0.8%	2.4%	1.1%	0.7%
NE		-	0.2%	0.7%	0.2%	0.3%
ENE		-	0.2%	0.6%	0.4%	0.5%
E		-	0.2%	0.9%	0.5%	0.3%
ESE		-	0.2%	1.1%	0.8%	0.3%
SE		-	0.2%	1.5%	1.2%	0.9%
SSE		-	0.1%	1.0%	1.0%	1.3%
S		-	0.2%	0.7%	0.6%	1.2%
SSW		-	0.2%	0.6%	0.4%	0.6%
SW		0.1%	0.6%	2.0%	1.4%	0.5%
WSW		0.2%	1.1%	6.5%	1.3%	0.1%
W		0.2%	1.2%	4.5%	0.8%	0.5%
WNW		0.2%	0.6%	1.2%	0.6%	0.3%
NW		0.1%	0.4%	0.6%	0.1%	-
NNW		0.2%	0.6%	0.4%	0.1%	-

Table 14 – Stability Class Wind Analysis, F and G Class Stability Conditions Winter Evening and Night (6.00 pm to 7.00 am)

F and G Class Stability Conditions - 39.0%						
	< 0.76	0.76 to < 1.5	1.5 to < 3.0	3.0 to < 4.5	4.5 to 6.0	> 6.0
N	24.1%	0.6%	2.6%	-	-	-
NNE		0.2%	0.4%	-	-	-
NE		0.1%	0.3%	-	-	-
ENE		0.1%	0.3%	-	-	-
E		0.1%	0.2%	-	-	-
ESE		0.1%	0.2%	-	-	-
SE		-	0.2%	-	-	-
SSE		0.1%	0.1%	-	-	-
S		0.1%	0.1%	-	-	-
SSW		0.1%	0.2%	-	-	-
SW		0.2%	0.4%	-	-	-
WSW		0.3%	1.9%	-	-	-
W		0.6%	2.6%	-	-	-
WNW		0.3%	0.7%	-	-	-
NW		0.3%	0.4%	-	-	-
NNW		0.4%	0.7%	-	-	-

From the analysis of the meteorological data F class stability conditions are present more than 30 per cent of the time.

Temperature Inversion and Drainage Flow

Drainage flow is the low level wind associated with the flow of cold air from higher ground to lower during the presence of a temperature inversion.

The INP states that the:

> drainage-flow wind default value should generally be applied where a development is at a higher altitude than the residential receiver, with no intervening higher ground.

The area surrounding the Project is typically undulating with residential receivers at both a higer and lower altitude to the Project.

The meteorological data for the September 2011 to August 2012 period was analysed to determine the prevalence and speed of the prevailing winds from the north-west during winter evening and night. The results of this analysis are summarised in **Table 13** and **Table 14**.

Based on the data presented in **Table 13** and **Table 14, t**he meteorological data from Ballina Airport indicates predominantly calm conditions associated with winter night time inversion conditions. If present, drainage flow in the Teven Valley would be from the north following the topography of the valley and due to topography is unlikely to significantly impact on receivers to the south of the Project.

Modelling Parameters

The meteorological conditions that should be considered as a part of the assessment of the noise levels for the noise impact assessment are:

- day time and evening all seasons calm;
- summer evening 3 m/s east-north-east wind;
- autumn evening 3 m/s west-south-west wind;
- winter evening 3 m/s west wind;
- winter evening F class stability under calm conditions; and
- spring evening 3 m/s north-north-east wind; and

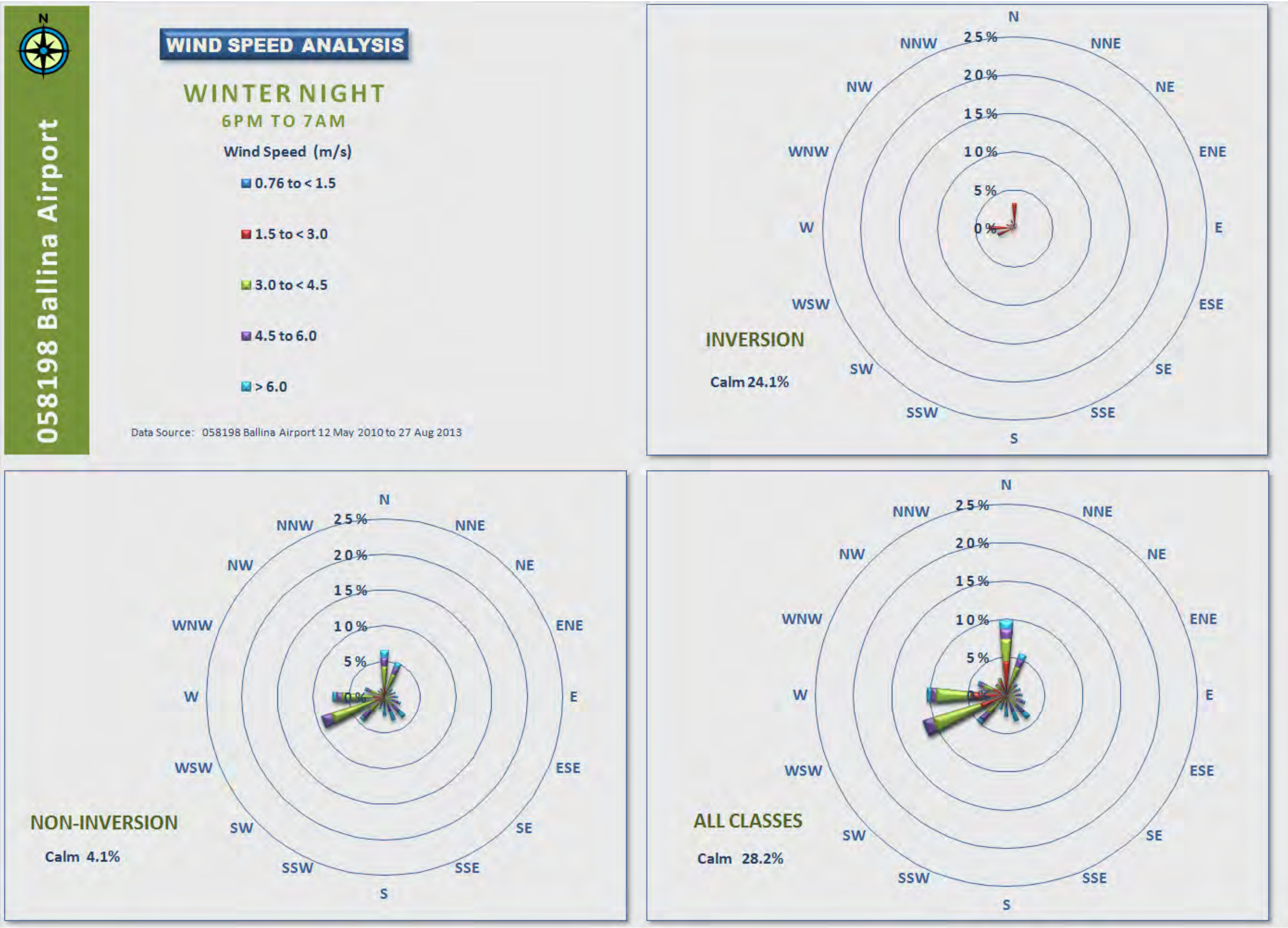


Figure F.5 – Wind Speed Analysis, Winter Night (6.00 pm to 7.00 am

APPENDIX 6

Air Quality Impact Assessment

Teven Quarry Project

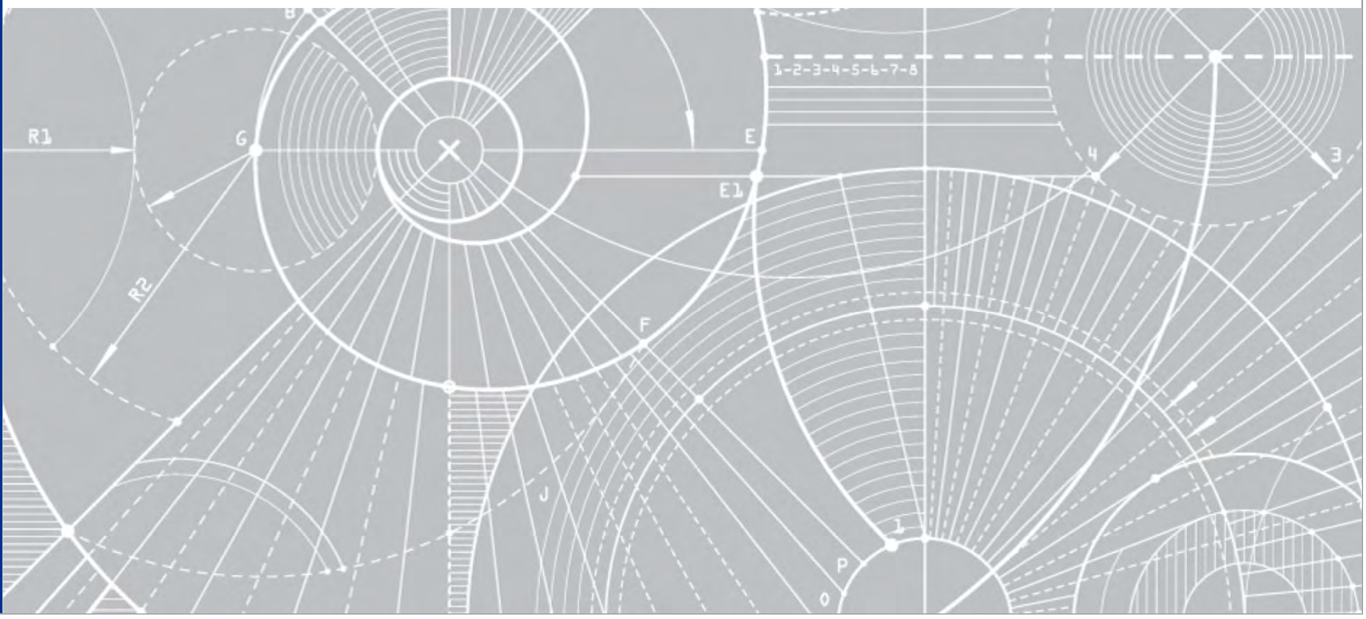
HOLCIM (AUSTRALIA) PTY LTD

Air Quality Impact Assessment

EN04314 | Final

-

3 December 2014



JACOBS SKM

Teven Quarry Project

Project no:	EN04314
Document title:	Air Quality Impact Assessment
Document no:	EN04314
Revision:	Final
Date:	3 December 2014
Client name:	Holcim (Australia) Pty Ltd
Client no:	-
Project manager:	Shane Lakmaker
Author:	Shane Lakmaker
File name:	I:\ENVR\Projects\EN04314\Deliverables\Reports\EN04314_JacobsSKM_Teven Quarry AQ_Final 3 Dec 2014.docx

(Jacobs)

www.jacobs.com

Document history and status

Revision	Date	Description	By	Review	Approved
1	6/5/14	Draft report	S Lakmaker	S Thomas	S Thomas
Final draft	11/6/14	Final draft report	S Lakmaker	-	-
Final draft	4/8/14	Final draft report	S Lakmaker	-	B Watson
Final	11/11/14	Final for adequacy	S Lakmaker	Holcim	B Watson
Final	3/12/14	Final	S Lakmaker	S Lakmaker	B Watson

Contents

List of figures

List of tables

Executive summary

The purpose of this study was to determine the potential air quality impacts due to a proposed increase in the intensity of the operations at Teven Quarry.

In summary the main objective of this study was to meet the requirements of the Department of Planning and Environment and the Environment Protection Authority. This involved:

- Identification of the key air quality issues.
- Prediction of potential air quality impacts.
- Development of suitable monitoring and management measures to help minimise impacts.

A computer-based air dispersion model was used to predict dust and odour impacts due to the quarry activities and model predictions were compared to EPA assessment criteria in order to assess the potential effect on the existing air quality environment, including at nearest sensitive receptors. The modelling took account of meteorological conditions, land use and terrain information and used emission estimates to predict the off-site air quality impacts. Potential impacts were assessed for both construction and operational scenarios.

The key potential air quality issue was identified as dust from the general quarrying activities.

The main conclusions of the study were as follows:

- Annual average PM_{10}, TSP and dust deposition levels will be in compliance with air quality criteria at sensitive receptors during Project operation.
- There is a potential risk that existing and proposed activities will contribute to exceedances of the 24-hour average PM_{10} criterion (50 $\mu g/m^3$), especially if background levels are higher than average. Two properties were predicted to experience 24-hour average PM_{10} concentrations above the 50 $\mu g/m^3$ criterion for up to one day per year, due to the combined effect of Teven Quarry activities and maximum background levels. However, the change in off-site dust impacts is expected to be negligible as the results for the Existing scenario and the Project scenarios were very similar.

A conservative approach was adopted for the assessment whereby maximum predictions were added to 95^{th} percentile background levels. This means that actual air quality impacts are likely to be lower than predicted.

Meteorological monitoring would assist with the identification of adverse conditions (in terms of elevated dust concentrations) and for developing targeted dust mitigation measures that will avoid exceedances of the PM_{10} criterion as far as practicable.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs SKM is to describe and assess air quality impacts from the proposed expansion of Teven Quarry in accordance with the scope of services set out in the contract between Jacobs SKM and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs SKM has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs SKM has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs SKM derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs SKM has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs SKM for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs SKM's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs SKM and the Client. Jacobs SKM accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

Holcim (Australia) Pty Ltd (Holcim) is proposing to continue operations at Teven Quarry, near Ballina in NSW, and to increase the maximum permissible production rate from the quarry. This report provides an assessment of the potential air quality impacts associated with the proposal.

The main objectives of this assessment were to:

- Identify potential air quality issues;
- Quantify potential air quality impacts; and
- Identify suitable air quality management measures, as appropriate, to minimise impacts.

This assessment also seeks to address the requirements of both the Department of Planning and Environment (DPE) and the Environment Protection Authority (EPA). These requirements are outlined in **Table 1** and **Table 2** below.

Table 1 Department of Planning and Environment requirements

Requirement	Section(s) of this report
Air quality – including a quantitative assessment of potential:	
- Construction and operational impacts;	Section 7 and 8
- Reasonable and feasible mitigation measures to minimise dust emissions; and	Section 9
- Monitoring and management measures.	Section 9

Table 2 Environment Protection Authority requirements

Requirement	Section(s) of this report
Describe baseline conditions	
- Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data.	Section 4
Assess impacts	
- Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point.	Section 5
- Estimate the resulting ground level concentrations of all pollutants. Where necessary (e.g. potentially significant impacts and complex terrain effects), use an appropriate dispersion model to estimate ambient pollutant concentrations. Discuss choice of model and parameters with the EPA.	Section 6 and 7
- Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals.	Section 7
- Describe the contribution that the development will make to regional and global pollutant, particularly in sensitive locations.	Section 7
- Reference should be made to *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005); Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC 2007).*	Throughout report
Describe management and mitigation measures	
- Outline specifications of pollution control equipment (including manufacturer's performance guarantees where available) and management protocols for both point and fugitive emissions.	Section 9

Requirement	Section(s) of this report
Where possible, this should include cleaner production processes.	

The assessment is based on the use of an air dispersion model to predict concentrations of substances emitted to air due to the proposed activities. Model predictions have been compared with air quality criteria referred to by the EPA in order to assess the effect that the Project may have on the existing air quality environment.

In summary, this report provides information on the following:

- The local setting and proposed operations (**Section 2**);
- Air quality criteria (**Section 3**);
- Existing meteorological and air quality conditions (**Section 4**);
- Emissions to air from existing and proposed activities (**Section 5**);
- Methods used to predict air quality impacts (**Section 6**);
- Expected air quality impacts during operations, as determined by comparison of model results with the air quality target (**Section 7**);
- Expected air quality impacts during operations (**Section 8**); and
- Suitable air quality management measures to be implemented such that potential impacts are avoided as far as practicable, including the monitoring of impacts (**Section 9**).

2. Project Description

Holcim operates the Teven Quarry, an existing hard rock quarry located at Stokers Lane, Teven (Lots 1, 2 and 3 DP 732288), approximately eight kilometres (km) north west of Ballina. **Figure 1** shows the location of the quarry, including the location of nearest sensitive receptors. Receiver number 12, which is within the quarry boundary, is leased by Holcim. Holcim is current negotiating a purchase agreement for Receiver 9 located to the west of the site.

Figure 1 Location of Teven Quarry

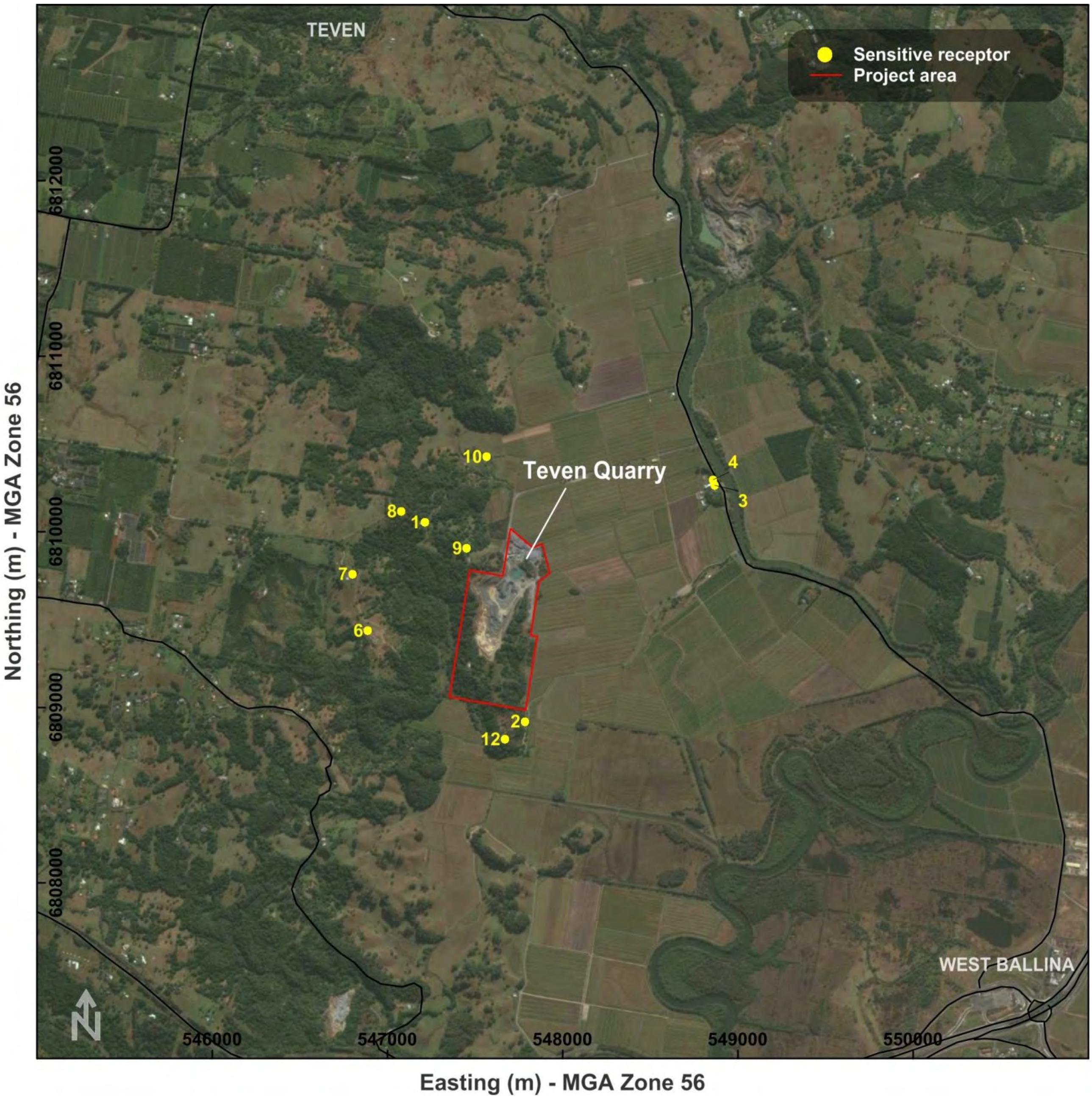
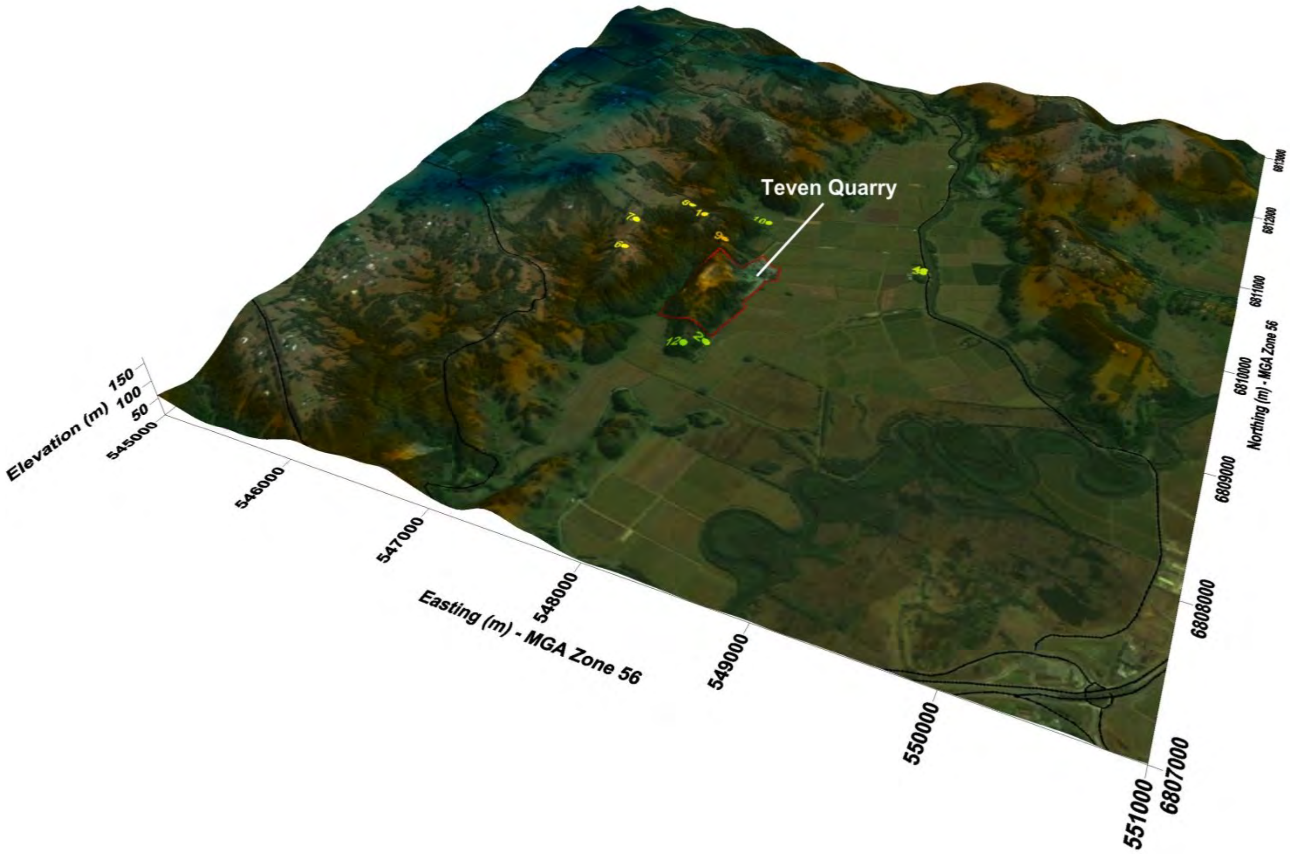


Figure 2 shows the topography in the vicinity of Teven Quarry. This topographical information has been used in the development of the air quality models, discussed further in **Section 6**.

Figure 2 Topography in the vicinity of Teven Quarry



The quarry includes fixed primary, secondary and tertiary crushing and screening plants with quarry products transported by road throughout the region. Operations are generally undertaken between the hours of 7 am and 5 pm Monday to Friday and 7 am and 4 pm Saturdays. The current (2014) approved production is up to approximately 265,000 tonnes per annum (tpa).

Holcim is proposing to increase production at the quarry from 265,000 tpa to 500,000 tpa (the Project). This will be achieved by maximising use of existing fixed plant (350,000 tpa capacity) and adding an in-pit mobile plant to cater for periods of peak demand (150,000 tpa). The Project also includes a mobile pugmill and allowance for recycling of surplus concrete from local approved batching facilities in the region for re-use as product.

Holcim is also seeking to extend the hours of operation of the quarry for truck loading and product transport, stockpile management, and maintenance. The proposed extended operating hours would allow the above activities to operate up to 10.00 pm Monday to Friday on a campaign basis. No blasting, quarrying, crushing or screening would be undertaken during the proposed extended hours of operation.

The Project does not involve any change to the existing approved disturbance footprint or depth of the quarry.

One of the main objectives of this assessment was to determine how air quality may change at these nearest receptors as a result of the Project. This was done by quantifying the potential impacts of both existing (approved) and proposed quarry activities.

Air quality issues can arise when emissions from an industry or activity lead to deterioration in the ambient air quality. Potential air quality issues have been identified from a review of the Project and associated activities. This identification process has considered the types of emissions to air and proximity of these emission sources to sensitive receptors.

Emissions to air would be from a variety of activities including material handling, material transport, processing, wind erosion, and blasting. These emissions would mainly comprise of particulate matter (TSP, PM_{10} and $PM_{2.5}$) although there could also be minor emissions (relatively) from equipment exhausts such as carbon monoxide (CO) and oxides of nitrogen (NO_x).

In summary, the key air quality issue associated with the existing and proposed quarry activities has been identified as dust (that is, particulate matter in the form of TSP, PM_{10} or $PM_{2.5}$) from the general quarrying activities.

The potential dust impacts of the project are the focus of this assessment.

3. Air Quality Criteria

Typically, air quality is quantified by the concentrations of air pollutants in the ambient air, where an air pollutant is a substance that is known to cause health, nuisance and/or environmental effects. With regard to human health and nuisance effects, the air pollutant most relevant to the quarry activities is dust (or particulate matter).

There are various classifications of particulate matter with State regulatory authorities often providing standards, goals, objectives, criteria or targets for:

- Total suspended particulates (TSP), to protect against nuisance impacts;
- Particulate matter with equivalent aerodynamic diameter less than or equal to 10 microns (PM_{10}), to protect against health impacts;
- Particulate matter with equivalent aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$), to protect against health impacts; and
- Deposited dust, to protect against nuisance impacts.

Air quality impacts from the Project will be determined by the level of compliance with air quality criteria set by the EPA as part of their *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005). These criteria, including the NEPM advisory reporting standards for $PM_{2.5}$, are outlined in **Table 3** and apply to existing and potential sensitive receptors such as such as residences, schools and hospitals.

Table 3 Relevant air quality assessment criteria

Pollutant	Averaging time	Criterion	Agency
Particulate matter (PM_{10})	24-hour	50 µg/m^3	EPA
	Annual	30 µg/m^3	EPA
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m^3	NEPM Advisory Reporting Goals. Not applied on a project specific basis.
	Annual	8 µg/m^3	
Total Suspended Particulates (TSP)	Annual	90 µg/m^3	EPA
Deposited dust	Annual (maximum increase)	2 g/m^2/month	EPA
	Annual (maximum total)	4 g/m^2/month	EPA

The EPA air quality assessment criteria relate to the total concentration of air pollutants in the air (that is, cumulative) and not just the contribution from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess impacts. Further discussion of background levels in the study area is provided in **Section 4.2**.

At this stage the NEPM Advisory Reporting Goals for $PM_{2.5}$ have not been adopted by the EPA for assessment of impacts from specific projects. Therefore, no further consideration of $PM_{2.5}$ has been undertaken.

4. Existing Environment

This section provides a description of the environmental characteristics in the area, including a review of the local meteorological and ambient air quality conditions.

4.1 Dispersion Meteorology

Meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. The key meteorological requirements of air dispersion models are, typically, hourly records of wind speed, wind direction, temperature, atmospheric stability class and mixing layer height. For air quality assessments, a minimum one year of hourly data is usually required, which means that almost all possible meteorological conditions, including seasonal variations, are considered in the simulations.

The data used for this assessment were collected by the Bureau of Meteorology from their automatic weather station at Ballina Airport (station number 058198), approximately six kilometres to the east of Teven Quarry. These data consisted of 15-minute average records of temperature, wind speed and wind direction, among other parameters. Data from May 2010 to August 2013 were obtained and analysed.

Figure 3 shows the wind patterns as measured by the Ballina Airport weather station, for all available data (that is, May 2010 to August 2013). From these data, the most common winds are from the west-southwest and north. The west-southwest winds most commonly occur in autumn and winter, while the northerly winds prevail in summer and spring.

Figure 4 shows the annual and seasonal wind-roses for the 2012 calendar year. In this data period the wind patterns were similar to the longer term (2010 to 2013) records, with the most common winds from the west-southwest and north. The 2012 data were used for the modelling.

The analysis above suggests that there is little variation in wind patterns from year to year and that meteorological data collected in 2012 are likely to be representative of longer-term conditions in the vicinity of Teven Quarry. Methods used for incorporating these data into meteorological modelling (CALMET) and air dispersion modelling (CALPUFF) are discussed in detail in **Section 6**.

Figure 3 Measured wind patterns at Ballina Airport (May 2010 to Aug 2013)

Figure 4 Measured wind patterns at Ballina Airport (Jan 2012 to Dec 2012)

4.2 Existing Air Quality

Air quality criteria generally refer to pollutant levels which are cumulative. That is, the criteria relate to the contribution from a specific project plus the contribution from existing sources of the pollutant. To fully assess impacts against all the relevant air quality criteria (see **Section 3**) it is necessary to have information or estimates on existing air pollutant levels in the area in which the Project is likely to contribute to these levels. This section provides a description of the existing air quality.

As a semi-rural location, there are no industrial sources that contribute to the concentrations of air pollutants in the surrounding environment. Existing air quality in the vicinity of the quarry is therefore likely to be influenced by agricultural activities, sea salt, pollens, traffic on local roads, dust storms, and bush-fires.

There are no known monitoring stations in the Ballina region which can be used to quantify the existing air quality in the vicinity of Teven Quarry. However, the OEH has established a network of monitoring stations across NSW and records are published on the OEH website. The monitoring data are used to measure compliance with ambient air quality criteria, for identifying trends in air quality, and for developing plans to reduce air emissions to improve local and regional air quality.

The closest OEH monitoring station to Teven Quarry is at Tamworth, over 300 km to the southwest. Based on this distance the data from Tamworth are unlikely to be representative of conditions in the Ballina region, therefore a review of data collected at OEH sites in similar, semi-rural, coastal environments has been undertaken. Data from the OEH monitoring sites at Kembla Grange, Albion Park South, and Bargo have been analysed. While these sites are also well removed from the Ballina region, they are situated in semi-rural and/or coastal environments and, as such, have been used to understand any potential issues with compliance against air quality criteria. Of these three sites, air quality conditions around Bargo are likely to be most representative of conditions near Ballina, since Kembla Grange and Albion Park South are near the city of Wollongong and significant industrial sources.

Table 4 shows statistics for relevant air quality monitoring data collected between 2004 and 2013 by the OEH. These data show that PM_{10} concentrations have exceeded the 24-hour average criterion (50 µg/m^3) at all sites but concentrations are below the annual average criterion (30 µg/m^3). The cause of exceedances is not identified from these statistics however a few exceedances of the 24-hour average PM_{10} criterion each year are common for most parts of NSW, mainly due to bushfires, dust-storms and regional scale events. The 95th percentiles have been provided as an estimate of maximum levels, excluding bushfires, dust-storms and regional scale events etc. The 95th percentile is consistent with reporting compliance against air quality criteria, according to the then Department of Sustainability, Environment, Water, Population and Communities (DSEWPC 2011).

Table 4 Air quality statistics for data collected by the OEH from 2004 to 2013

Pollutant / averaging time	Kembla Grange	Bargo	Albion Park South	Criteria (µg/m^3)
PM_{10}				
Maximum 24-hour average	1,174	209	1360	50
95th percentile 24-hour average	37	26	32	-
Annual average	19	14	16	30

The data from Bargo (shaded cells in **Table 4**) have been adopted as background levels that would apply at nearest sensitive receptors around Teven Quarry. These levels are likely to be conservative estimates of the Teven area since the Bargo monitoring site is in a more densely populated area and near the Hume Highway.

5. Emissions to Air

The most significant emissions to air at Teven Quarry are from material handling, material transport, processing, wind erosion, and blasting. Estimates of these emissions are required by the dispersion model. Total dust emissions have been estimated by analysing the material handling schedule, equipment listing and site plans and identifying the location and intensity of dust generating activities. Operations have been combined with emissions factors developed both locally and by the US EPA.

The emission factors used for this assessment have been drawn largely from the following sources:

- *Emission Estimation Technique Manual for Mining* (NPI, 2012); and
- AP 42 (US EPA, 1985 and updates).

The project description and site plans have been used to determine haul road distances and routes, stockpile areas and locations, activity operating hours, truck sizes and other details necessary to estimate dust emissions for the assessment scenarios. Three scenarios have been modelled (one existing and two proposed) to identify the likely change in impacts, and to cover potential worst-case operations (in terms of dust).

Table 5 shows the annual dust emission estimates as TSP and PM_{10} for the existing and future scenarios. It can be seen from these estimates that haulage over unsealed roads and wind erosion from exposed areas are the most significant sources of dust. **Appendix A** provides details of the dust emission calculations, including assumed emission controls and allocation of emissions to locations.

Table 5 Dust emission estimates

Activity	Annual emissions (kg/y)					
	Existing		Year 1		Year 11	
	TSP	PM_{10}	TSP	PM_{10}	TSP	PM_{10}
Excavators loading overburden to trucks	202	96	253	120	152	72
Hauling overburden to dumps	1920	567	2400	709	1440	426
Unloading overburden to dumps	960	344	1200	430	720	258
Drilling rock	177	93	177	93	177	93
Blasting rock	344	178	344	178	344	178
Loading rock to mobile crusher	0	0	379	179	379	179
Crushing (mobile)	0	0	750	300	750	300
Loading rock to trucks	670	317	1265	598	1265	598
Hauling rock to plant	14840	4385	28000	8274	32000	9456
Primary crushing	265	106	350	140	350	140
Secondary crushing	795	318	1050	420	1050	420
Tertiary crushing	3975	1325	5250	1750	5250	1750
Screening	2385	795	3150	1050	3150	1050
Mobile pugmill (blending)	0	0	2250	750	2250	750
Loading product stockpiles	335	159	632	299	632	299
Wind erosion from overburden dumps	3504	1752	3504	1752	3504	1752
Wind erosion from all pits / topsoil piles	8970	4485	8970	4485	8970	4485
Wind erosion from product stockpiles	876	438	876	438	876	438
Loading product to trucks	670	317	1265	598	1265	598
Hauling product off-site	2304	681	4348	1285	4348	1285
Total (kg/y)	**43,194**	**16,356**	**66,403**	**23,849**	**68,872**	**24,528**

6. Approach to Assessment

6.1 Overview

The computer-based dispersion model known as CALPUFF has been used to predict ground-level pollutant concentrations due to the identified emission sources, and the model predictions have been compared with relevant air quality objectives. Details of the modelling are provided below.

6.2 Meteorological Modelling

CALPUFF requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radiosondes or numerical models, such as the CSIRO's prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land-use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model.

There are no known upper air stations in the Ballina region that collect suitable data to be used as observations in CALMET. The meteorological modelling therefore followed the guidance of TRC (2011) whereby gridded prognostic data from TAPM were used as the initial guess wind field for CALMET, supplemented with surface meteorological data. This approach is referred to as "Hybrid" mode. Key model settings for TAPM are shown in **Table 6**.

Table 6 Model settings and inputs for TAPM

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	3 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 x 35 x 25
Year(s) of analysis	2012 with one "spin-up" day.
Centre of analysis	Teven Quarry (28°50.5' S, 153°29.5' E)
Meteorological data assimilation	None

Table 7 lists the model settings and input data for CALMET.

Table 7 Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	SRTM
Land-use data source(s)	USGS and digitized from aerial imagery
Meteorological grid domain	6 km x 6 km
Meteorological grid resolution	0.1 km
Meteorological grid dimensions	60 x 60 x 9
Meteorological grid origin	545000 mE, 6807000 mN
Surface meteorological stations	Ballina Airport for wind speed and wind direction. TAPM for ceiling height, cloud cover, temperature, relative humidity and pressure.
Upper air meteorological stations	None. The 3-dimensional meteorological output from TAPM was used as the initial guess wind-field for CALMET.
Simulation length	8784 hours (1 Jan 2012 to 31 Dec 2012)

Terrain information was extracted from the NASA Shuttle Research Topography Mission database which has global coverage at approximately 90 metre resolution. Land use data were extracted from aerial imagery.

Figure 5 shows the model grid, land-use and terrain information, as used by CALMET.

Figure 6 shows a snapshot of winds as simulated by the CALMET model under stable conditions. This plot shows the effect of the topography on local wind flows (for this particular hour), and highlights the non-uniform wind patterns in the area.

Figure 5 Model grid, land-use and terrain information

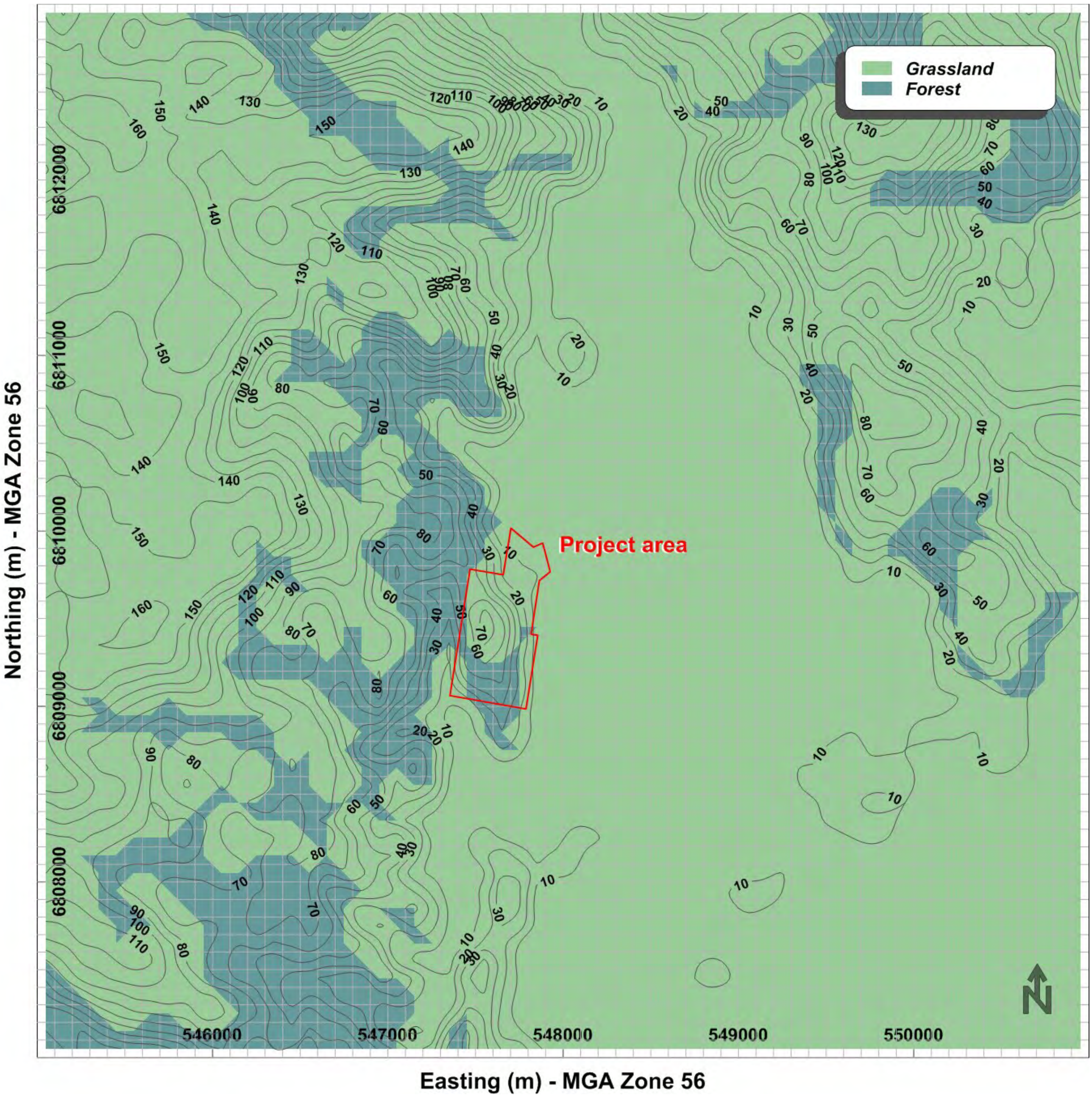
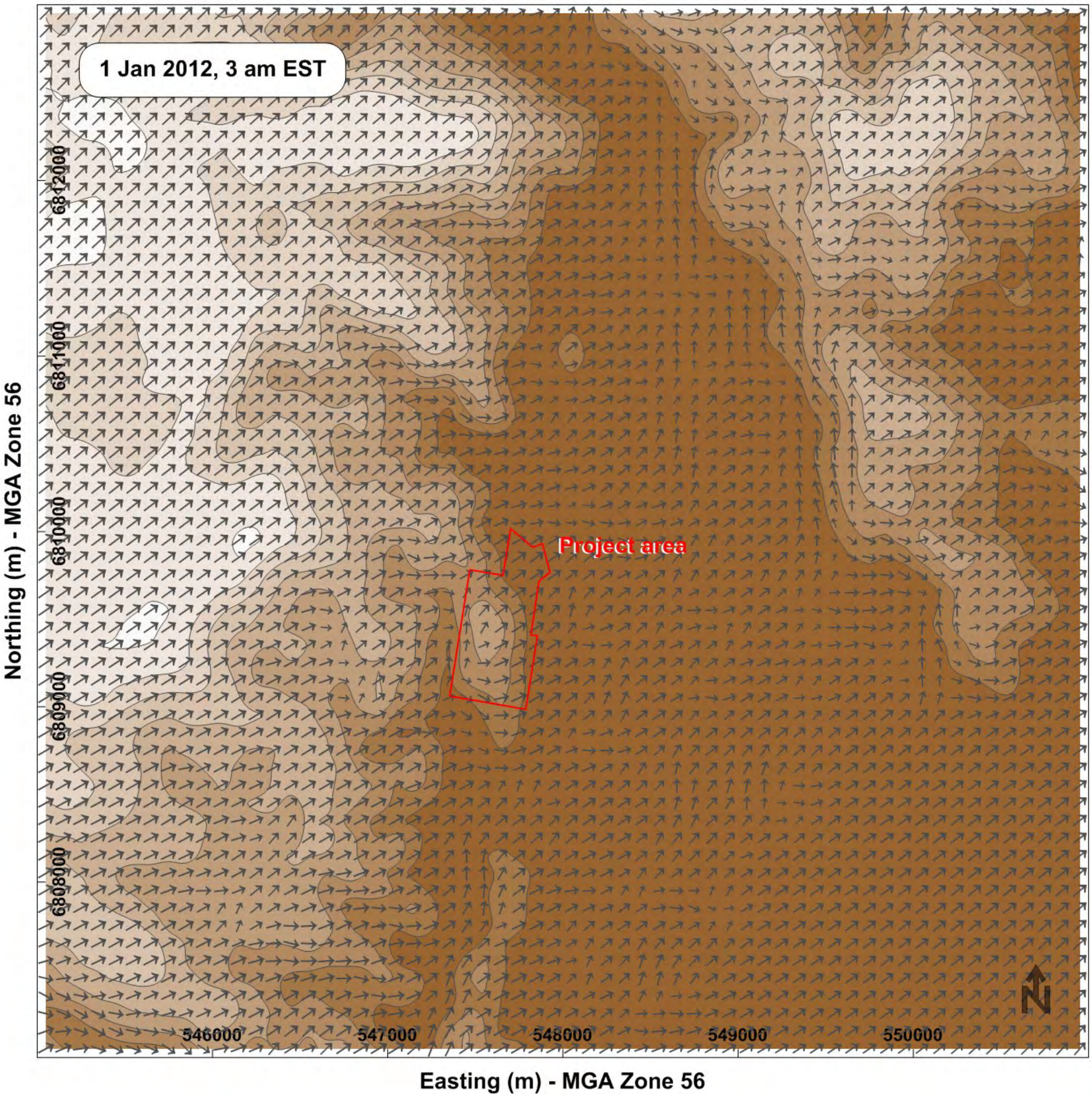


Figure 6 Example of simulated ground-level wind flows



6.3 Dispersion Modelling

Ground-level TSP, PM_{10} and deposited dust due to the emission sources have been predicted using CALPUFF (Version 6.42). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap and the serial release is representative of a continuous release.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME and ISCST3) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions. It is the preferred model of the United States Environmental Protection Agency for the long-range transport of pollutants and for complex terrain (TRC 2007) and has been listed by the EPA as an approved model for air quality modelling assessments in NSW (DEC 2005). CALPUFF has the ability to model the effect of emissions entrained into the thermal internal boundary layer that forms over land, both through fumigation and plume trapping. Based on the meteorological modelling discussed in **Section 6.2** the area around the quarry experiences non-uniform wind patterns which are driven by the local topography. This outcome supports the choice of CALPUFF to model the quarry emissions.

The modelling was performed using the emission estimates from **Section 5** and using the meteorological information provided by the CALMET model, described in **Section 6.2**. Predictions were made at 299 discrete receptors (including sensitive receptors) to allow for contouring of results. The list of receptors can be provided on request.

Quarry operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. **Figure 7** shows the location of the modelled sources, where the emissions from the dust generating activities listed in **Table 5** were assigned to one or more of these source locations (refer to **Appendix A** for details of the allocations).

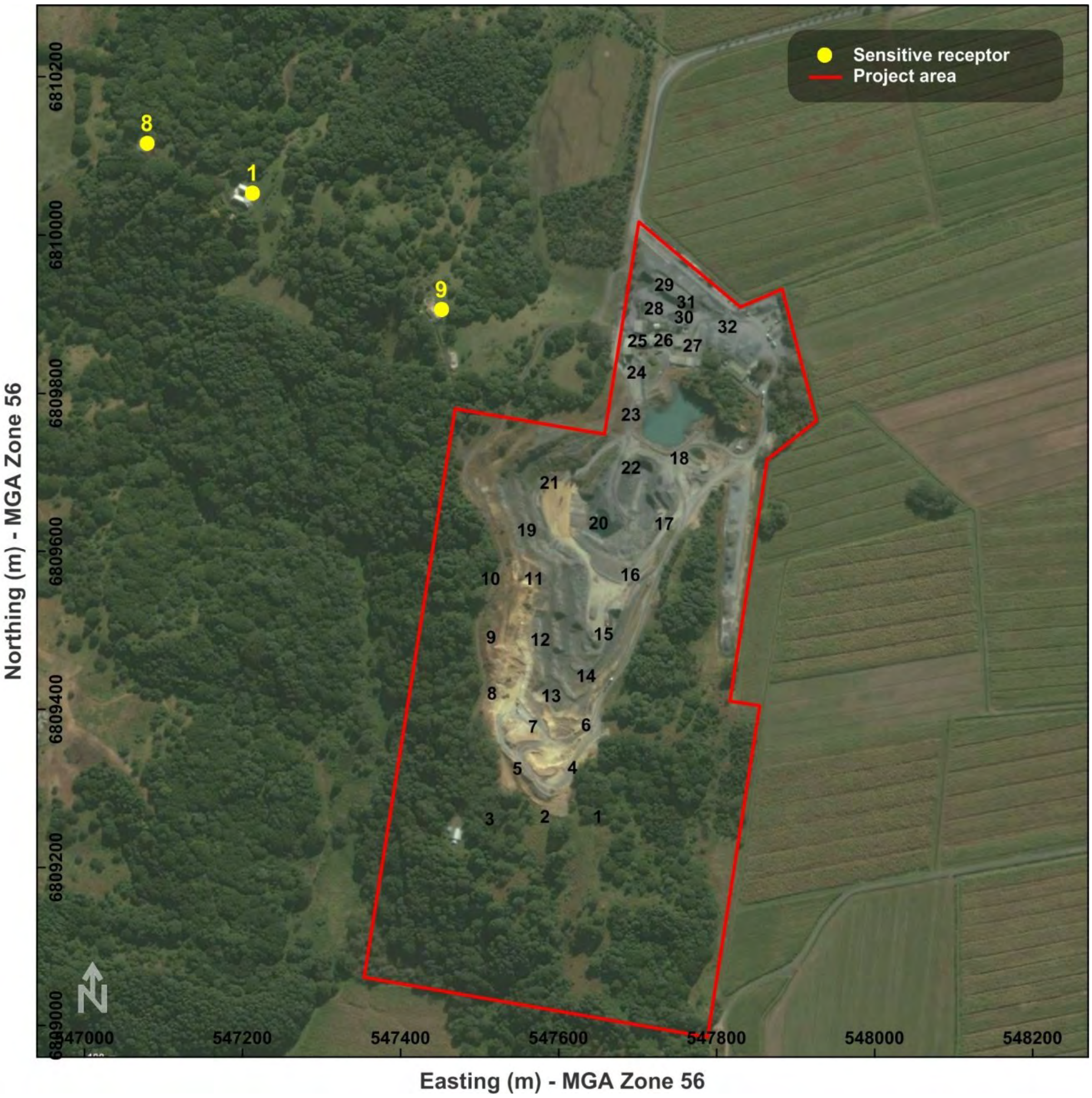
Dust emissions for all modelled quarry-related sources have been considered to fit in one of three categories, as follows:

- Wind insensitive sources, where emissions do not vary with wind speed (for example, crushing);
- Wind sensitive sources, where emissions vary with the hourly wind speed, raised to the power of 1.3 (for example, loading and unloading of waste to/from trucks) (US EPA 1987); and
- Wind sensitive sources, where emissions also vary with the hourly wind speed, but raised to the power of 3 (for example, wind erosion from stockpiles, overburden dumps or active pits) (Skidmore 1998).

Emissions from each volume source were developed on an hourly time step, taking into account the level of activity at that location and, in some cases, the hourly wind speed. This approach ensured that light winds corresponded with lower dust generation and higher winds, with higher dust generation.

Project emissions associated with the quarry activities were assumed to take place for the hours prescribed in the project description, except for wind erosion emissions which were assumed to occur for 24 hours per day.

Figure 7 Location of modelled sources



Model predictions at identified sensitive receptors were then compared with the air quality objectives, previously discussed in **Section 3**. Contour plots have also been created to show the spatial distribution of model predictions.

Key model settings and inputs for CALPUFF are provided in **Table 8**.

Table 8 Model settings and inputs for CALPUFF

Parameter	Value(s)
Model version	6.42
Computational grid domain	60 x 60
Chemical transformation	None
Dry deposition	Yes
Wind speed profile	ISC rural

Parameter	Value(s)
Puff element	Puff
Dispersion option	Turbulence from micrometeorology
Time step	3600 seconds (1 hour)
Terrain adjustment	Partial plume path
Number of volume sources	32
Number of discrete receptors	299

7. Operational Impacts

Table 9 shows the model results for each sensitive receptor location. These results include the predicted contribution due to the quarry activities, the predicted cumulative results (that is, quarry plus background), and the relevant air quality criteria. Shaded cells represent predictions which are higher than the associated air quality criteria.

The maximum 24-hour average predictions represent the potential worst-case day in a one year period, for each location.

Table 9 Summary of model predictions for each sensitive receptor

Receiver ID	Predicted, due to quarry activities			Cumulative (predicted plus background)			Criteria
	Existing	Year 1	Year 11	Existing	Year 1	Year 11	
Maximum 24-hour average PM_{10} concentrations (µg/m^3) (number of days above 50 µg/m^3 in parentheses)							
1	9	10	10	35	36	36	50
2	4	5	5	30	31	31	50
3	1	2	2	27	28	28	50
4	1	2	2	27	28	28	50
6	24	25	25	50	51 (1)	51 (1)	50
7	13	14	14	39	40	40	50
8	6	7	7	32	33	33	50
9	29	31	31	55 (1)	57 (1)	57 (1)	50
10	6	8	8	32	34	34	50
12	4	5	5	30	31	31	50
Annual average PM_{10} concentrations (µg/m^3)							
1	0.7	1.0	1.0	14.7	15.0	15.0	30
2	0.4	0.5	0.5	14.4	14.5	14.5	30
3	0.1	0.2	0.2	14.1	14.2	14.2	30
4	0.1	0.2	0.2	14.1	14.2	14.2	30
6	0.3	0.4	0.4	14.3	14.4	14.4	30
7	0.3	0.4	0.4	14.3	14.4	14.4	30
8	0.5	0.6	0.6	14.5	14.6	14.6	30
9	2.4	3.2	3.3	16.4	17.2	17.3	30
10	0.8	1.1	1.2	14.8	15.1	15.2	30
12	0.4	0.5	0.5	14.4	14.5	14.5	30
Annual average TSP concentrations (µg/m^3)							
1	1.0	1.5	1.6	36.0	36.5	36.6	90
2	0.6	0.9	0.9	35.6	35.9	35.9	90
3	0.2	0.3	0.3	35.2	35.3	35.3	90
4	0.2	0.3	0.3	35.2	35.3	35.3	90
6	0.4	0.6	0.6	35.4	35.6	35.6	90
7	0.4	0.5	0.6	35.4	35.5	35.6	90
8	0.6	0.9	1.0	35.6	35.9	36.0	90
9	4.1	5.9	6.1	39.1	40.9	41.1	90
10	1.3	2.0	2.1	36.3	37.0	37.1	90
12	0.6	0.8	0.8	35.6	35.8	35.8	90
Annual average dust deposition (g/m^2/month)							
1	0.2	0.3	0.3	2.2	2.3	2.3	4
2	0.1	0.1	0.1	2.1	2.1	2.1	4
3	<0.1	<0.1	<0.1	2.0	2.0	2.0	4

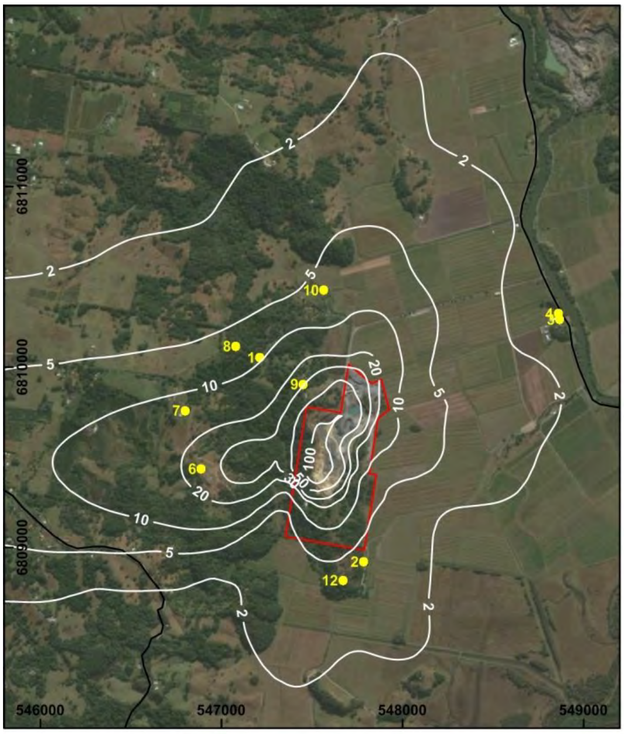
Receiver ID	Predicted, due to quarry activities			Cumulative (predicted plus background)			Criteria
	Existing	Year 1	Year 11	Existing	Year 1	Year 11	
4	<0.1	<0.1	<0.1	2.0	2.0	2.0	4
6	0.1	0.1	0.1	2.1	2.1	2.1	4
7	0.1	0.1	0.1	2.1	2.1	2.1	4
8	0.1	0.2	0.2	2.1	2.2	2.2	4
9	0.6	0.9	0.9	2.6	2.9	2.9	4
10	0.2	0.3	0.3	2.2	2.3	2.3	4
12	0.1	0.1	0.1	2.1	2.1	2.1	4

The model results have also been presented as contour plots showing the spatial distribution of dust concentration and deposition levels (see **Figure 8** to **Figure 10**).

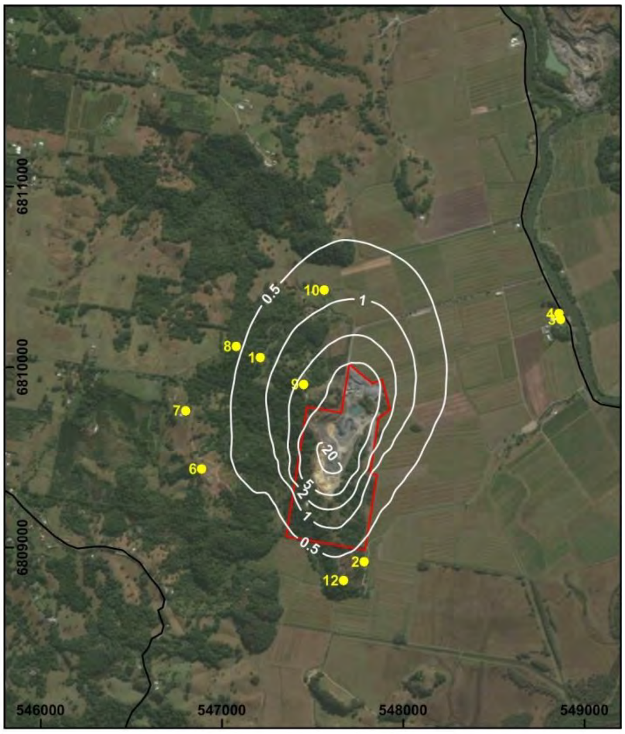
The following conclusions have been made from review of the model results:

- Two properties (9 and 5) are predicted to experience 24-hour average PM_{10} concentrations above the 50 µg/m^3 criterion on up to one day each year, due to the combined effect of Teven Quarry activities and maximum adopted background levels, for both existing and proposed operations. However, the change in off-site dust impacts is expected to be negligible as the results for the Existing, Year 1 and Year 11 scenarios are very similar. This is because emissions from wind erosion of exposed areas is the main influence to off-site impacts, and not the emissions due to material processing.
- A conservative approach was adopted for the assessment of 24-hour average PM_{10} concentrations whereby maximum predictions were added to 95th percentile background levels. If, on any day, the background levels were on the average (at 16 µg/m^3) then no properties would be predicted to experience 24-hour average PM_{10} concentrations above the 50 µg/m^3 criterion.
- Annual average PM_{10} and TSP concentrations and annual average dust deposition levels are predicted to comply with the EPA criteria at all sensitive receptor locations, for all modelled scenarios. Again, the change in off-site dust impacts due to the Project is expected to be negligible since the results for the Existing, Year 1 and Year 11 scenarios are very similar.

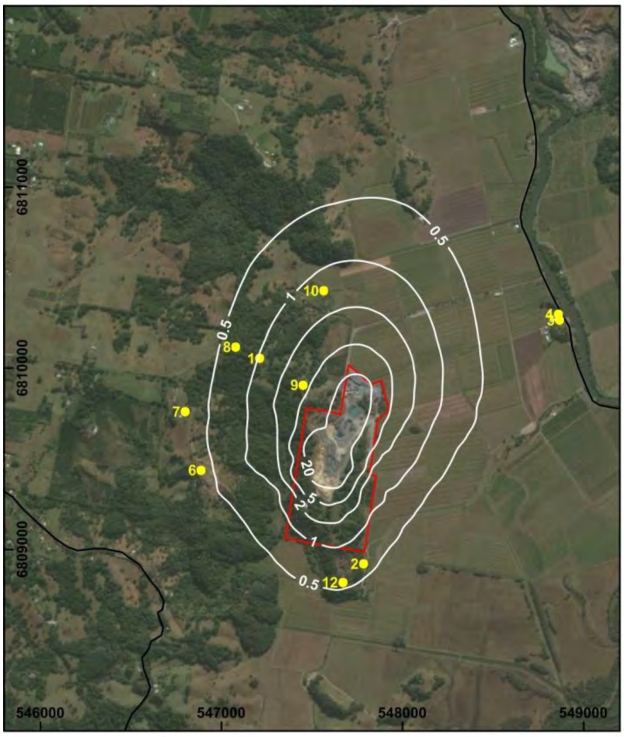
Figure 8 Predicted dust concentration and deposition levels due to existing operations



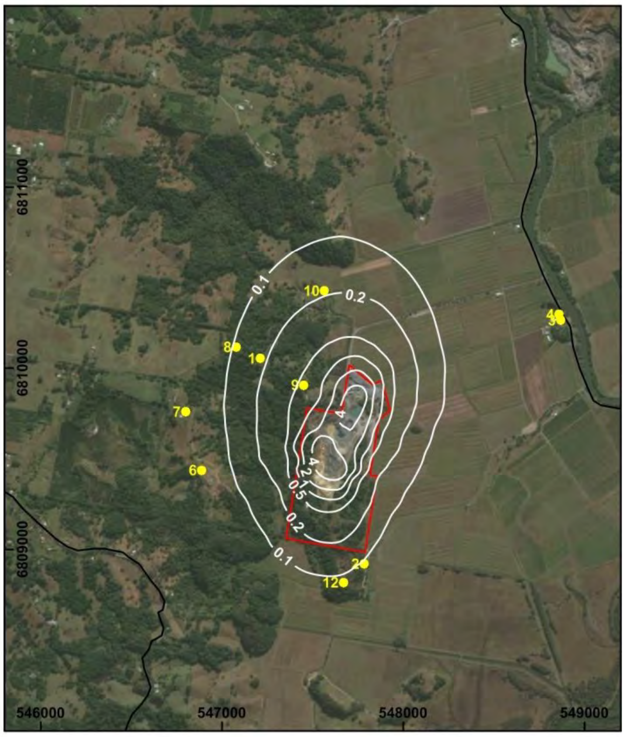
Maximum 24-hour average PM_{10} ($\mu g/m^3$)



Annual average PM_{10} ($\mu g/m^3$)

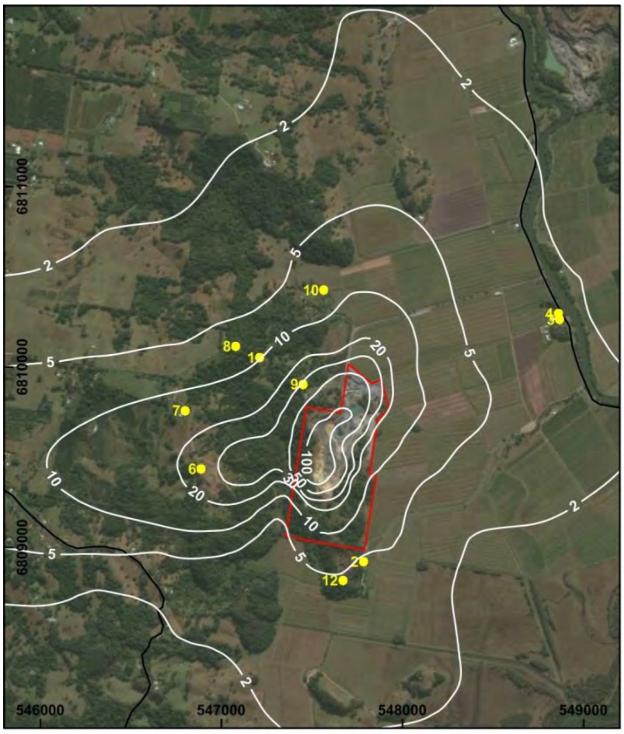


Annual average TSP ($\mu g/m^3$)

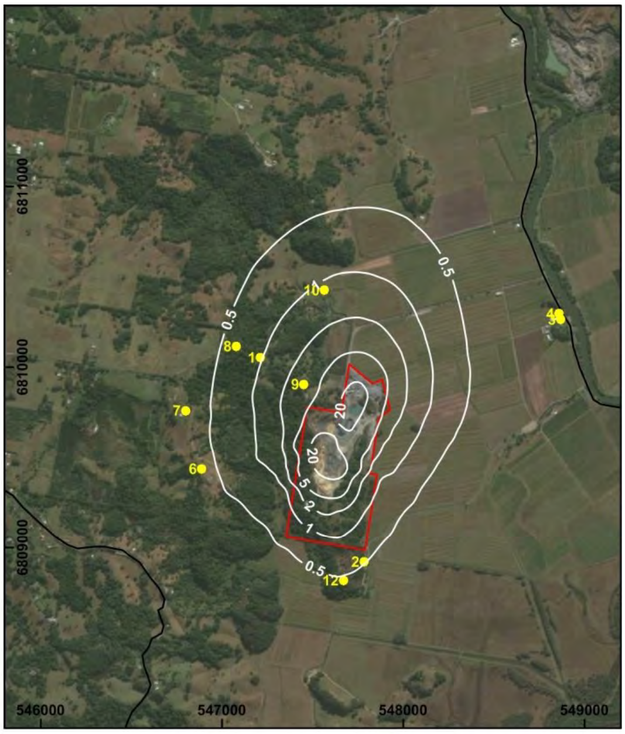


Annual average dust deposition (g/m^2 /month)

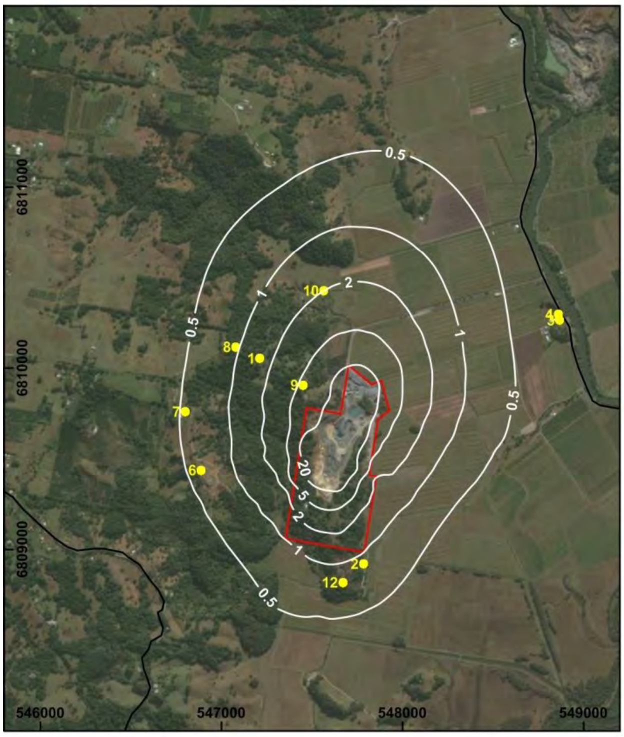
Figure 9 Predicted dust concentration and deposition levels due to Year 1 operations



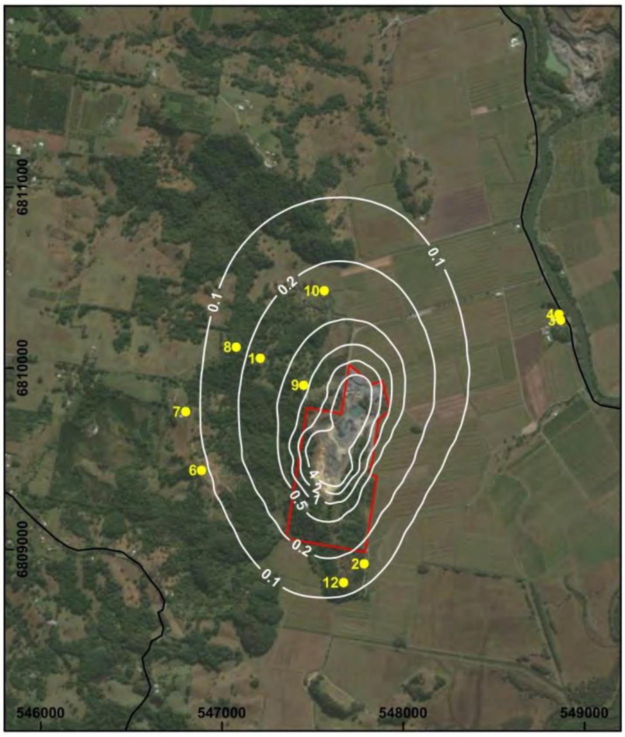
Maximum 24-hour average PM_{10} ($\mu g/m^3$)



Annual average PM_{10} ($\mu g/m^3$)

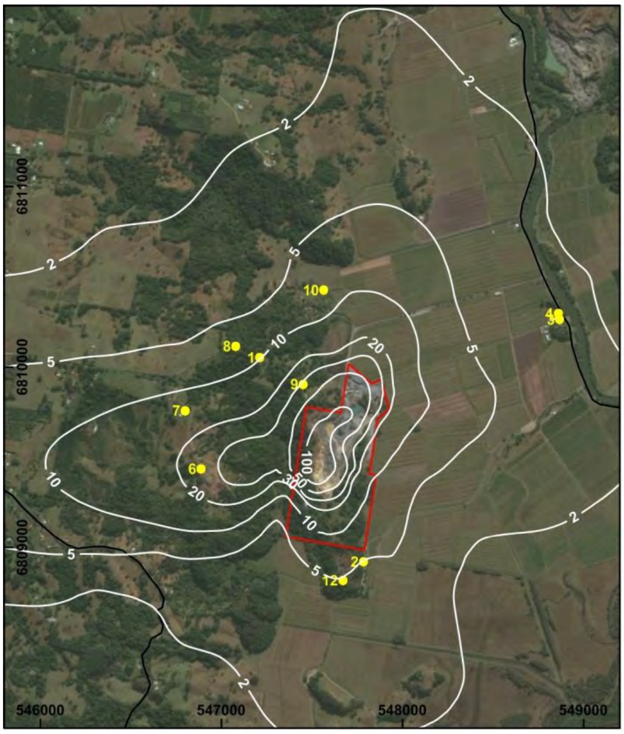


Annual average TSP ($\mu g/m^3$)

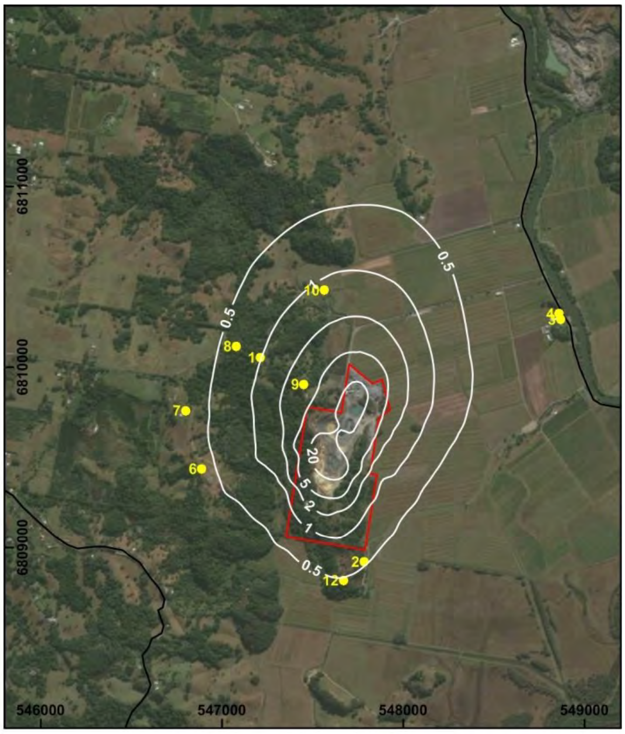


Annual average dust deposition (g/m^2 /month)

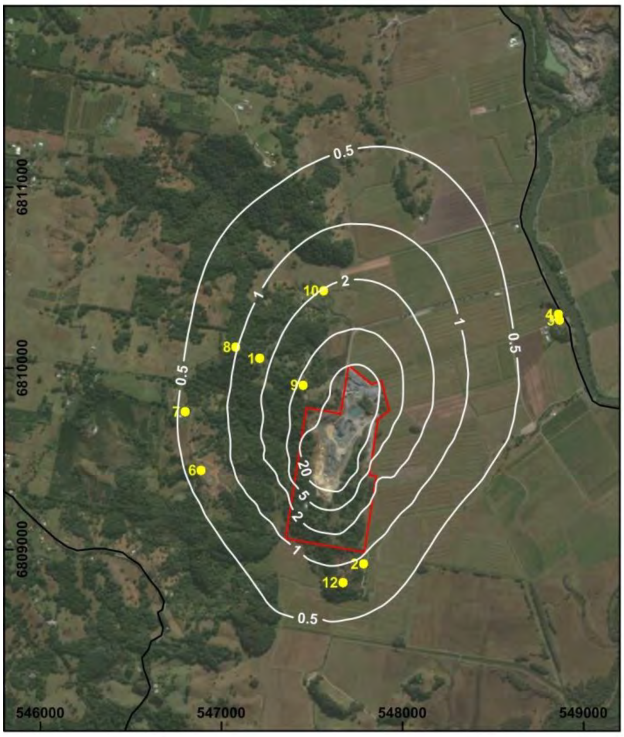
Figure 10 Predicted dust concentration and deposition levels due to Year 11 operations



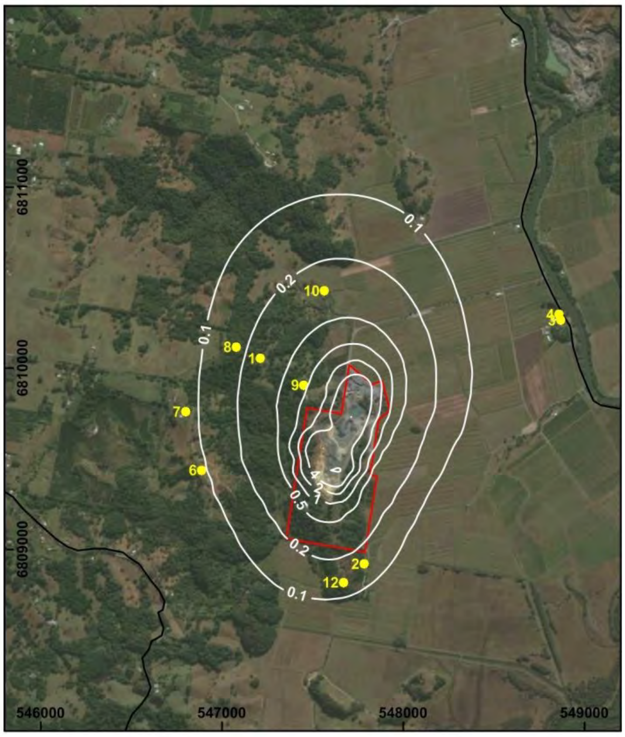
Maximum 24-hour average PM_{10} ($\mu g/m^3$)



Annual average PM_{10} ($\mu g/m^3$)



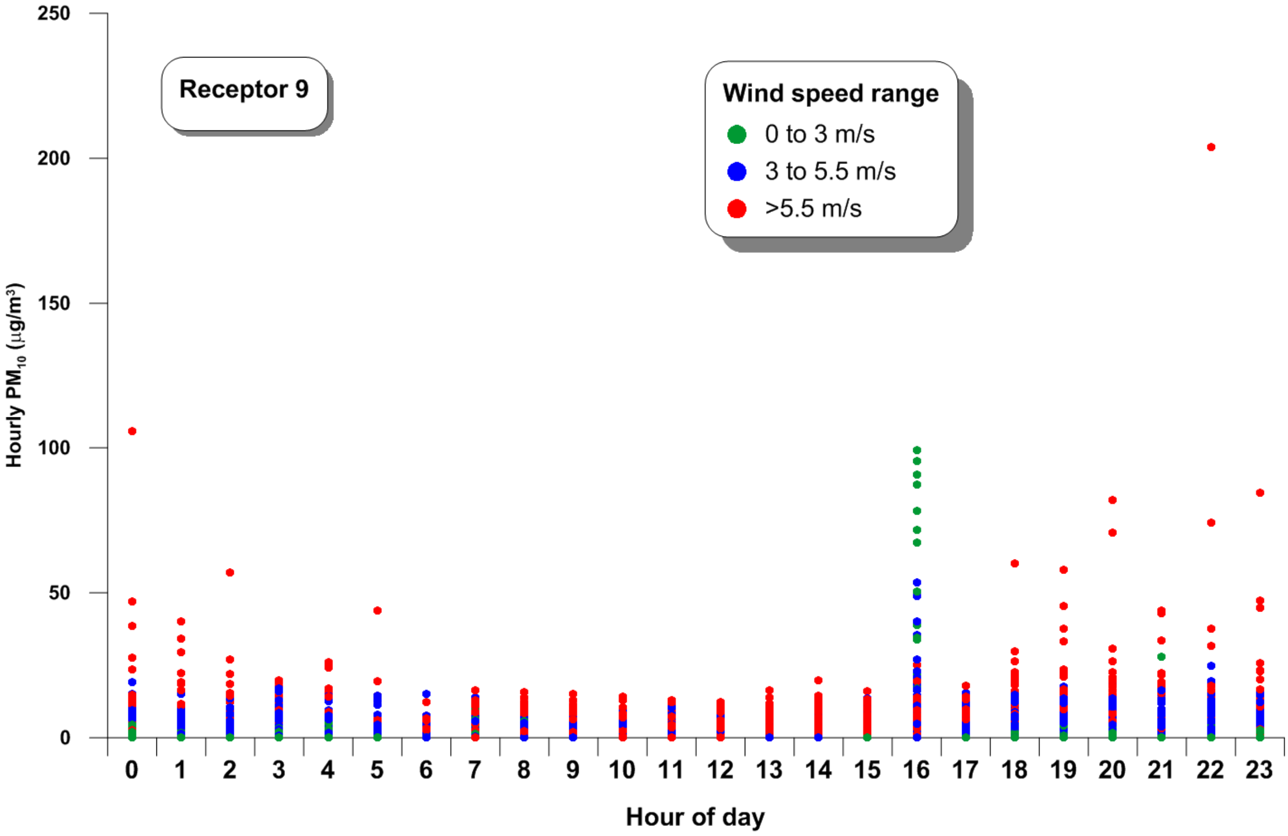
Annual average TSP ($\mu g/m^3$)



Annual average dust deposition (g/m^2/month)

The model results for existing operations have also been analysed to identify adverse meteorological conditions in terms of elevated dust impacts. **Figure 11** shows the model predictions of hourly PM_{10} concentrations at Receptor 9 by time of day and by wind speed. These results show that the stronger winds (that is, greater than 5.5 m/s) are more commonly associated with elevated PM_{10} concentrations.

Figure 11 Predicted hourly PM_{10} concentrations due to the existing quarry by time of day and wind speed



8. Construction Impacts

The Teven Quarry Project will not require a specific construction phase, however the project will require the commissioning of new mobile equipment. Air quality impacts during commissioning would be expected to be minimal since the Project is based around an increase in production by using, predominantly, the existing plant and equipment. There will however be some emissions to air associated with the addition of:

- An in-pit mobile crushing plant.
- A mobile pugmill.

The most significant emissions to air from commissioning of the additional plant will be particulate matter (dust), due to handling of equipment and ground disturbance. Potential dust impacts due to these activities will be minimal, and well within the potential impacts due to the existing quarry activities. Further, the commissioning activities will be temporary and likely to be completed within one month.

Nevertheless, it is anticipated that dust management will be incorporated into the commissioning activities. Management measures would typically include:

- Limiting dust-generating activities during periods of dry and windy weather.
- Applying water to key transfer points.
- Imposing speed limits on site roads.
- Reshaping and rehabilitating stockpiles and exposed areas as soon as practicable.

9. Monitoring and Management

The foregoing assessment has indicated that annual average PM_{10}, TSP and dust deposition levels will be in compliance with air quality criteria at sensitive receptors for each stage of the Project. There is however a potential risk that existing and proposed activities will contribute to exceedances of the 24-hour average PM_{10} criterion (50 $\mu g/m^3$) on up to one day per year. This may occur when background levels are higher than average or during adverse meteorological conditions.

The dispersion model used for this assessment provides a prediction of the potential future impacts, so it will be important to manage site activities to avoid these exceedances as far as practicable. This section outlines suitable mitigation, monitoring and management measures for minimising daily dust impacts.

9.1 Monitoring

The Bureau of Meteorology operates a weather station at Ballina Airport, approximately six kilometres to the east and while these data are useful for understanding conditions at Teven Quarry, the data can only be used retrospectively, and not in real-time.

Based on the outcomes of the foregoing assessment, the identification of “adverse” meteorological conditions would assist Holcim with the management of emissions from the quarry on a daily basis. A suitable monitoring program to identify “adverse” meteorological conditions would include:

- One real-time meteorological station which collects, as a minimum, hourly (or finer resolution) wind speed and wind direction data.

The real-time data would assist Holcim with the identification of adverse weather conditions (such as strong winds blowing towards sensitive receptors). Meteorological monitoring for the purposes of air quality management should be carried out with consideration of the *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DEC 2007).

9.2 Management Measures

Holcim currently adopts the follow dust management measures for specific activities at Teven Quarry.

Table 10 Dust control measures for specific activities

Activity	Existing controls	Future controls	Assumptions for modelled dust control
Hauling overburden to dumps	Water cart.	Water cart. Install sprinklers along haul roads.	75% control. Based on watering only and application of >2 litres / m^2 / h
Drilling rock	Drill rig fitted with dust suppression system	Drill rig fitted with dust suppression system	70% control.
Loading rock to mobile crusher	NA	Water sprays will be utilised with all mobile crushing and screening plant and equipment.	50% control. Use of water sprays
Crushing (mobile)	NA	Water sprays will be utilised with all mobile crushing and screening plant and equipment.	50% control. Use of water sprays
Hauling rock to plant	Water cart.	Water cart. Install sprinklers along haul roads.	75% control. Based on watering only and application of >2 litres / m^2 / h

Activity	Existing controls	Future controls	Assumptions for modelled dust control
Primary crushing	Primary is enclosed. Water sprays are used on all conveyors. Sprinklers on the ramp/entrance to the primary crushing bin.	Primary is enclosed. Water sprays to be used on all conveyors. Sprinklers on the ramp/entrance to the primary crushing bin.	70% control. Based on enclosure.
Secondary crushing	Secondary is enclosed. Water sprays on all conveyors.	Secondary is enclosed. Water sprays on all conveyors.	70% control. Based on enclosure.
Tertiary crushing	Ring of sprays on dust belt.	Ring of sprays on dust belt.	50% control. Based on water sprays.
Screening	Wash plant for all aggregates. Water sprays on all conveyors.	Wash plant for all aggregates. Water sprays on all conveyors.	70% control. Enclosure / water sprays.
Mobile pugmill (blending)	NA	Water sprays will be utilised with all mobile crushing and screening plant and equipment.	50% control. Based on water sprays.
Loading product stockpiles	Sprinklers on all product stockpiles.	Sprinklers on all product stockpiles.	50% control. Based on water sprays.
Wind erosion from overburden dumps	Reshaping and earthworks. Dumps are progressively rehabilitated when they reach final.	Reshaping and earthworks. Dumps are progressively rehabilitated when they reach final.	No control assumed.
Wind erosion from all pits / topsoil piles	Topsoil bunds are shaped and profiled, bunds are not more than 2m high.	Topsoil bunds are shaped and profiled, bunds are not more than 2m high.	No control assumed.
Wind erosion from product stockpiles	Sprinklers on product stockpiles.	Sprinklers on product stockpiles.	50% control. Based on water sprays.
Hauling product off-site	Watering of stockpile areas. Minimal unsealed area. Wheel wash at weighbridge. Trucks mainly travelling on sealed road.	Watering of stockpile areas Five new sprinklers on roads. Minimal unsealed area. Wheel wash at weighbridge. Trucks mainly travelling on sealed road.	75% control. Based on watering only and application of >2 litres / m^2 / h

In addition, Holcim adopts the following general approaches for managing emissions:

- Defining all roads and limiting access to minor and non-designated access roads.
- Imposition of speed limits on all internal roads.
- Disturbance of the minimum area practicable for quarry operations.
- Designing of blasts to minimise dust, including adequate stemming.
- Consideration of current weather conditions prior to blasting. This includes observations of wind speed and wind direction to determine whether any dust emissions from the blast would be carried in the direction of nearest sensitive receptors.
- Implementation of blast fume management procedures. Post-blast blast fume can be produced in non-ideal explosive conditions of the ammonium nitrate/fuel oil (ANFO) and visible as an orange / brown plume. Post-blast fume comprises oxides of nitrogen (NOx) including nitric oxide (NO) and the more harmful nitrogen dioxide (NO_2). Key fume management measures include:
  - Monitoring of sleep time.
  - Defining risk zone based upon weather patterns and permission to fire.

- Risk assessment prior to firing

- Environmental training and awareness to employees and contractors.

10. Conclusions

This report has provided an assessment of potential air quality impacts due to a proposed increase in production at Teven Quarry. Potential impacts have been assessed for both construction and operational scenarios.

The key potential air quality issue was identified as dust from the general quarrying activities.

The computer-based model known as CALPUFF was used to predict air quality impacts at the nearest sensitive receptors. This modelling was carried out in accordance with EPA guidelines (DEC 2005).

The conclusions of the assessment were as follows:

- Annual average PM_{10}, TSP and dust deposition levels will be in compliance with air quality criteria at sensitive receptors during Project operation.
- There is a potential risk that existing and proposed activities will contribute to exceedances of the 24-hour average PM_{10} criterion (50 $\mu g/m^3$), especially if background levels are higher than average. Two properties were predicted to experience 24-hour average PM_{10} concentrations above the 50 $\mu g/m^3$ criterion for up to one day per year, due to the combined effect of Teven Quarry activities and maximum background levels. However, the change in off-site dust impacts is expected to be negligible as the results for the Existing, Year 1 and Year 11 scenarios were very similar.

A conservative approach was adopted for the assessment whereby maximum predictions were added to 95th percentile background levels. This means that actual air quality impacts are likely to be lower than predicted.

Meteorological monitoring would assist with the identification of adverse conditions (in terms of elevated dust concentrations) and for developing targeted dust mitigation measures that will avoid exceedances of the PM_{10} criterion as far as practicable.

11. References

DEC (2005) *"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW"*. Published by the DEC (now EPA), August 2005.

DEC (2007) *"Approved Methods for the Sampling and Analysis of Air Pollutants in NSW*".

DSEWPC (2011) "*State of the Environment Report 2011"*. Independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities.

GHD (2009) *"Report on Ulverstone Asphalt Plant Air Quality Assessment"*. Prepared by GHD, October 2009.

National Pollutant Inventory (2012) "*Emission Estimation Technique Manual for Mining*". Version 3.1, January 2012.

NSW Minerals Council (2000) *"Particulate Matter and Mining Interim Report"*.

OEH (2014) Air quality monitoring data from the Office of Environment and Heritage website http://www.environment.nsw.gov.au/AQMS/search.htm Accessed April 2014.

Skidmore, E.L. (1998) "Wind Erosion Processes", USDA-ARS Wind Erosion Research Unit, Kansas State University. Wind Erosion in Africa and West Asia: Problems and Control Strategies. Proceedings of the expert group meeting 22-25 April 1997, Cairo, Egypt.

TRC (2007) CALPUFF model web-site (http://www.src.com/calpuff/regstat.htm).

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

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. Now a web-based document.

US EPA (1987) Update of fugitive dust emission factors in AP-42 Section 11.2, EPA Contract No. 68-02-3891, Midwest Research Institute, Kansas City, MO, July 1987.

Appendix A. **Emission calculations**

Existing: Intensities and emission factors

Activity	Control (%)	Level of activity		TSP		PM10	
		Intensity	Units	Factor	Units	Factor	Units
Drilling overburden	0	0	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting overburden	0	0	blasts/y	27.5	kg/blast	14.3	kg/blast
Excavators loading overburden to trucks	0	80000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling overburden to dumps	75	80000	t/y	0.09600	kg/t	0.02837	kg/t
Unloading overburden to dumps	0	80000	t/y	0.01200	kg/t	0.0043	kg/t
Drilling rock	70	1000	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting rock	0	12.5	blasts/y	27.5	kg/blast	14.3	kg/blast
Loading rock to mobile crusher	0	0	t/y	0.00253	kg/t	0.0012	kg/t
Crushing (mobile)	50	0	t/y	0.01	kg/t	0.004	kg/t
Loading rock to trucks	0	265000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling rock to plant	75	265000	t/y	0.22400	kg/t	0.06619	kg/t
Primary crushing	90	265000	t/y	0.01	kg/t	0.004	kg/t
Secondary crushing	90	265000	t/y	0.03	kg/t	0.012	kg/t
Tertiary crushing	50	265000	t/y	0.03	kg/t	0.01	kg/t
Screening	70	265000	t/y	0.03	kg/t	0.01	kg/t
Mobile pugmill (blending)	50	0	t/y	0.03	kg/t	0.01	kg/t
Loading product stockpiles	50	265000	t/y	0.00253	kg/t	0.0012	kg/t
Wind erosion from overburden dumps	0	1	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from all pits / topsoil piles	0	8	ha	1121.3	kg/ha/y	560.6	kg/ha/y
Wind erosion from product stockpiles	50	0.5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Loading product to trucks	0	265000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling product off-site	75	265000	t/y	0.03478	kg/t	0.01028	kg/t

Existing: Variables

Activity	Variables									
	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	winds > 5.4 m/s (%)	Average no. of raindays
Drilling overburden	-	-	-	-	-	-	-	-	-	-
Blasting overburden	2500	-	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling overburden to dumps	-	-	-	-	4.0	25	0.6	-	-	-
Unloading overburden to dumps	-	-	-	-	-	-	-	-	-	-
Drilling rock	-	-	-	-	-	-	-	-	-	-
Blasting rock	2500	-	-	-	-	-	-	-	-	-
Loading rock to mobile crusher	-	2.14	2	-	-	-	-	-	-	-
Crushing (mobile)	-	-	-	-	-	-	-	-	-	-
Loading shot rock to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling rock to plant	-	-	-	-	4.0	25	1.4	-	-	-
Primary crushing	-	-	-	-	-	-	-	-	-	-
Secondary crushing	-	-	-	-	-	-	-	-	-	-
Tertiary crushing	-	-	-	-	-	-	-	-	-	-
Screening	-	-	-	-	-	-	-	-	-	-
Mobile pugmill (blending)	-	-	-	-	-	-	-	-	-	-
Loading product stockpiles	-	2.14	2	-	-	-	-	-	-	-
Wind erosion from overburden dumps	-	-	-	-	-	-	-	-	-	-
Wind erosion from all pits / topsoil piles	-	-	-	-	-	-	-	8.3	5	159
Wind erosion from product stockpiles	-	-	-	-	-	-	-	-	-	-
Loading product to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling product off-site	-	-	-	-	4.0	23	0.2	-	-	-

Existing: Activities and source allocations

```
--------------------------------      27-May-2014 13:36
  DUST EMISSION CALCULATIONS XL1
 -------------------------------

 Output emissions file  : C:\Users\SLakmaker\Projects\EN04314_Teven_Quarry\calpuff_r2\Existing\emiss.vol
 Meteorological file    : NA
 Number of dust sources : 32
 Number of activities   : 22

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 202 kg/y TSP  96 kg/y PM10  10 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling overburden to dumps
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1920 kg/y TSP  567 kg/y PM10  96 kg/y PM2.5
 FROM SOURCES  : 7
7 8 9 10 11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Unloading overburden to dumps
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 960 kg/y TSP  344 kg/y PM10  48 kg/y PM2.5
 FROM SOURCES  : 4
7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 177 kg/y TSP  93 kg/y PM10  9 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 344 kg/y TSP  178 kg/y PM10  17 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to mobile crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Crushing (mobile)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 670 kg/y TSP  317 kg/y PM10  34 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling rock to plant
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 14840 kg/y TSP  4385 kg/y PM10  742 kg/y PM2.5
 FROM SOURCES  : 11
11 12 13 14 15 16 17 18 22 23 24
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
```

```
 ACTIVITY NAME : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 265 kg/y TSP  106 kg/y PM10  13 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 795 kg/y TSP  318 kg/y PM10  40 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3975 kg/y TSP  1325 kg/y PM10  199 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2385 kg/y TSP  795 kg/y PM10  119 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Mobile pugmill (blending)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 335 kg/y TSP  159 kg/y PM10  17 kg/y PM2.5
 FROM SOURCES  : 4
28 29 30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Wind erosion from overburden dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3504 kg/y TSP  1752 kg/y PM10  175 kg/y PM2.5
 FROM SOURCES  : 4
7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from all pits / topsoil piles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 8970 kg/y TSP  4485 kg/y PM10  449 kg/y PM2.5
 FROM SOURCES  : 13
6 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 876 kg/y TSP  438 kg/y PM10  44 kg/y PM2.5
 FROM SOURCES  : 4
28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 670 kg/y TSP  317 kg/y PM10  34 kg/y PM2.5
 FROM SOURCES  : 2
30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product off-site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2304 kg/y TSP  681 kg/y PM10  115 kg/y PM2.5
 FROM SOURCES  : 3
30 31 32
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
```

Year 1: Intensities and emission factors

Activity	Control (%)	Level of activity		TSP		PM10	
		Intensity	Units	Factor	Units	Factor	Units
Drilling overburden	0	0	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting overburden	0	0	blasts/y	27.5	kg/blast	14.3	kg/blast
Excavators loading overburden to trucks	0	100000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling overburden to dumps	75	100000	t/y	0.09600	kg/t	0.02837	kg/t
Unloading overburden to dumps	0	100000	t/y	0.01200	kg/t	0.0043	kg/t
Drilling rock	70	1000	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting rock	0	12.5	blasts/y	27.5	kg/blast	14.3	kg/blast
Loading rock to mobile crusher	0	150000	t/y	0.00253	kg/t	0.0012	kg/t
Crushing (mobile)	50	150000	t/y	0.01	kg/t	0.004	kg/t
Loading rock to trucks	0	500000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling rock to plant	75	500000	t/y	0.22400	kg/t	0.06619	kg/t
Primary crushing	90	350000	t/y	0.01	kg/t	0.004	kg/t
Secondary crushing	90	350000	t/y	0.03	kg/t	0.012	kg/t
Tertiary crushing	50	350000	t/y	0.03	kg/t	0.01	kg/t
Screening	70	350000	t/y	0.03	kg/t	0.01	kg/t
Mobile pugmill (blending)	50	150000	t/y	0.03	kg/t	0.01	kg/t
Loading product stockpiles	50	500000	t/y	0.00253	kg/t	0.0012	kg/t
Wind erosion from overburden dumps	0	1	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from all pits / topsoil piles	0	8	ha	1121.3	kg/ha/y	560.6	kg/ha/y
Wind erosion from product stockpiles	50	0.5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Loading product to trucks	0	500000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling product off-site	75	500000	t/y	0.03478	kg/t	0.01028	kg/t

Year 1: Variables

Activity	Variables									
	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	winds > 5.4 m/s (%)	Average no. of raindays
Drilling overburden	-	-	-	-	-	-	-	-	-	-
Blasting overburden	2500	-	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling overburden to dumps	-	-	-	-	4.0	25	0.6	-	-	-
Unloading overburden to dumps	-	-	-	-	-	-	-	-	-	-
Drilling rock	-	-	-	-	-	-	-	-	-	-
Blasting rock	2500	-	-	-	-	-	-	-	-	-
Loading rock to mobile crusher	-	2.14	2	-	-	-	-	-	-	-
Crushing (mobile)	-	-	-	-	-	-	-	-	-	-
Loading shot rock to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling rock to plant	-	-	-	-	4.0	25	1.6	-	-	-
Primary crushing	-	-	-	-	-	-	-	-	-	-
Secondary crushing	-	-	-	-	-	-	-	-	-	-
Tertiary crushing	-	-	-	-	-	-	-	-	-	-
Screening	-	-	-	-	-	-	-	-	-	-
Mobile pugmill (blending)	-	-	-	-	-	-	-	-	-	-
Loading product stockpiles	-	2.14	2	-	-	-	-	-	-	-
Wind erosion from overburden dumps	-	-	-	-	-	-	-	-	-	-
Wind erosion from all pits / topsoil piles	-	-	-	-	-	-	-	8.3	5	159
Wind erosion from product stockpiles	-	-	-	-	-	-	-	-	-	-
Loading product to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling product off-site	-	-	-	-	4.0	23	0.2	-	-	-

Year 1: Activities and source allocations

```
--------------------------------      27-May-2014 13:41
  DUST EMISSION CALCULATIONS XL1
 -------------------------------

 Output emissions file  : C:\Users\SLakmaker\Projects\EN04314_Teven_Quarry\calpuff_r2\Year01\emiss.vol
 Meteorological file    : NA
 Number of dust sources : 32
 Number of activities   : 22

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 253 kg/y TSP  120 kg/y PM10  13 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling overburden to dumps
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2400 kg/y TSP  709 kg/y PM10  120 kg/y PM2.5
 FROM SOURCES  : 7
7 8 9 10 11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Unloading overburden to dumps
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1200 kg/y TSP  430 kg/y PM10  60 kg/y PM2.5
 FROM SOURCES  : 4
7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 177 kg/y TSP  93 kg/y PM10  9 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 344 kg/y TSP  178 kg/y PM10  17 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to mobile crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 379 kg/y TSP  179 kg/y PM10  19 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Crushing (mobile)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 750 kg/y TSP  300 kg/y PM10  38 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1265 kg/y TSP  598 kg/y PM10  63 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling rock to plant
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 28000 kg/y TSP  8274 kg/y PM10  1400 kg/y PM2.5
 FROM SOURCES  : 11
11 12 13 14 15 16 17 18 22 23 24
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
```

```
 ACTIVITY NAME : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 350 kg/y TSP  140 kg/y PM10  18 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1050 kg/y TSP  420 kg/y PM10  53 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5250 kg/y TSP  1750 kg/y PM10  263 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3150 kg/y TSP  1050 kg/y PM10  158 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Mobile pugmill (blending)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2250 kg/y TSP  750 kg/y PM10  113 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 632 kg/y TSP  299 kg/y PM10  32 kg/y PM2.5
 FROM SOURCES  : 4
28 29 30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Wind erosion from overburden dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3504 kg/y TSP  1752 kg/y PM10  175 kg/y PM2.5
 FROM SOURCES  : 4
7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from all pits / topsoil piles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 8970 kg/y TSP  4485 kg/y PM10  449 kg/y PM2.5
 FROM SOURCES  : 13
6 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 876 kg/y TSP  438 kg/y PM10  44 kg/y PM2.5
 FROM SOURCES  : 4
28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1265 kg/y TSP  598 kg/y PM10  63 kg/y PM2.5
 FROM SOURCES  : 2
30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product off-site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4348 kg/y TSP  1285 kg/y PM10  217 kg/y PM2.5
 FROM SOURCES  : 3
30 31 32
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
```

Year 11: Intensities and emission factors

Activity	Control (%)	Level of activity		TSP		PM10	
		Intensity	Units	Factor	Units	Factor	Units
Drilling overburden	0	0	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting overburden	0	0	blasts/y	27.5	kg/blast	14.3	kg/blast
Excavators loading overburden to trucks	0	60000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling overburden to dumps	75	60000	t/y	0.09600	kg/t	0.02837	kg/t
Unloading overburden to dumps	0	60000	t/y	0.01200	kg/t	0.0043	kg/t
Drilling rock	70	1000	holes/y	0.59	kg/hole	0.31	kg/hole
Blasting rock	0	12.5	blasts/y	27.5	kg/blast	14.3	kg/blast
Loading rock to mobile crusher	0	150000	t/y	0.00253	kg/t	0.0012	kg/t
Crushing (mobile)	50	150000	t/y	0.01	kg/t	0.004	kg/t
Loading rock to trucks	0	500000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling rock to plant	75	500000	t/y	0.25600	kg/t	0.07565	kg/t
Primary crushing	90	350000	t/y	0.01	kg/t	0.004	kg/t
Secondary crushing	90	350000	t/y	0.03	kg/t	0.012	kg/t
Tertiary crushing	50	350000	t/y	0.03	kg/t	0.01	kg/t
Screening	70	350000	t/y	0.03	kg/t	0.01	kg/t
Mobile pugmill (blending)	50	150000	t/y	0.03	kg/t	0.01	kg/t
Loading product stockpiles	50	500000	t/y	0.00253	kg/t	0.0012	kg/t
Wind erosion from overburden dumps	0	1	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Wind erosion from all pits / topsoil piles	0	8	ha	1121.3	kg/ha/y	560.6	kg/ha/y
Wind erosion from product stockpiles	50	0.5	ha	3504.0	kg/ha/y	1752.0	kg/ha/y
Loading product to trucks	0	500000	t/y	0.00253	kg/t	0.0012	kg/t
Hauling product off-site	75	500000	t/y	0.03478	kg/t	0.01028	kg/t

Year 11: Variables

Activity	Variables									
	Area (m2)	(ws/2.2)^1.3	Moisture (%)	Drop distance (m)	kg/VKT	t/truck	km/trip	Silt (%)	winds > 5.4 m/s (%)	Average no. of raindays
Drilling overburden	-	-	-	-	-	-	-	-	-	-
Blasting overburden	2500	-	-	-	-	-	-	-	-	-
Excavators loading overburden to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling overburden to dumps	-	-	-	-	4.0	25	0.6	-	-	-
Unloading overburden to dumps	-	-	-	-	-	-	-	-	-	-
Drilling rock	-	-	-	-	-	-	-	-	-	-
Blasting rock	2500	-	-	-	-	-	-	-	-	-
Loading rock to mobile crusher	-	2.14	2	-	-	-	-	-	-	-
Crushing (mobile)	-	-	-	-	-	-	-	-	-	-
Loading shot rock to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling rock to plant	-	-	-	-	4.0	25	1.6	-	-	-
Primary crushing	-	-	-	-	-	-	-	-	-	-
Secondary crushing	-	-	-	-	-	-	-	-	-	-
Tertiary crushing	-	-	-	-	-	-	-	-	-	-
Screening	-	-	-	-	-	-	-	-	-	-
Mobile pugmill (blending)	-	-	-	-	-	-	-	-	-	-
Loading product stockpiles	-	2.14	2	-	-	-	-	-	-	-
Wind erosion from overburden dumps	-	-	-	-	-	-	-	-	-	-
Wind erosion from all pits / topsoil piles	-	-	-	-	-	-	-	8.3	5	159
Wind erosion from product stockpiles	-	-	-	-	-	-	-	-	-	-
Loading product to trucks	-	2.14	2	-	-	-	-	-	-	-
Hauling product off-site	-	-	-	-	4.0	23	0.2	-	-	-

Year 11: Activities and source allocations

```
--------------------------------      27-May-2014 13:46
  DUST EMISSION CALCULATIONS XL1
 -------------------------------

 Output emissions file  : C:\Users\SLakmaker\Projects\EN04314_Teven_Quarry\calpuff_r2\Year10\emiss.vol
 Meteorological file    : NA
 Number of dust sources : 32
 Number of activities   : 22

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Excavators loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 152 kg/y TSP  72 kg/y PM10  8 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling overburden to dumps
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1440 kg/y TSP  426 kg/y PM10  72 kg/y PM2.5
 FROM SOURCES  : 7
7 8 9 10 11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Unloading overburden to dumps
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 720 kg/y TSP  258 kg/y PM10  36 kg/y PM2.5
 FROM SOURCES  : 4
7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 177 kg/y TSP  93 kg/y PM10  9 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Blasting rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 344 kg/y TSP  178 kg/y PM10  17 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to mobile crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 379 kg/y TSP  179 kg/y PM10  19 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Crushing (mobile)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 750 kg/y TSP  300 kg/y PM10  38 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1265 kg/y TSP  598 kg/y PM10  63 kg/y PM2.5
 FROM SOURCES  : 3
11 12 13
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling rock to plant
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 32000 kg/y TSP  9456 kg/y PM10  1600 kg/y PM2.5
 FROM SOURCES  : 11
11 12 13 14 15 16 17 18 22 23 24
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
```

```
 ACTIVITY NAME : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 350 kg/y TSP  140 kg/y PM10  18 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1050 kg/y TSP  420 kg/y PM10  53 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5250 kg/y TSP  1750 kg/y PM10  263 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3150 kg/y TSP  1050 kg/y PM10  158 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Mobile pugmill (blending)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2250 kg/y TSP  750 kg/y PM10  113 kg/y PM2.5
 FROM SOURCES  : 3
25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 632 kg/y TSP  299 kg/y PM10  32 kg/y PM2.5
 FROM SOURCES  : 4
28 29 30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Wind erosion from overburden dumps
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 3504 kg/y TSP  1752 kg/y PM10  175 kg/y PM2.5
 FROM SOURCES  : 4
7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from all pits / topsoil piles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 8970 kg/y TSP  4485 kg/y PM10  449 kg/y PM2.5
 FROM SOURCES  : 13
6 11 12 13 14 15 16 17 18 19 20 21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 876 kg/y TSP  438 kg/y PM10  44 kg/y PM2.5
 FROM SOURCES  : 4
28 29 30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1265 kg/y TSP  598 kg/y PM10  63 kg/y PM2.5
 FROM SOURCES  : 2
30 31
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product off-site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4348 kg/y TSP  1285 kg/y PM10  217 kg/y PM2.5
 FROM SOURCES  : 3
30 31 32
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0
```