Appendix 14

Air Quality Impact Assessment

ACOUSTICS AND AIR

HODGSON QUARRY PRODUCTS
SAND EXTRACTION
ROBERTS ROAD, MAROOTA

AIR QUALITY IMPACT ASSESSMENT

REPORT NO. 14229
VERSION B

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PREPARED FOR

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GLOSSARY OF AIR QUALITY TERMS

Air Pollution – The presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects.

Air Quality Standards – The level of pollutants prescribed by regulations that are not to be exceeded during a given time in a defined area.

Air Toxics – Any air pollutant for which a national ambient air quality standard (NAAQS) does not exist (i.e. excluding ozone, carbon monoxide, PM-10, sulphur dioxide, nitrogen oxide) that may reasonably be anticipated to cause cancer; respiratory, cardiovascular, or developmental effects; reproductive dysfunctions, neurological disorders, heritable gene mutations, or other serious or irreversible chronic or acute health effects in humans.

Airborne Particulates – Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. Chemical composition of particulates varies widely, depending on location and time of year. Sources of airborne particulates include dust, emissions from industrial processes, combustion products from the burning of wood and coal, combustion products associated with motor vehicle or non-road engine exhausts, and reactions to gases in the atmosphere.

Area Source – Any source of air pollution that is released over a relatively small area, but which cannot be classified as a point source. Such sources may include vehicles and other small engines, small businesses and household activities, or biogenic sources, such as a forest that releases hydrocarbons, may be referred to as nonpoint source.

Concentration – The relative amount of a substance mixed with another substance. Examples are 5 ppm of carbon monoxide in air and 1 mg/l of iron in water.

Emission – Release of pollutants into the air from a source. We say sources emit pollutants.

Emission Factor – The relationship between the amount of pollution produced and the amount of raw material processed. For example, an emission factor for a blast furnace making iron would be the number of pounds of particulates per ton of raw materials.

Emission Inventory – A listing, by source, of the amount of air pollutants discharged into the atmosphere of a community; used to establish emission standards.

Flow Rate – The rate, expressed in gallons -or litres-per-hour, at which a fluid escapes from a hole or fissure in a tank. Such measurements are also made of liquid waste, effluent, and surface water movement.

Fugitive Emissions – Emissions not caught by a capture system.

Hydrocarbons (HC) – Chemical compounds that consist entirely of carbon and hydrogen.

Hydrogen Sulphide (H_2S) – Gas emitted during organic decomposition. Also, a by-product of oil refining and burning. Smells like rotten eggs and, in heavy concentration, can kill or cause illness.

Inhalable Particles – All dust capable of entering the human respiratory tract.

Nitric Oxide (NO) – A gas formed by combustion under high temperature and high pressure in an internal combustion engine. NO is converted by sunlight and photochemical processes in ambient air to nitrogen oxide. NO is a precursor of ground-level ozone pollution, or smog.

Nitrogen Dioxide (NO_2) – The result of nitric oxide combining with oxygen in the atmosphere; major component of photochemical smog.

Nitrogen Oxides (NO_x) – A criteria air polluant. Nitrogen oxides are produced from burning fuels, including gasoline and coal. Nitrogen oxides are smog formers, which react with volatile organic compounds to form smog. Nitrogen oxides are also major components of acid rain.

Mobile Sources – Moving objects that release pollution; mobile sources include cars, trucks, buses, planes, trains, motorcycles and gasoline-powered lawn mowers.

Particulates; Particulate Matter (PM-10) – A criteria air pollutant. Particulate matter includes dust, soot and other tiny bits of solid materials that are released into and move around in the air. Particulates are produced by many sources, including burning of diesel fuels by trucks and buses, incineration of garbage, mixing and application of fertilizers and pesticides, road construction, industrial processes such as steel making, mining operations, agricultural burning (field and slash burning), and operation of fireplaces and woodstoves. Particulate pollution can cause eye, nose and throat irritation and other health problems.

Parts Per Billion (ppb)/Parts Per Million (ppm) – Units commonly used to express contamination ratios, as in establishing the maximum permissible amount of a contaminant in water, land, or air.

PM10/PM2.5 – PM10 is measure of particles in the atmosphere with a diameter of less than 10 or equal to a nominal 10 micrometres. PM2.5 is a measure of smaller particles in the air.

Point Source – A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g. a pipe, ditch, ship, ore pit, factory smokestack.

Scrubber – An air pollution device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Source – Any place or object from which pollutants are released.

Stack – A chimney, smokestack, or vertical pipe that discharges used air.

Stationary Source – A place or object from which pollutants are released and which does not move around. Stationary sources include power plants, gas stations, incinerators, houses etc.

Total suspended particulates – TSP is the measure of all particles that are suspended in air.

Temperature Inversion – One of the weather conditions that are often associated with serious smog episodes in some portions of the country. In a temperature inversion, air does not rise because it is trapped near the ground by a layer of warmer air above it. Pollutants, especially smog and smog-forming chemicals, including volatile organic compounds, are trapped close to the ground. As people continue driving and sources other than motor vehicles continue to release smog-forming pollutants into the air, the smog level keeps getting worse.

1 INTRODUCTION

Hodgson Quarry Products Pty Ltd have operated a sand extraction facility at Roberts Road, Maroota since approval was granted in May 2000. The approval is due to expire in May 2015; however, the resource has not been completely mined. This report provides a quantitative assessment of potential dust impacts of the proposed continuation of current operations at the existing facility until 2025, based on air quality monitoring results and dispersion modelling predictions. There is no proposed change in the approved extraction quantities.

The facility is located adjacent to the Old Northern Road at Maroota in **Figure 1-1**.

Consideration has been given to the previous air quality assessments and Conditions of Approval.

Figure 1-1 Locality Map

2 SITE DESCRIPTION, CURRENT & PROPOSED OPERATION

2.1 The Existing Site

The existing consent allows 50 laden truck movement per day. The approved hours are 6.00am to 6.00pm, Monday to Friday and 6.00am to 1.00pm on Saturday with the extraction and processing commencing at 7.00am. Loading of trucks is only permitted in the period 6.00am to 7.00am on all days. **Figure 2-2** shows the site truck route in blue.

The present operation involves extraction of material, stockpiling and processing (screening). **Figure 2-1** shows the existing processing plant. **Figure 2-2** shows the current location of the processing plant in green. The extraction on site is conducted with an excavator to win material and two dump trucks to transport to the processing plant. The processing plant includes pumps, screens, conveyers, cyclones.

There is intermittent need to use a dozer to rip the friable sandstone which generally occurs at lower levels within the quarry (RL195 with the exception of the north-western corner where it occurs up to RL205) and also an additional excavator to build mounds, remove topsoil and construct the final landform.

Figure 2-1 Existing Processing Plant

2.2 Surrounding Land Use and Sensitive Receptors

The land surrounding the site is rural, although there are a number of other sand quarries in the area. The nearest existing residences are shown in **Figure 2-2**. Residences are located to the east and south on the corner of Roberts Road and Old Telegraph Road (R1) and on the opposite side of Roberts Road (R2 & R3). One residence (R4) is located near the corner of Old Northern Road and Roberts Road. Residences are also located to the north on either side of Old Northern Road, one on the eastern side (R6) and one on the western side (R5).

Maroota Public School is located approximately 750 metres north of the mine site on Old Northern Road.

Figure 2-2 Sensitive Receptors

2.3 Future Operations

For future operations the extraction plan and excavation process is split into six stages as shown in **Figure 2-3**. The facility will develop further to the west and north for Stages 1-5 over a period of approximately 8 years, at which time the processing plant would be relocated to allow for the extraction of Stage 6 to include a cell near the northern boundary and the material beneath where the existing processing plant is located. It is noted that the lateral extent of the extraction will not exceed that of the approved development.

Operations also require further excavation and the emplacement of material to create the final landform. This would occur intermittently on a campaign basis, typically 2 weeks at a time, possibly once or twice per year, such that equipment / staff not needed to meet the supply of raw material would be utilised to haul material to the emplacement areas and an excavator to form the final landform.

Figure 2-3 Future Stages

The proposed extraction process requires an excavator and truck at surface level to remove the topsoil and overburden which is initially formed into perimeter bunds and remaining material is stockpiled. From this point onwards, the excavator works occur from below the surface and is able to pull material down from above.

The excavator and truck are therefore only at surface level for a small proportion of time (less than 10%) and most of this time it is operating behind a 5m bund wall relative to the nearest boundary.

With the exception of cells with suffix A, there is a need to rip Hawkesbury sandstone in the cells. The extraction operation includes the use of a dozer to rip. This occurs at RL195, with the exception of cells 4C and 6B where it will occur as high as RL205.

The extracted material then gets transported using a dump truck to the processing feed area, where a front end loader manages a few stockpiles to blend the different grades of sand as required before tipping into the power screen. Depending on the haul distance, either one or two dump trucks return to and from the processing plant area.

3 AIR QUALITY ASSESSMENT CRITERIA

3.1 NSW Air Quality Criteria

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The following section identifies the applicable air quality criteria for the potential air emissions that would be generated by the project.

Air quality goals relevant to this study relate to particulate matter and are sourced from the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005).

The air quality goals for the relevant particulate matter pollutants relate to the total pollutant burden in the air and not just the pollutant from the project. As such, consideration of background pollutant levels is required when using these goals to assess potential impacts.

Table 3-1 shows the criteria for each of the relevant dust metrics considered in this assessment.

Table 3-1 NSW EPA Air Quality Impact Assessment Criteria

Pollutant	Averaging Period	Impact	Criterion
Total suspended particulates (TSP)	Annual	Total	90 µg/m^3
Particulate matter ≤ 10µm (PM_{10})	Annual	Total	30 µg/m^3
	24-hour	Incremental	50 µg/m^3
Deposited dust (DD)	Annual	Incremental	2 g/m^2/month
	Annual	Total	4 g/m^2/month

There are currently no air quality goals for particulate matter ≤ 2.5 µm ($PM_{2.5}$) for projects within NSW. However, the National Environmental Protection Council (NEPC) has developed an advisory National Environmental Protection Measure (NEPM) for $PM_{2.5}$, as follows:

- A maximum 24 hour average concentration of 25 µg/m^3; and,
- An annual average concentration of 8 µg/m^3.

The above goals for $PM_{2.5}$ concentrations are considered advisory only.

3.2 Existing Consent

The existing Development Consent has the following conditions that deal with air quality:

Air Quality Criteria

28. The Applicant shall take all practical steps to manage the development so that the ambient air quality goals for total suspended particulates (TSP) of 90 ug/m^3 (annual average) and the dust deposition goal of 4g/m^2 (annual average) are not exceeded as a result of the development, when measured at any monitoring location specified in the Air Quality Management Plan.

Air Quality Management Plan

29. The Applicant shall prepare and implement an Air Quality Management Plan as part of the EMP.

The Air Quality Management Plan shall:

(a) identify existing and potential sources of dust deposition, TSP and fine particulates (PM10 and PM2.5) and specify appropriate monitoring intervals and locations. The purpose of the monitoring is to evaluate, assess and report on these emissions and the ambient impacts with the objective of understanding the development's contribution to levels of dust deposition, TSP and fine particulates in ambient air around the site;
(b) provide a monitoring plan having regard to local meteorology and relevant Australian Standards, identifying the methodologies to be used, including justification for monitoring intervals, weather conditions, seasonal variations, selecting locations, periods and times of measurements;
(c) provide details of dust suppression measures for all sources of dust from the development, including a planting and watering regime to ensure that no more than 3 hectares of the site are exposed and active at any one time. The use of a polymer in the water to minimise dust impacts shall be investigated as part of this Plan;
(d) provide details of actions to ameliorate impacts if they exceed the relevant criteria; and
(e) provide the design of the reactive management system intended to reduce the day to day impacts of dust and fine particulates due to the development.

30. Activities occurring at the premises must be carried out in a manner that will minimise emissions of dust from the premises.

31. The Applicant shall cease offending work at such times when the operations are resulting in visible dust emissions blowing in a direction as to cross onto public roads or lands not owned by the Applicant.

32. The Applicant shall install, operate and maintain a sprinkler system to adequately water all cleared areas and stockpiles so as to minimise dust emissions to acceptable levels.

33. The Applicant shall ensure that all vehicular movements on unsealed areas are restricted to specific routes and that all vehicles within the subject site keep to a speed limit of 30km/h.

34. The Applicant shall ensure that trucks are covered when entering and leaving the premises carrying loads of potentially dust generating material.

The existing Air Quality Management Plan that deals with the Conditions of Consent is presented in Appendix A.

4 LOCAL AIR QUALITY & CURRENT AIR QUALITY IMPACTS

Air quality standards and goals refer to pollutant levels which include the contribution from specific projects and existing sources.

The Development Consent conditions and Air Quality Management Plan required that PM_{10} and dust deposition be monitored to manage dust from the site. PM_{10} and dust deposition has been monitored since sand extraction began on the site. The monitoring locations are shown in **Figure 4-1.**

Figure 4-1 Dust Deposition & High Volume Air Sampler Monitoring Locations

The Project area is predominantly agricultural and mining land, although areas to the east of the site and the National Park are well vegetated. Sources of particulate matter in the area would include traffic on unsealed roads, mining activities, local building and construction activities, animal grazing activities and to a lesser extent traffic on roads.

The PM_{10} and dust deposition levels measured around the mine are summarised in **Table 4-1** and **Table 4-2**, respectively.

Table 4-1 PM_{10} Monitoring Results for the Hodgson Quarry Products Pty Ltd Sand Extraction Facility at Roberts Road

Year	Month	PM_{10} monthly averages 24 hour maximum (µg/m³)	
		NW HVAS	SE HVAS
2002	January	-	12
	February	-	12
	March	-	15
	April	-	16
	May	-	5
2008	April	18	33
	May	32	32
2011	November	14	14
	December	12	16
2012	January	4-	5
	February	< 2	< 2
	March	4	4
	April	< 2	4
	May	4	11
	June	11	7
	July	9	7
	August	8	11
	September	17	7
	October	15	16
	November	15	11
	December	6	6
2013	January	13	12
	February	22	17

Table 4-2 Dust Deposition Monitoring (g/m^2/month) Results for the Hodgson Quarry Products Pty Ltd Sand Extraction Facility at Roberts Road

Annual Averages	D1 Gate	D2 South East Corner	D3 Bund Wall	D3(a) Bund Wall
2005	5.7	1.5	4.8	-
2006	0.9	0.6	1.6	-
2007	<0.6	<0.6	<0.6	-
2008	1.6	1.3	1.8	-
2009	2.1	1.7	2.8	-
2010	1.2	1.4	1.9	-
2011	0.8	1.1	1.6	-
2012	0.8	1.2	1.30	1.96
2013	2.1	1.1	-	1.68
2014	0.96	1.1	-	2.86

The PM_{10} levels and dust deposition levels monitored for the life of the sand extraction facility indicated compliance with the EPA recommended air quality criteria of 50 µg/m^3 and 4 g/m^2/month.

An exceedance of the dust deposition criterion of 4 g/m^2/month was recorded in 2005; however, the monitoring reports suggest this was atypical due to the extended monitoring time the gauges were subject to, which lead to a build-up of bio-mass in the samples collected.

Typically, PM_{10} levels are approximately less than 50 percent of the TSP levels. As TSP levels were not monitored, and assuming this proportionality, it can be concluded that the TSP criterion of 90 µg/m^3 was also complied with for the life of the sand extraction facility.

5 LOCAL CLIMATE & DISPERSION METEOROLOGY & POTENTIAL DUST IMPACTS

Long-term climatic data from the Bureau of Meteorology weather station at Richmond RAAF were analysed to characterise the local climate in the proximity of the Project. The Richmond RAAF station is located approximately 20km south-west of the Project.

Table 5-1 presents a summary of data from the Richmond RAAF weather station collected over an approximate 30-year period.

The data indicates that January is the hottest month with a mean maximum temperature of 30ºC and July is the coldest month with mean minimum temperature of 3.6ºC.

Humidity levels exhibit variability over the day and seasonal fluctuations. Mean 9.00am humidity levels range from 58 per cent in October to 82 per cent in May. Mean 3.00pm humidity levels vary from 39 per cent in August to 53 per cent in June. Rainfall peaks during the summer months and declines during winter. The data shows February is the wettest month with an average rainfall of 122.9 mm over 8.4 days and July is the driest month with an average rainfall of 28.5 mm over 3.9 days.

Table 5-1 Monthly Climate Statistics Summary – Richmond RAAF

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean max. temperature (ºC)	30.0	29.0	26.8	23.9	20.7	17.9	17.6	19.8	22.9	25.1	26.7	28.5
Mean min. temperature (ºC)	17.6	17.7	15.6	11.5	7.5	5.1	3.6	4.4	8.0	10.9	14.1	15.9
Rainfall												
Rainfall (mm)	75.7	122.9	75.8	48.6	48.9	47.5	28.5	33.2	47.0	50.6	82.7	59.8
Mean No. of rain days (≥1mm)	7.5	8.4	7.9	5.9	5.5	5.6	3.9	3.5	4.5	5.7	7.9	6.4
9am Conditions												
Mean temperature (ºC)	22.1	21.3	19.1	17.0	13.1	10.0	8.9	11.4	15.4	18.3	19.2	20.9
Mean relative humidity (%)	72	78	80	76	82	83	80	69	63	58	68	68
Mean wind speed (km/h)	9.1	8.1	6.6	6.9	5.7	6.3	5.9	8.1	9.9	10.3	9.9	8.9
3pm Conditions												
Mean temperature (ºC)	28.5	27.4	25.8	23.0	19.7	17.0	16.5	18.7	21.5	23.5	25.2	27.5
Mean relative humidity (%)	47	52	52	49	53	53	48	39	39	40	46	44
Mean wind speed (km/h)	16.6	15.6	14.7	14.4	12.6	13.5	14.3	17.7	19.4	19.1	19.0	17.7

Source: Bureau of Meteorology, 2013

As the closest BOM metrological station is at Richmond RAAF, approximately 20km from the site, prognostic meteorological data was generated using The Air Pollution Model (TAPM), developed by the CSIRO to investigate site-specific wind conditions.

The site has a meteorological station; however, this is only used as a reactive dust management tool.

The prognostic modelling domain was centred at 33° 27′ S, 151° 0′ E and involved four nesting grids of 30 km, 10 km, 3 km and 1km with 25 vertical levels.

Observations of wind speed and direction from the BoM AWS at Richmond RAAF were assimilated into the TAPM model to refine details of local winds.

Windrose plots showing the distribution of wind direction and wind speed at Maroota for 2012 are presented for day, night and 24hour day in **Figure 5-1**, **Figure 5-2** and **Figure 5-3** respectively.

The prevailing wind directions for Maroota are presented **Table 5-2**.

Table 5-2 Predominant Maroota Season Wind Direction in the Day & Night

Season	Predominant Wind Direction	
	Day	**Night**
Autumn	North-easterly	North-easterly
Winter	South-westerly	North-westerly
Spring	Easterly	Northerly
Summer	Easterly	North-easterly

Figure 5-1 Windrose Plots – Maroota 2012 - Daytime

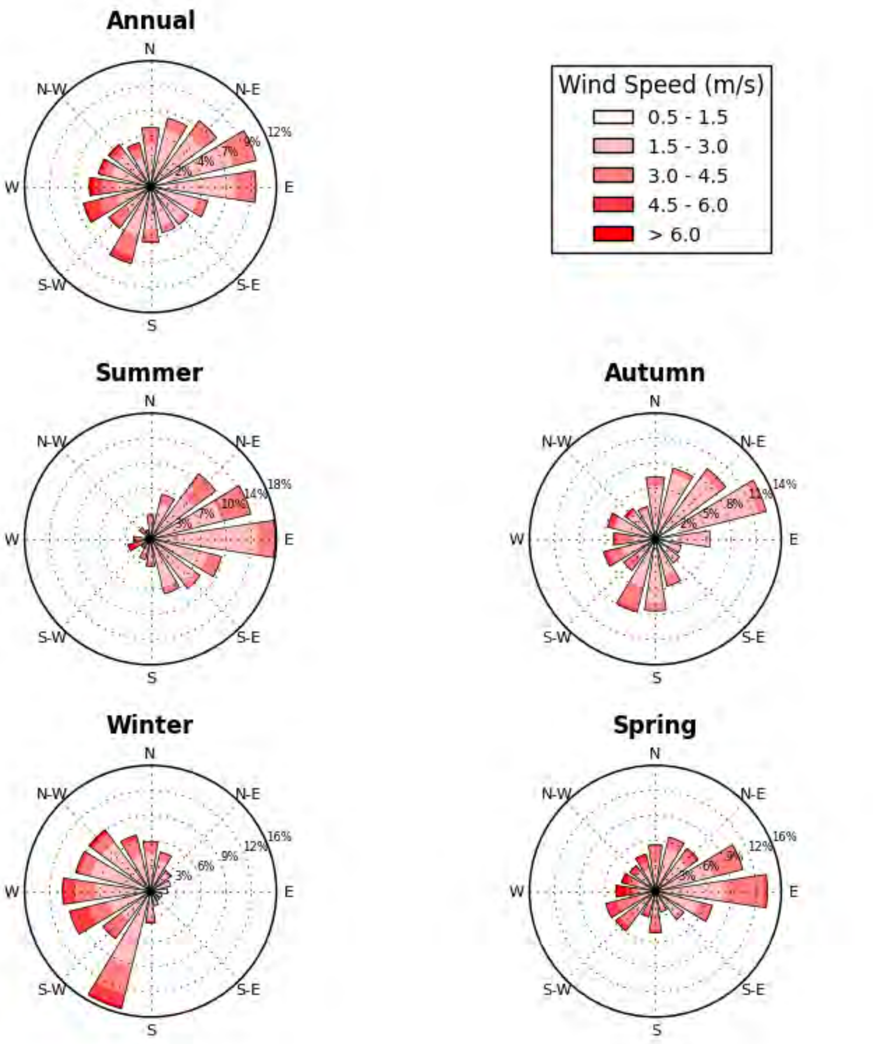


Figure 5-2 Windrose Plots – Maroota 2012 – Night Time

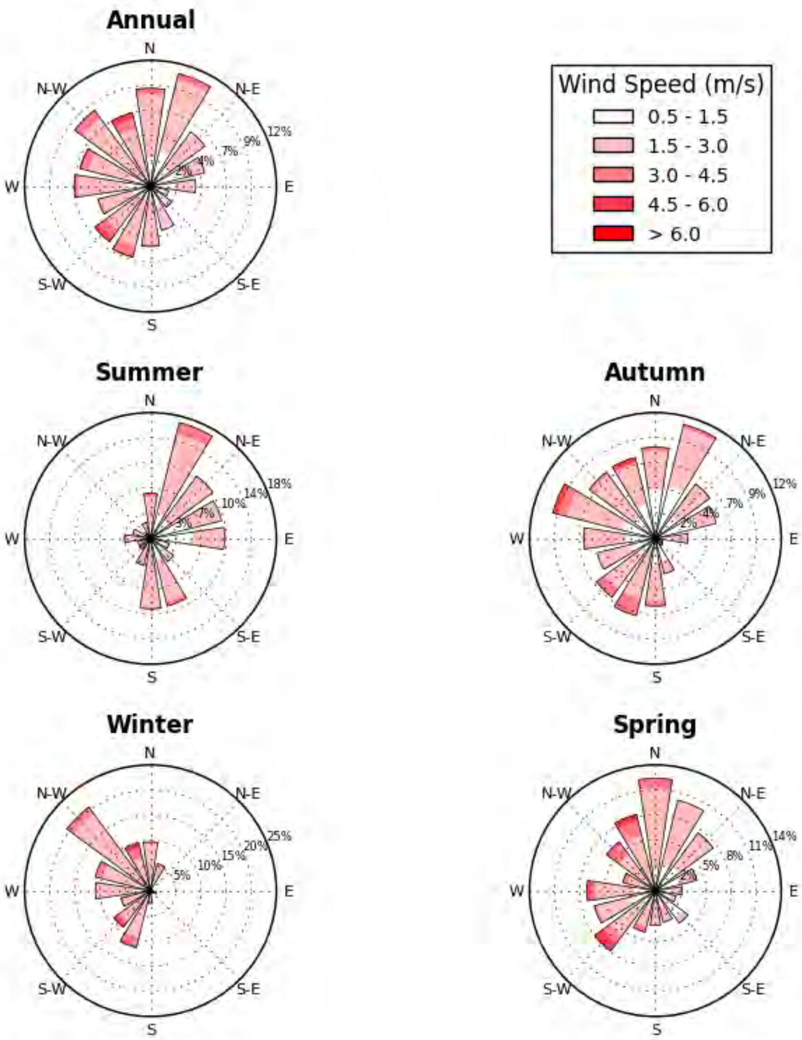
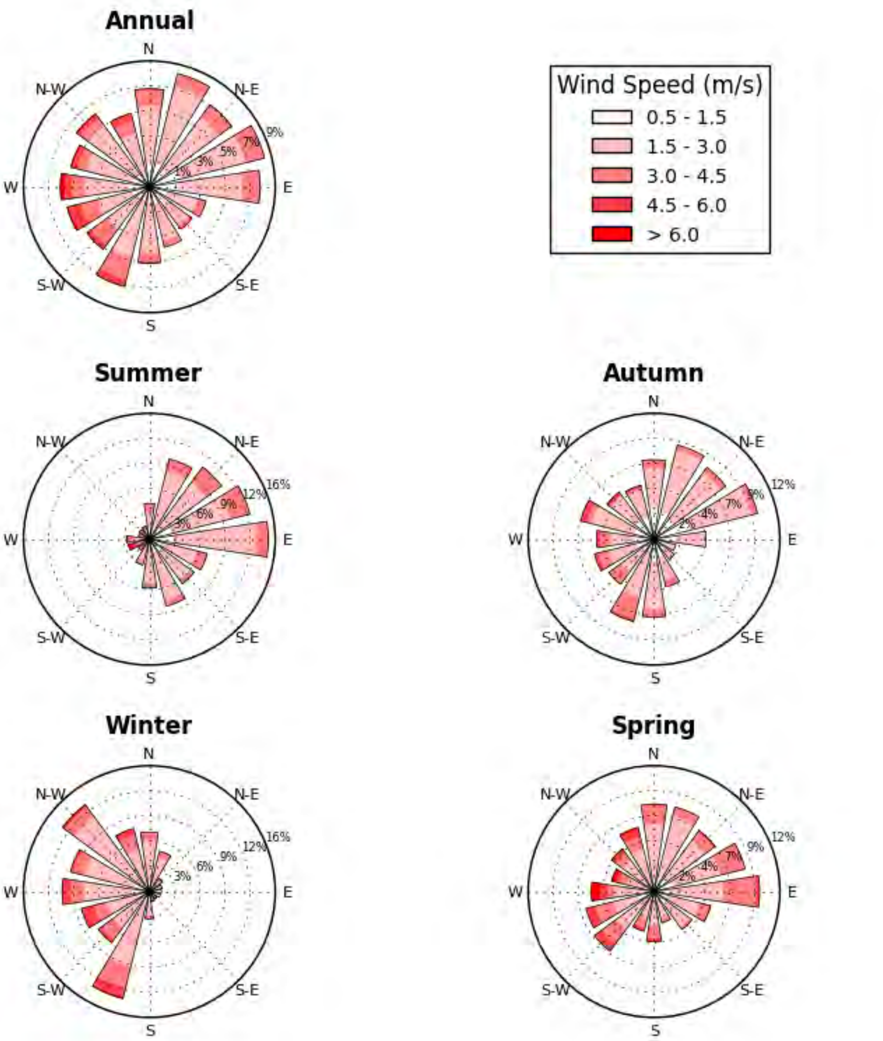


Figure 5-3 Windrose Plots – Maroota 2012 – Annual



6 MODELLING METHODOLOGY

6.1 Meteorological Modelling

6.1.1 TAPM

No meteorological observation data is available for the site. Therefore, site-specific meteorological data was generated through the use of a prognostic model. The prognostic model used was The Air Pollution Model (TAPM), developed and distributed by the Commonwealth Scientific and industrial Research Organisation (CSIRO).

TAPM is an incompressible, non-hydrostatic, primitive equations prognostic model with a terrain-following vertical coordinate for three-dimensional simulations. It predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of large scale meteorology provided by synoptic analyses. TAPM benefits from having access to databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature, and synoptic scale meteorological analyses for various regions around the world.

The prognostic modelling domain was centred at 33° 27′ S, 151° 0′ E and involved four nesting grids of 30 km, 10 km, 3 km and 1km with 25 vertical levels.

The TAPM model included assimilation of data collected at the Richmond RAAF AWS during the year 2012.

6.1.2 AERMET

The TAPM results, including predictions of wind speed, wind direction, temperature, humidity, cloud cover, solar radiation and rainfall, were used as inputs to AERMET – AERMOD's meteorological pre-processor. AERMET uses the TAPM data, along with land use data, to calculate mixing heights and velocity scaling parameters.

6.2 Dispersion Modelling

6.2.1 AERMOD

The dispersion model chosen for this assessment was AERMOD – the US EPA regulatory Gaussian plume air dispersion model.

AERMOD is a steady state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts. It includes treatment of both surface and elevated sources, and both simple and complex terrain.

6.2.2 Building Wake Effects

All emissions associated with this development were modelled using volume sources, which are not affected by building wakes.

7 EMISSIONS TO AIR

Dust emissions from the proposed Project have been estimated for all significant dust generating activities based on information provided by the client, using emission factors sourced from both locally developed and US EPA developed documentation. Total dust emissions from all significant dust generating activities for the Project are presented below. Detailed emission inventory and emission estimation calculations are presented in Appendix B.

Three extraction scenarios have been identified for assessment purposes. These scenarios are considered to represent the range of worst case future site operations. Extraction in the North West and South East corners of the site will bring activities closest to sensitive receptors in those areas, while moving the material processing area to the North East corner of the site will represent the worst case scenario for receptors in that vicinity.

7.1 North West Extraction

Estimated TSP and PM_{10} emissions during the North West extraction scenario are presented below in **Table 7-1**. The source locations adopted in the dispersion modelling for this scenario are shown in **Figure 7-1**.

Table 7-1 Emissions estimation – North West extraction

Activity	Emissions (kg/day)	
	TSP	**PM_{10}**
Dozer ripping face	13.34	1.99
Loading raw material into dump trucks	0.77	0.36
Dump truck unloading	1.15	0.55
Loading hopper	1.54	0.73
Screening	16.25	5.59
Unloading to stockpile	0.25	0.12
Loading processed material into trucks	1.18	0.56
Haul road - Outgoing	9.38	2.01
Haul road - Raw Material	7.65	1.64
Wind erosion - Extraction Area	2.40	1.20
Wind erosion - Processing Area	4.80	2.40
Total		
	58.73	**17.14**

Figure 7-1 Source locations - North West extraction

7.2 North East Processing

Estimated TSP and PM_{10} emissions during the North East processing scenario are presented below in **Table 7-2**. The source locations adopted in the dispersion modelling for this scenario are shown in **Figure 7-2**.

Table 7-2 Emissions estimation – North East processing

Activity	Emissions (kg/day)	
	TSP	PM_{10}
Dozer ripping face	13.34	1.99
Loading raw material into dump trucks	0.77	0.36
Dump truck unloading	1.15	0.55
Loading hopper	1.54	0.73
Screening	16.25	5.59
Unloading to stockpile	0.25	0.12
Loading processed material into trucks	1.18	0.56
Haul road - Outgoing	7.21	1.54
Haul road - Raw Material	5.89	1.26
Wind erosion - Extraction Area	2.40	1.20
Wind erosion - Processing Area	4.80	2.40
Total		
	54.80	**16.30**

Figure 7-2 Source locations - North East processing

7.3 South East Extraction

Estimated TSP and PM_{10} emissions during the North East extraction scenario are presented below in **Table 7-3**. The source locations adopted in the dispersion modelling for this scenario are shown in **Figure 7-3**.

Table 7-3 Emissions estimation – South East extraction

Activity	Emissions (kg/day)	
	TSP	**PM_{10}**
Dozer ripping face	13.34	1.99
Loading raw material into dump trucks	0.77	0.36
Dump truck unloading	1.15	0.55
Loading hopper	1.54	0.73
Screening	16.25	5.59
Unloading to stockpile	0.25	0.12
Loading processed material into trucks	1.18	0.56
Haul road - Outgoing	11.90	2.55
Haul road - Raw Material	9.72	2.08
Wind erosion - Extraction Area	2.40	1.20
Wind erosion - Processing Area	4.80	2.40
Total		
	63.31	**18.12**

Figure 7-3 Source locations - South East extraction

8 ASSESSMENT OF IMPACTS

The following section presents the results of dispersion modelling and assesses the potential for air quality impacts in accordance with the impact assessment criteria introduced in Section 3.1.

The calculation of total concentrations requires that the incremental impact, as predicted by the dispersion model, is added to the background concentration for each pollutant of interest. Most importantly, the background concentrations used to predict total impacts should not be influenced by the current site operations.

Based on the range of monitoring results presented in Section 4, the background PM_{10} ground level concentration in the area is approximately 10 µg/m^3.

Estimates of the annual average background TSP concentrations can be determined from a relationship between TSP and PM_{10}. This relationship assumes that PM_{10} accounts for approximately 40% of TSP. This relationship was established as part of a review of ambient monitoring data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (NSW Minerals Council, 2000).

Applying this relationship with the estimated background PM_{10} concentration gives an estimated background TSP concentration of 25 µg/m^3.

To estimate annual average dust deposition levels, a similar process to the TSP estimation method is used. This approach assumes that a TSP concentration of 90µg/m^3 will have an equivalent dust deposition value of 4g/m^2/month.

This relationship indicates a background annual average dust deposition of 1.1g/m^2/month for the area surrounding the project.

8.1 PM_{10} Impact Assessment

The maximum predicted incremental and total 24 hour average ground level concentrations of PM_{10} at each sensitive receptor are presented in **Table 8-1** and **Table 8-2**, respectively.

Table 8-1 24 hour average PM_{10} - incremental impact

Receptor	Ground Level Concentration (µg/m^3)		
	North West	North East	South East
R1	7	31	8
R2	18	39	17
R3	21	18	23
R4	5	7	17
R5	14	10	4
R6	10	6	5

Table 8-2 24 hour average PM_{10} - total impact

Receptor	Ground Level Concentration (µg/m³)			Criteria (µg/m³)	Complies?
	North West	North East	South East		
R1	17	41	18	50	Yes
R2	28	49	27	50	Yes
R3	31	28	33	50	Yes
R4	15	17	27	50	Yes
R5	24	20	14	50	Yes
R6	20	16	15	50	Yes

Review of **Table 8-2** indicates that the total 24 hour average PM_{10} concentrations comply with the impact assessment criterion of 50 µg/m³ at all sensitive receptors.

Contour plots of the incremental 24 hour average PM_{10} impacts due to each extraction scenario are presented in Appendix C.

The maximum predicted incremental and total annual average ground level concentrations of PM_{10} at each sensitive receptor are presented in **Table 8-3** and **Table 8-4**, respectively.

Table 8-3 Annual average PM_{10}– incremental impact

Receptor	Ground Level Concentration (µg/m³)		
	North West	North East	South East
R1	1	4	1
R2	1	5	2
R3	2	4	2
R4	1	1	4
R5	1	0	0
R6	1	0	0

Table 8-4 Annual average PM_{10}– total impact

Receptor	Ground Level Concentration (µg/m³)			Criteria (µg/m³)	Complies?
	North West	North East	South East		
R1	11	14	11	30	Yes
R2	11	15	12	30	Yes
R3	12	14	12	30	Yes
R4	11	11	14	30	Yes
R5	11	10	10	30	Yes
R6	11	10	10	30	Yes

Review of **Table 8-4** indicates that the total annual average PM_{10} concentrations comply with the impact assessment criterion of 30 µg/m³ at all sensitive receptors.

8.2 TSP Impact Assessment

The maximum predicted incremental and total annual average ground level concentrations of TSP at each sensitive receptor are presented in **Table 8-5** and **Table 8-6**, respectively.

Table 8-5 Annual average TSP– incremental impact

Receptor	Ground Level Concentration (µg/m^3)		
	North West	North East	South East
R1	2	8	2
R2	32	10	4
R3	4	8	5
R4	2	1	10
R5	3	1	1
R6	2	1	1

Table 8-6 Annual average TSP– total impact

Receptor	Ground Level Concentration (µg/m^3)			Criteria (µg/m^3)	Complies?
	North West	North East	South East		
R1	27	33	27	90	Yes
R2	57	35	29	90	Yes
R3	29	33	30	90	Yes
R4	27	26	35	90	Yes
R5	28	26	26	90	Yes
R6	27	26	26	90	Yes

Review of **Table 8-6** indicates that the total annual average TSP concentrations comply with the impact assessment criterion of 90 µg/m^3 at all sensitive receptors.

8.3 Deposited Dust

The maximum predicted incremental and total annual average dust deposition levels at each sensitive receptor are presented in **Table 8-7** and **Table 8-8**, respectively.

Table 8-7 Annual average deposited dust– incremental impact

Receptor	Ground Level Concentration (g/m^2/month)			Criteria (g/m^2/month)	Complies?
	North West	North East	South East		
R1	0.1	0.6	0.1	2	Yes
R2	0.1	0.6	0.2	2	Yes
R3	0.2	0.4	0.3	2	Yes
R4	0.1	0.1	0.5	2	Yes
R5	0.2	0.0	0.1	2	Yes
R6	0.1	0.0	0.0	2	Yes

Review of **Table 8-7** indicates that the annual average incremental dust deposition levels comply with the impact assessment criterion of 2 g/m^2/month at all sensitive receptors.

Table 8-8 Annual average deposited dust– total impact

Receptor	Ground Level Concentration (g/m^2/month)			Criteria (g/m^2/month)	Complies?
	North West	North East	South East		
R1	1.2	1.7	1.2	4	Yes
R2	1.2	1.7	1.3	4	Yes
R3	1.3	1.5	1.4	4	Yes
R4	1.2	1.2	1.6	4	Yes
R5	1.3	1.1	1.2	4	Yes
R6	1.2	1.1	1.1	4	Yes

Review of **Table 8-8** indicates that the annual average total dust deposition levels comply with the impact assessment criterion of 4 g/m^2/month at all sensitive receptors.

9 CONCLUSIONS

This study has assessed the potential dust impacts associated with the proposed continuation of the Hodgson Quarry Products Pty Ltd sand extraction facility at Roberts Road, Maroota.

For existing sand extraction operations, PM_{10} and dust deposition levels recorded from approximately 2002 have been reviewed. It was found that the TSP, PM_{10} and dust deposition levels monitored for the life of the sand extraction facility indicated compliance with the EPA recommended air quality criteria of 50 µg/m^3 and 4 g/m^2/month.

Dispersion modelling results for the three worst case future extraction scenarios indicated that the continued operation of the site is unlikely to impact on sensitive receptors providing that the application of dust mitigation measures identified in the existing air quality management plan continues.

APPENDIX A

AIR QUALITY MANAGEMENT PLAN

Air Quality Management Plan

1. Objectives

- To minimise and manage dust generated from the operation and maintain dust levels below EPA criteria.

2. Targets

- No complaints received, with monitoring showing that criteria are being met.

3. Air Quality Goals

- Total suspended particulates (TSP) not to exceed 90 µg/m3 (annual average).
- Fine particulates (PM10) not to exceed 50 µg/m3 (24 hour).
- Dust deposition not to exceed 4 g/m2/mth (annual average).

4. Licences/ Permits

- Development consent issued by Minister for Urban Affairs and Planning (Ref 598/00772) issued 31 May, 2000.
- Modification to development consent 598/00772 issued by the Minister for Urban Affairs and Planning on 29 November, 2000.
- EPA Licence 6535 - expiring 12 March 2012.

5. References

- Consent conditions 28, 29, 30, 31, 32, 33, 34, 35, 36, 37;
- EIS (1999) Sections 3.4, 6.2, 7.6, 8.2 and Appendix 10.

6. Existing Environment and Background

Examination of aerial photography from 1998 indicates approximately 7 to 8 hectares of area was exposed at this site at this time. At present approximately 2.6 Ha are regularly trafficked as the remainder is either not in use or inaccessible. Consent conditions granted in the year 2000 stipulate that no more than 3 hectares of area is to be exposed. Clearly the site was never compliant with this condition but the intention of the condition was to ensure dust levels remained below guideline levels.

HB Maroota is required under the Conditions of Consent to manage dust emissions such that they do not exceed 90 µg/m3 (annual average) for TSP and dust deposition is not to exceed 4 g/m2/mth (annual average). There are no specific limits set under the EPA licence.

It has been past practice to monitor the site for fine particulates (PM10) by High Volume Air Sampling (HVAS) however HVAS's have not been monitored regularly to assess the effectiveness of control measures and seasonal variations. This has been noted in the most recent site Audit undertaken by Umwelt Pty Ltd in 2011. At the time of this report writing further testing is underway and results to date are attached. Results indicate the quarry is compliant with the limits set.

Regular depositional dust monitoring has been undertaken monthly.

There have been no dust complaints received by the quarry. Both the Depositional Dust Gauge monitoring and High Volume Air Sampling indicate that although the area exposed is greater than 3 hectares the dust mitigation measure are working.

The compliance of the depositional dust monitoring gauges with the Australian Standards was reviewed in the Umwelt 2011 Audit and several issues must be addressed. It was noted that some gauges do not have a 120 degree clear sky angle and that a review of the dust gauge locations should be undertaken. In Addition some of the gauges pose a safety risk to personnel due to their accessibility. In this regard new locations will be implemented as soon as practicable and are shown on Figure Thirteen.

A new metrological station measuring wind speed and direction is in the process of being installed on the site as previous instruments have malfunctioned. The OEH has been informed of the position of the station (see Figure Four) via correspondence date the 28th of July 2011. The letter stated that if no response was received within 14 days that it would be assumed that the matter is acceptable to the Office. Since no response was forthcoming the proposed site has now been deemed acceptable to the Office.

7. Dust Sources

- Bulldozer on the clay extraction areas and front-end loader on the quarry floor;
- Front-end loader loading product sand into trucks;
- Trucks transporting product sand off site;
- wind erosion from exposed clay drying areas, clay and sand stockpiles.
- Dry stockpiles.

8. Proposed Activities and Procedures

8.1. Extraction and Processing

- No more than 3 hectares is to be exposed and active at any one time.
- Progressively rehabilitate the site, where possible, to minimise the area exposed to wind erosion (Refer to Appendix J Rehabilitation Plan)
- Potential dust generating material is to be processed and stored in a damp condition.
- A water cart is to be used to water internal roads, stockpiles and cleared areas to reduce dust generating potential.
- If monitoring finds that criteria are not being met, installation of a fixed sprinkler system to water cleared areas and stockpiles will be investigated.
- A polymer in the water to assist in minimising dust impacts will be used if dust monitoring indicates that targets are not being met.

8.2. Transportation

- All vehicle movements on unsealed areas are to be restricted to internal haul roads and working areas.
- Vehicle speeds on the quarry site are to be restricted to 20 km/hr.
- All trucks entering and leaving quarry which are carrying loads to be covered.

8.3. Wind Breaks and Bunds

- Wind breaks of natural vegetation around the boundary of the site are to be established and maintained in accordance with the Rehabilitation Plan.
- Bund walls are to be constructed at the corner of Roberts Road and Old Northern Road.

9. Summary of Progress

Table 1. Progress to Date

Item	Activity	Completed
Extraction and Processing	· No more than 3 hectares is to be exposed and active at any one time	Incomplete
	· Progressively rehabilitate the site to minimise the area exposed to wind erosion	Ongoing
	· Potential dust generating material is to be processed and stored in a damp condition	Ongoing
	· A water cart is to be used to water internal roads, stockpiles and cleared areas to reduce dust generating potential	Ongoing
	· If monitoring finds that criteria are not being met, installation of a fixed sprinkler system to water cleared areas and stockpiles will be investigated.	Not required as yet
	· A polymer in the water to assist in minimising dust impacts will be used if dust monitoring indicates that targets are not being met.	Not required as yet
Transportation	· All vehicle movements on unsealed areas are to be restricted to internal haul roads and working areas.	Ongoing
	· Vehicle speeds on the quarry site are to be restricted to 20 km/hr.	Ongoing
	· All trucks entering and leaving quarry which are carrying loads to be covered	Ongoing
Windbreaks and Bunds	· Wind breaks of natural vegetation around the boundary of the site are to be established and maintained in accordance with the Rehabilitation Plan.	Incomplete
	· Bund walls are to be constructed at the corner of Roberts Road and Old Northern Road.	Completed 2001
Monitoring	· Monthly independent Depositional Dust monitoring	Ongoing
	· Monitoring of HVAS to determine compliance with predictions from EIS. Discuss results with OEH and DPI.	Ongoing
	· A weather station measuring wind speed and direction is to be installed and operated continuously.	Ongoing

Item	Activity	Completed
	· location will be discussed with the OEH to confirm appropriateness prior to installation	Completed 14/8/2011
	· A flashing light or similar notification will be installed on the station to show when wind speeds are above 10 metres/second	Incomplete

10. Monitoring

- Dust deposition is to monitored monthly at the gauge locations shown on Figure Twelve.
- Indicative positions of relocated dust deposition gauges are shown in Figure Thirteen. Exact positions will be recorded by GPS Co-ordinates when positions are finalised.
- High volume air samplers (TSP, PM10) are to be installed for a period of three months (commencing in October 2011) to determine compliance with predictions from EIS (that predicted operations would be below criteria). TSP and PM10 are to be monitored for a period of 24 hours every six days. At the end of the three month period results will be discussed with the OEH and DPI to determine the need for ongoing monitoring.
- A weather station measuring wind speed and direction is to be installed and operated continuously at the location shown on the Figure Four. This location will be discussed with the OEH to confirm appropriateness prior to installation. Information from this station will be used in the assessment of HVAS results, to ensure that a variety of representative wind conditions was experienced during the trial period. A flashing light or similar notification will be installed on the station to show when wind speeds are above 10 metres/second. This will alert operators to consider more frequent use of the water truck or a reduction in dust generating activities.
- All staff are to be trained in methods to reduce dust and to notify the Plant Manager or delegate of activities generating excessive dust.
- Any complaints regarding dust are to be recorded in the complaints logbook (refer Section 6.5).

11. Reporting

- Conditions Compliance Report to the DPI annually for 2001, 2001, 2003 to report monthly dust deposition results, HVAS results and interpretation and discussion of results and any complaints received relating to dust and actions taken to mitigate complaints.
- Annual Return to the EPA to be submitted 11 May each year (60 days after licence renewal date of 12 March), including monitoring and complaints summary and Statement of Compliance.

12. Emergency Response

- Works to cease when the operation is resulting in visible dust blowing across public roads or lands not owned by Dr L.S.Martin.

- Operating procedures to be reviewed after works ceased to minimise dust generation - e.g.: extraction or processing to cease.

13. Responsibility

- Plant Manager - for monitoring dust and implementing measures to reduce dust, e.g.: deploying water truck.
- Truck drivers on site - for adhering to speed restrictions and covering loads.
- All staff - for identifying excessive dust generating activities and reducing dust accordingly.

APPENDIX B

EMISSIONS INVENTORY

B.1 Particulate Emission Factor Equations

Haul roads

Wheel generated particulate emissions associated with material haulage are estimated using the following US EPA emission factors (US EPA, 1985 and updates):

$$E[kg/VKT] = 0.2819 \times a \times \left(\frac{s}{12}\right)^b \times \left(\frac{1.1023 \times W}{3}\right)^{0.45}$$

Where:

a = 4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$

b = 0.7 for TSP and 0.9 for PM_{10} and $PM_{2.5}$

s = silt content [%] of road surface

W = weight of vehicle [t]

Particulate emissions from vehicles travelling along sealed haul roads have been estimated using the above equations, and including a control factor of 90%.

Loading / unloading / transferring material

Each tonne of material handles will generate quantities of particulate matter that will depend on the wind speed and the moisture content of the material according to the US EPA emission factor (US EPA, 1985 and updates) shown below:

$$E[kg/t] = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2.0}\right)^{1.4}}\right)$$

Where:

k = 0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$

U = wind speed [ms^{-1}]

M = moisture content [%]

The wind speed is taken as the average wind speed from the TAPM dataset.

Dozers shaping fill material

Particulate emissions for dozers have been estimated using US EPA emission factor equations (US EPA, 1985 and updates) for dozers on overburden as follows:

$$E[kg/h] = a \times \left(\frac{s^b}{M^c}\right)$$

Where:

a = 2.6 for TSP, 0.8775 for PM_{10} and 0.273 for $PM_{2.5}$

b = 1.2 for TSP, 1.5 for PM_{10} and 1.2 for $PM_{2.5}$

c = 1.3 for TSP, 1.4 for PM_{10} and 1.3 for $PM_{2.5}$

s = silt content [%]

M = moisture content [%]

Wind erosion

Particulate emission factors for wind erosion, taken from the NPI (NPI, 2012), are 0.4 kg/ha/h for TSP and 0.2 kg/ha/h for PM_{10}

Screening

Particulate emission factors for screening concrete have been taken from the US EPA (US EPA, 1985 and updates) and are summarised below:

Activity	Emission Factor [kg/t]		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Screening (uncontrolled)	0.0125	0.0043	*

* No emissions data available

B.2 Emission Estimates

Table B-1 Summary of TSP Emissions – North West extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	13.34	11	hours/day	2.426	kg/hr	1.0	machines	2.425885778	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.77	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	4.68	24	trucks/day	0.396	kg/truck	0.3	km/trip (one way)	1.524329448	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	1.15	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	2.97	24	trucks/day	0.251	kg/truck	0.3	km/trip (one way)	0.966894584	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	1.54	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	16.25	1300	t/day	0.0125	kg/t									
unloading to stockpile	0.25	1000	t/day	0.000254321	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	3.55	31	trucks/day	0.227	kg/truck	0.3	km/trip (one way)	0.874519749	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	1.18	1000	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	5.82	31	trucks/day	0.373	kg/truck	0.3	km/trip (one way)	1.433752493	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	4.80	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					
Wind Erosion - Pit	2.40	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					50
TOTAL	**58.73**													

Table B-2 Summary of PM_{10} Emissions – North West extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	1.99	11	hours/day	0.362	kg/hr	1.0	machines	0.361723544	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.36	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	1.00	24	trucks/day	0.085	kg/truck	0.3	km/trip (one way)	0.33	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	0.55	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	0.64	24	trucks/day	0.054	kg/truck	0.3	km/trip (one way)	0.21	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	0.73	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	5.59	1300	t/day	0.0043	kg/t									
unloading to stockpile	0.12	1000	t/day	0.000120287	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	0.76	31	trucks/day	0.049	kg/truck	0.3	km/trip (one way)	0.19	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	0.56	1000	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	1.25	31	trucks/day	0.080	kg/truck	0.3	km/trip (one way)	0.31	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	2.40	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					
Wind Erosion - Pit	1.20	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					50
TOTAL	**17.14**													

Table B-3 Summary of TSP Emissions – North East processing

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	13.34	11	hours/day	2.426	kg/hr	1.0	machines	2.425885778	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.77	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	3.60	24	trucks/day	0.305	kg/truck	0.2	km/trip (one way)	1.524329448	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	1.15	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	2.29	24	trucks/day	0.193	kg/truck	0.2	km/trip (one way)	0.966894584	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	1.54	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	16.25	1300	t/day	0.0125	kg/t									
unloading to stockpile	0.25	1000	t/day	0.000254321	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	2.73	31	trucks/day	0.175	kg/truck	0.2	km/trip (one way)	0.874519749	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	1.18	1000	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	4.48	31	trucks/day	0.287	kg/truck	0.2	km/trip (one way)	1.433752493	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	4.80	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					
Wind Erosion - Pit	2.40	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					50
TOTAL	**54.80**													

Table B-4 Summary of PM_{10} Emissions – North East processing

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	1.99	11	hours/day	0.362	kg/hr	1.0	machines	0.361723544	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.36	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	0.77	24	trucks/day	0.065	kg/truck	0.2	km/trip (one way)	0.33	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	0.55	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	0.49	24	trucks/day	0.041	kg/truck	0.2	km/trip (one way)	0.21	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	0.73	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	5.59	1300	t/day	0.0043	kg/t									
unloading to stockpile	0.12	1000	t/day	0.000120287	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	0.58	31	trucks/day	0.037	kg/truck	0.2	km/trip (one way)	0.19	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	0.56	1000	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	0.96	31	trucks/day	0.061	kg/truck	0.2	km/trip (one way)	0.31	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	2.40	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					
Wind Erosion - Pit	1.20	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					50
TOTAL	**16.30**													

Table B-5 Summary of TSP Emissions – South East extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	13.34	11	hours/day	2.426	kg/hr	1.0	machines	2.425885778	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.77	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	5.94	24	trucks/day	0.503	kg/truck	0.3	km/trip (one way)	1.524329448	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	1.15	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	3.77	24	trucks/day	0.319	kg/truck	0.3	km/trip (one way)	0.966894584	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	1.54	1300	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	16.25	1300	t/day	0.0125	kg/t									
unloading to stockpile	0.25	1000	t/day	0.000254321	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	4.51	31	trucks/day	0.289	kg/truck	0.3	km/trip (one way)	0.874519749	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	1.18	1000	t/day	0.001184	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	7.39	31	trucks/day	0.473	kg/truck	0.3	km/trip (one way)	1.433752493	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	4.80	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					
Wind Erosion - Pit	2.40	24	hours/day	0.200	kg/h	0.5	area [ha]	0.4	kg/ha/h					50
TOTAL	**63.31**													

Table B-6 Summary of PM_{10} Emissions – South East extraction

Activity	Emission [kg/day]	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Control [%]
dozer ripping face	1.99	11	hours/day	0.362	kg/hr	1.0	machines	0.361723544	kg/hr	2.00	silt content [%]	2	moisture content [%]	50
loading dump truck	0.36	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					50
dump truck hauling to washery	1.27	24	trucks/day	0.108	kg/truck	0.3	km/trip (one way)	0.33	kg/VKT	55	vehicle mass [t]	2	silt content [%]	50
dump truck unloading	0.55	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					25
dump truck returning to face	0.81	24	trucks/day	0.068	kg/truck	0.3	km/trip (one way)	0.21	kg/VKT	20	vehicle mass [t]	2	silt content [%]	50
loading washery hopper	0.73	1300	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
screening	5.59	1300	t/day	0.0043	kg/t									
unloading to stockpile	0.12	1000	t/day	0.000120287	kg/t	2.2	wind speed [m/s]	6.00	moisture content [%]					
empty trucks entering site	0.96	31	trucks/day	0.062	kg/truck	0.3	km/trip (one way)	0.19	kg/VKT	16	vehicle mass [t]	2	silt content [%]	50
loading trucks	0.56	1000	t/day	0.00056	kg/t	2.2	wind speed [m/s]	2.00	moisture content [%]					
loaded trucks leaving site	1.58	31	trucks/day	0.101	kg/truck	0.3	km/trip (one way)	0.31	kg/VKT	48	vehicle mass [t]	2	silt content [%]	50
Wind Erosion - Washery	2.40	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					
Wind Erosion - Pit	1.20	24	hours/day	0.100	kg/h	0.5	area [ha]	0.20	kg/ha/h					50
TOTAL	**18.12**													

APPENDIX C

CONTOUR PLOTS

Figure C-1 24 hour PM_{10} Concentration [µg/m³] – North West extraction

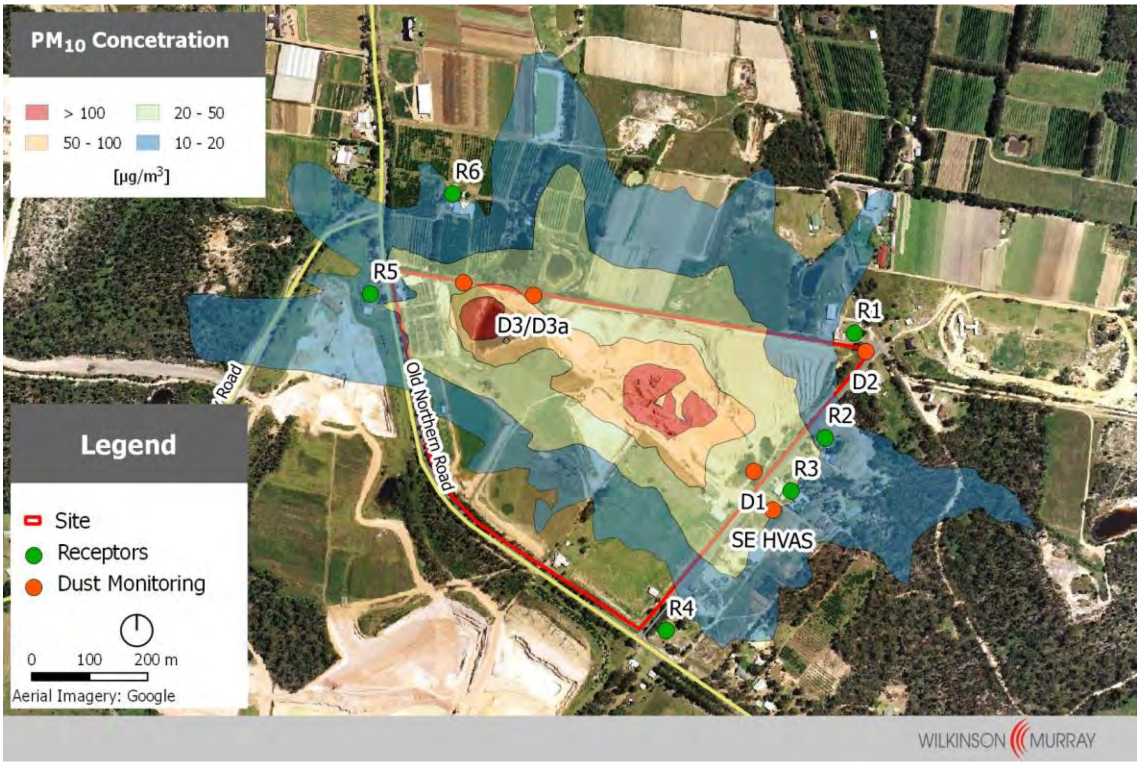


Figure C-2 24 hour PM_{10} Concentration [µg/m³] – North East processing

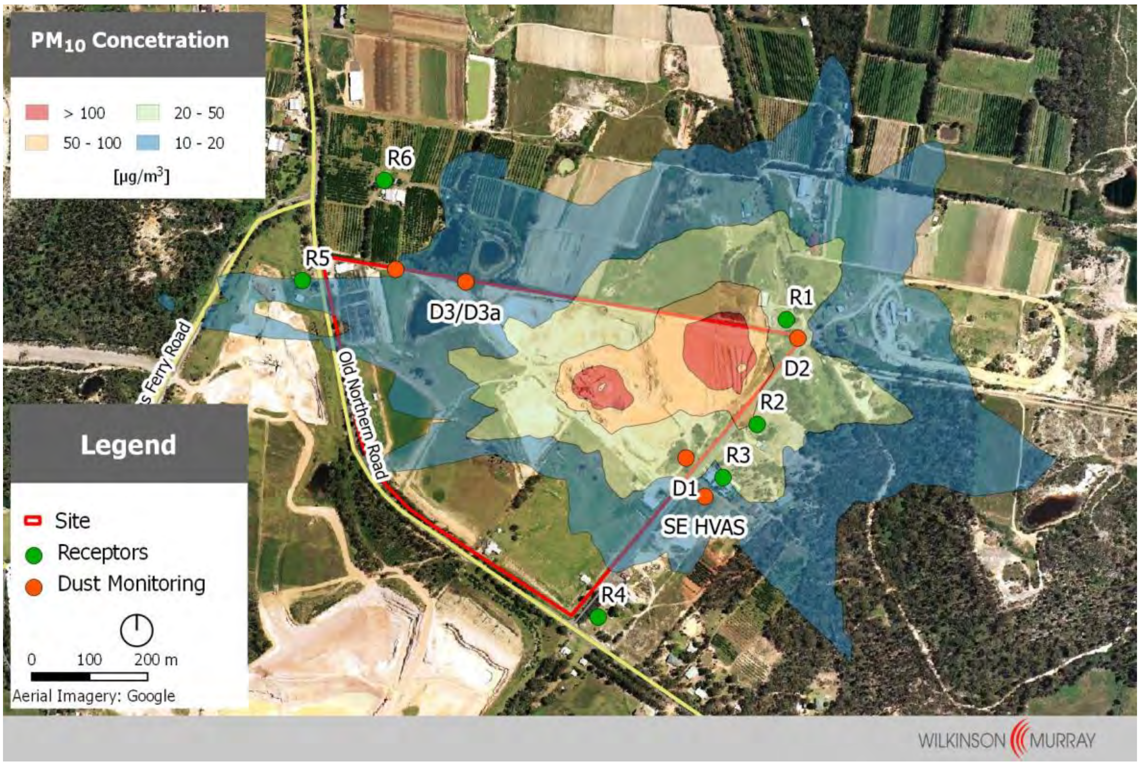


Figure C-3 24 hour PM_{10} Concentration [μg/m³] – South East extraction

Appendix 15

Acoustic Impact Assessment

ACOUSTICS AND AIR

HODGSON QUARRY PRODUCTS SAND EXTRACTION ROBERTS ROAD, MAROOTA

OPERATIONAL NOISE ASSESSMENT

REPORT NO. 14229
VERSION B

MAY 2015

PREPARED FOR

HODGSON QUARRY PRODUCTS PTY LTD
PO BOX 1778
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WILKINSON MURRAY

DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
A	Final	11 November 2014	Neil Gross	John Wassermann
B	Final	25 May 2015	Neil Gross	-

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

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GLOSSARY OF ACOUSTIC TERMS

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

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

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

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

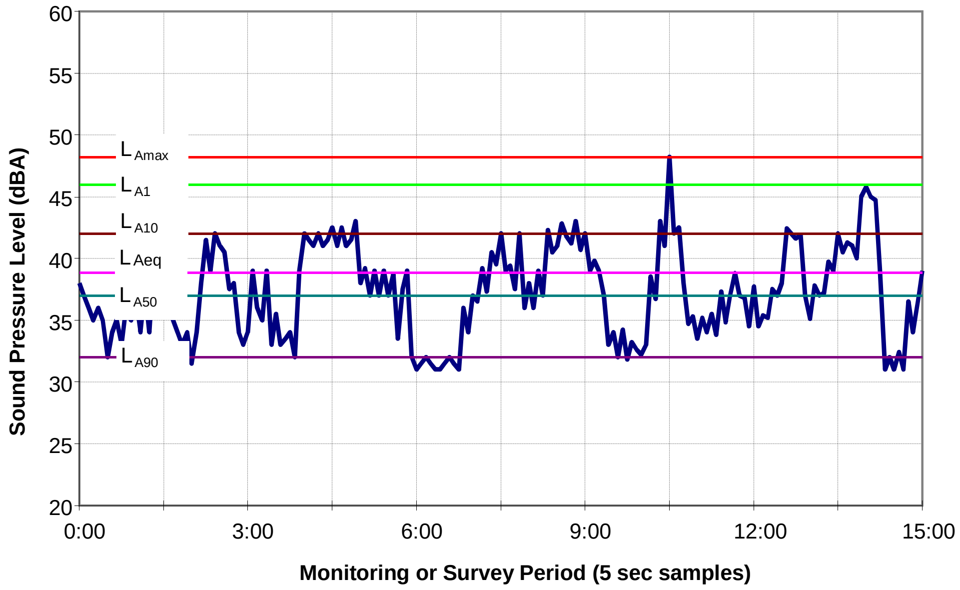
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

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

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

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

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Hodgson Quarry Products Pty Ltd have undertaken sand extraction at Roberts Road, Maroota since approval was granted in May 2000. The approval is due to expire in May 2015; however, the resource has not been completely extracted.

Hodgson Quarry Products Pty Ltd seeks a modification to the existing consent to permit the continuation of extraction on the site until May 2025. Since the approval of the extraction in 2000, Hodgson Quarry Products Pty Ltd has altered the method of extraction to ensure that the most efficient extraction processes are operating on the site. The proposed modification seeks to also modify the consent to regularise the current extraction processes.

The proposed modification does not seek to modify the approved number of trucks entering or leaving the site, nor does it propose to modify the quantity of material taken from the site on a daily basis, the lateral extent of the approved extraction, the depth of extraction, or the approved operating hours.

This report provides a noise impact assessment of the proposed continuation of current operations at the existing quarry until 2025.

The extraction site is located adjacent to Old Northern Road at Maroota (Figure 1-1).

The Hills Shire Council in their DCP (2012) Part B refers to acoustic management of extractive industry. This document references superseded EPA Standards and contains conflicting advice regarding noise criteria. For this reason, the DCP is considered erroneous and this noise assessment evaluates potentially noisy activities from fixed and mobile plant on site associated with the extraction and processing of material, in accordance with the preferred EPA *Industrial Noise Policy (INP).*

Although there is no proposed change in the approved extraction quantities, traffic noise associated with truck movements to and from the site has been addressed in accordance with the EPA *Road Noise Policy (RNP).*

For this noise assessment, consideration has been given to the previous noise assessment and current Conditions of Approval.

This report also considers issues raised by the Department of Planning in their letter of 12 May 2015 and the section where they are discussed.

a) *Further details of the exact locations of the two noise logger locations (L1 and L2) are required, including common justification for the appropriateness of those locations.* ***Section 3***

b) *Justification for the limited background noise monitoring is required (less than one day), including specific reference to the minimum background noise monitoring requirements for noise impact assessments, as outlined in the NSW Industrial Noise Policy (INP).* ***Section 3***

c) *The noise impact assessment (Section 4) does not adequately or clearly detail how applicable noise criteria have been derived from sufficient background noise data gathered, analysed and processed in accordance with the INP.* ***Section 4.2***

d) *The noise impact assessment (Section 4.4) does not adequately or clearly detail how the proposed project-specific noise criteria have been derived with reference to background monitoring data or existing noise limits.* ***Section 4.4***

e) *The noise impact assessment does not adequately detail assumptions (such as plant and equipment numbers and locations) that have been applied to the 'future operations' (Section 5.3.2) and with specific reference to the scenarios listed in Table 5-4.* ***Section 5 Table 5-4***

f) *Further detailed consideration of the application of all feasible and reasonable noise mitigation measures is required, particularly noting that the noise impact assessment predicts exceedances of the suggested noise criteria by up to 10 dB(A). The EA does not currently present an adequate consideration of potential measures to minimise noise impacts.* ***Section 7***

Figure 1-1 Locality Map

Figure 1-2 Site Plan & Surrounding Residences (Aerial photo not up to date)

2 SITE DESCRIPTION, CURRENT & PROPOSED OPERATION

2.1 Quarry Site

The existing consent allows 50 laden truck movement per day. The approved hours are 6.00am and 6.00pm, Monday to Friday and 6.00am to 1.00pm on Saturday with the extraction and processing commencing at 7.00am. Loading of trucks only is permitted in the period 6.ooam to 7.00am on all days. The present operation, which involves extraction of material, stockpiling and screening, operates a processing plant (highlighted in green in Figure 1-2 and includes pumps, screens, conveyers, cyclone) plus an excavator to win material and 2 dump trucks to transport to the processing plant.

There is intermittent need to use a dozer to rip the friable sandstone which generally occurs at lower levels within the quarry (RL195 with the exception of the north-western corner where it occurs up to RL205) and also an additional excavator to build mounds, remove topsoil and construct the final landform.


A front end loader is used to feed the processing plant and another front end loader is used to load haul trucks. On a typical busy day there would be 50 trucks loaded (33.5 tonnes per load), i.e. over 12 hours, this is on average 4 per hour or 1 in any 15-minute period. These follow the blue path shown in Figure 1-2.

2.2 Surrounding Areas

The land surrounding the quarry site is rural, although there are a number of other sand quarries in the area. The nearest existing residences, as shown in Figure 1-2 and retains the same nomenclature as the original noise report. Residences are located to the east and south on the corner of Roberts Road and Old Telegraph Road (A) and on the opposite side of Roberts Road (B, G & H). One residence (D) is located near the corner of Old Northern Road and Roberts Road. Residences are also located to the north on either side of Old Northern Road, one on the eastern side (C) and one on the western side (F).

3 EXISTING NOISE ENVIRONMENT

The *INP* recommends collecting one week of background noise data in order to determine the RBL which is then used to set criteria. However, background noise by definition can't include any noise from the industry being assessed. Therefore background data can't be collected in accordance with the *INP* unless the industry ceases operation for a minimum of a week, or longer if unsuitable weather prevails.

Background data had been collected at residences surrounding this site for the original EA in 1999. Whilst there is a general trend for background noise levels to increase over time as a result of urbanisation and more traffic, it was expected background noise levels wouldn't have changed significantly in this area over time.

Since background noise data each 15minute is used to determine the RBL it is normally the periods in the middle of the day outside the peak hours which affect the RBL. For this reason we organised for all quarry activities including the arrival and departure of trucks to cease for a period of approximately 90 minutes, whilst short term background noise levels were measured at the three surrounding residences (A-C).

The weather conditions at this time were fine and dry with minimal wind, hence ideal for the collection of suitable background data. It was also noted there were no other short term extraneous noises which may have affected the background from surrounding properties such as construction work.

In the circumstances we believe this was the most appropriate methodology to obtain suitable background data. Even if data was collected over further days it is not considered a lower background noise level would have been measured based on our observations. It is more likely that higher levels may have been obtained at other times.

For this reason, background noise levels for the purpose of setting criteria were established based on previous background noise monitoring in the area (which is unlikely to have changed significantly) and the short-term attended measurements during our site visit when we were able to cease operations between approximately 12.00pm and 1.30pm to measure background levels.

Because the quarry is operational, it was possible to measure noise levels from typical on site activities using attended / unattended noise measurements on Thursday, 11 September 2014 at each of the three receivers A, B and C. In addition, loggers were left at Locations L1 and L2 (as shown in Figure 1-2 within the quarry boundary) for a period of approximately 4-5 hours, where they had line of sight to much of the quarry operations. The purpose of these logger measurements was to determine noise emissions from the existing operation to be used to validate the noise model, rather than background noise.

The noise survey indicated that the background noise levels on the day were lower than previously measured; however, activities on site, although just audible at locations A and B and inaudible at Location C, would comply with the existing consent's noise condition.

3.1 Previous Unattended Noise Monitoring

Unattended long-term noise monitoring was conducted for the original assessment at locations shown in Figure 2-1. The measured median background levels extracted from that report are presented in Table 3-1.

Table 3-1 Measured Median Background Levels (Benbow 1999) – dBA

Location	6am-7am	7am-6pm
A – 155 Roberts Road	42	50(1)
B – 2a Roberts Road	38	47(1)
C – 156 Old Northern Road	41	43

Note: 1 Daytime background noise influenced by dam construction on site.

3.2 Attended / Unattended Noise Monitoring

Attended noise measurements were conducted at Locations A, B and C whilst the site was temporarily shut down on Thursday, 11 September. In addition, noise loggers at Locations L1 and 2 operated during this period.

All attended measurements were conducted using an Nti Type XL2 Sound Level Meter. This sound level meter conforms to Australian Standard 1259 *Acoustics – Sound Level Meters* as a Type 1 Precision Sound Level Meter which has an accuracy suitable for field and laboratory use. The A-Weighting filter of the meter was selected and the time weighting was set to "Fast". The calibration of the meter was checked before and after the measurements with a Bruel and Kjaer Type 4231 sound level calibrator and no significant drift was noted.

The XL2 and 4231 have been laboratory calibrated within the previous two years in accordance with our in-house Quality Assurance Procedures.

The unattended noise monitoring equipment used for this measurement consisted of an ARL NGARA environmental noise logger set to A-weighted, fast response, continuously monitoring in 0.1 second intervals for later detailed analysis of required descriptors. The equipment calibration was checked before and after the survey and no significant drift was noted.

The analysis of the logger typically determines L_{Amax} L_{A10}, L_{A90} and L_{Aeq} levels of the ambient noise. L_{A10} and L_{A90} are the levels exceeded for 10% and 90% of the sample time respectively (see Glossary of Acoustic Terms for definitions). The L_{Amax} is indicative of maximum noise levels due to individual noise events. This is used for the assessment of sleep disturbance. The L_{A90} level is normally taken as the background noise level during the relevant period. The L_{Aeq} is the energy average level which is widely used in many standards and guidelines to assess potential noise impact.

Graphs of noise levels versus time at the two unattended sites are shown below. The two periods when the site was temporarily shutdown are highlighted.

Figure 3-1 Logger Location L1 (Southern boundary)

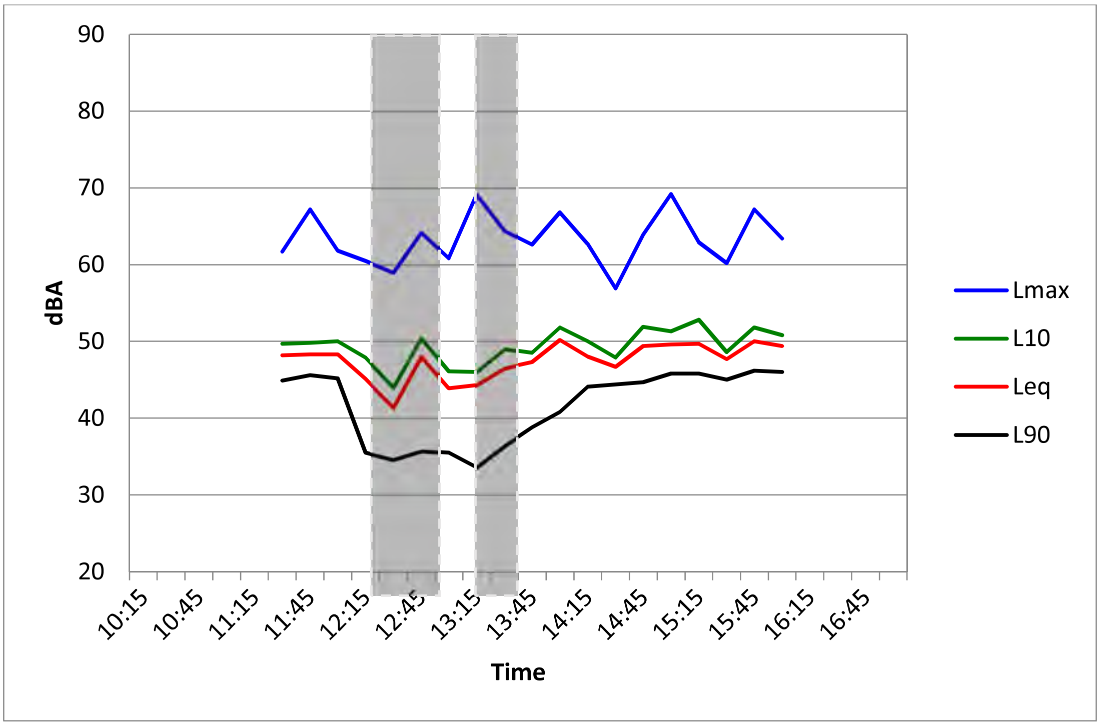


Figure 3-2 Logger Location L2 (Edge of existing pit towards Northern boundary)

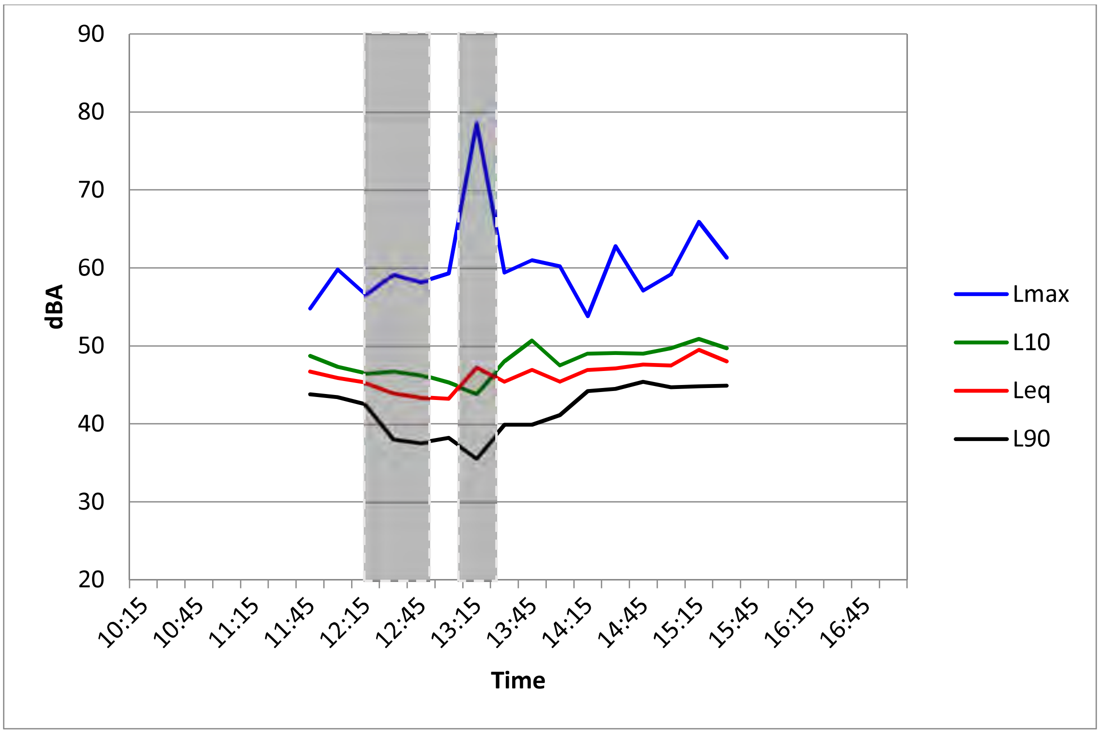


Table 3-2 presents a summary of measured noise levels during the temporary shutdown period.

Table 3-2 Background Noise Measurement Results – 11 September 2014

Location	Comments	Time	Measured Noise Levels (dBA)	
			L_{Aeq}	L_{A90}
A	Distant traffic, birds in trees, tractor	12:05 – 12:20	37	32
B	Distant traffic, birds in trees, wind in trees, traffic on Roberts Road	12:25 – 12:40	46	34
C	Traffic on Old Northern Road, Birds and wind in trees	12:55 – 13:10	45	34
L1	-	12:00 – 12:15	44	36
		12:15 – 12:30	43	35
		12:30 – 12:45	43	36
		13:00 – 13:15	45	34
L2	-	12:00 – 12:15	45	43
		12:15 – 12:30	41	38
		12:30 – 12:45	48	38
		13:00 – 13:15	44	36

Before and after this temporary shutdown during normal operations, the following noise levels were measured and summarised in Table 3-3.

Table 3-2 Residential / Boundary Noise Measurement Results – 11 September 2014

Location	Site Activities	Time	Measured Noise Levels (dBA)	
			L_{Aeq}	L_{A90}
A	Normal. Processing plant audible	11:54 – 11:59	40	35
A	Processing plant only (30 seconds)	11:59 – 12:00	37	35
C	Processing plant off – Truck being loaded	12:43 – 12:55	61	36
L2	Processing plant off – Truck being loaded	12:43 – 12:55		
A	Normal. Processing plant audible	15:10 – 15:15	37	34
B	Normal. Processing plant audible, traffic on Roberts Road	15:22 – 15:27	52	39
C	Normal. Processing plant inaudible	15:35 – 15:45	48	41
L2	Normal. Processing plant audible	15:15 – 15:30	48	45
L1	Normal. Processing plant only audible	15:55 – 16:00	50	46
L1	Normal. Processing plant audible and loader passby at 100m	16:00 – 16:01	50	48

Note: Gentle breeze from north-west blowing towards residences A & B and away from residence C.

4 OPERATIONAL NOISE CRITERIA

The following documents provide guidance in relation to noise generated on site:

- The Hills DCP 2012;
- EPA *NSW Industrial Noise Policy; and*
- Conditions of Approval.

4.1 The Hills DCP (2012) Section B.2.9 Acoustic Management

As discussed previously we note this document references superseded EPA documents and the requirements for noise are dealt with more comprehensively within the current EPA *Industrial Noise Policy (INP);* however, the DCP requirements are copied here for completeness.

OBJECTIVES

(i) To maintain the acoustic quality of the Shire.

(ii) To protect and maintain the acoustic environment of residents, Public & Community facilities and other receivers in the Shire.

(iii) To limit the potential offensiveness of noise from specific sources.

DEVELOPMENT CONTROLS

(a) Extractive operations should provide an effective acoustic buffer to residences and public places not associated with their operations.

(b) Proponents should implement effective noise control measures where noise emissions exceed maximum average background noise level.

(c) Proponents should encourage innovative extraction techniques which facilitate low noise emissions.

(d) Noise emissions from extractive operations should achieve the minimum acoustic criteria & standards set down by the Office of Environment and Heritage.

(e) Proponents should ensure that background noise measurements include the most sensitive points nearest to the development site during adverse weather conditions and proposed hours of operations.

(f) Proponents should ensure that the maximum average noise emission level of extraction is no more than 5dB(A) above maximum average background noise levels.

(g) Extraction activities should not occur within 100 metres of a residence not associated with the activities.

(h) Proponents are encouraged to implement the extraction "cell" technique as a means of facilitating acoustic shielding around worked extraction sites.

(i) Proponents should ensure that noise emissions meet all minimum acoustic standards defined in Chapters 19, 20 & 21 of the Environmental Noise Control Manual, 1994.

(j) Proponents should ensure that road traffic noise is minimised to reduce potential impacts upon the acoustic environment of residents and community facilities within the locality. In this regard proponents should indicate the special transport needs of the activity, which are most likely to generate noise outside normal operating hours.

Proponents should ensure that the hours of operation of extraction and the transportation of materials are kept between 7.00am to 6.00pm Monday to Friday inclusive, and 7.00am to 4.00pm Saturday. Variations to these hours may be justified having regard to the nature and location of a particular project.

Signs and barriers should be installed and maintained at the point of access to ensure compliance. The barriers should be kept locked except during authorised hours of operation.

4.2 EPA *Industrial Noise Policy*

The EPA *Industrial Noise Policy (INP)* is the current method to assess potential noise impacts from extractive industries. The *INP* recommends two criteria, "intrusiveness" and "amenity", both of which are relevant for the assessment of noise from the site. In most situations, one of these is more stringent than the other and becomes the project specific noise criteria. The criteria are based on the L_{Aeq} descriptor, which is explained in the Glossary of Acoustic Terms.

For sources such as the fixed and mobile plant associated with the extraction site, appropriate noise criteria are specified in the *INP*. The criterion depends on whether existing noise levels in an area are close to recommended amenity levels for different types of residential receiver areas (i.e. urban, rural, near existing roads).

In areas where existing noise levels are low, noise levels from the proposed operation are limited by the intrusiveness criterion. In general, the L_{Aeq} noise level from such sources should not exceed the RBL by more than 5dBA. This is assessed over a typical worst case 15-minute period.

As discussed in Section 3, it was not considered feasible to obtain a full week of background noise data to derive an RBL in accordance with the *INP*. The RBL for the daytime was therefore based on the range of single 15 minute background L_{A90} noise levels measured during our site visit at what was considered to be the quiet part of the day and shown in Table 4-1. The intrusive criterion adds 5dB to these levels. It is possible a higher daytime RBL would have been obtained since this is based on the 90th percentile value for each day (the 4th lowest value out of 44, 15-minute periods) and then the median of the 7 days.

Where noise levels from industrial sources are close to or above the acceptable levels then the amenity criterion, which incorporates a sliding scale to set limits, would apply. The sliding scale prevents the overall noise level exceeding the acceptable level due to the addition of a new noise source. Amenity criterion also needs to consider noise level from all industrial sources in the region, which includes the existing extraction site. The intention is that the sum of all local noise sources remains within the acceptable levels for each time period.

The amenity criteria are determined by which particular characterisation surrounding residences become classified as. The potentially affected residences near the quarry site are in an area which would be classified as "rural" and the relevant recommended "acceptable" amenity criteria for $L_{Aeq,period}$ are 50, 45 and 40dBA for daytime, evening and night time periods respectively. "Maximum" recommended levels are also part of the criteria and are all 5dBA higher than the "acceptable" levels.

Since the extraction site is approved to operate between 6.00am and 6.00pm, the early morning shoulder period and daytime period are assessed. The early morning period relied on previous data as this is considered to be influenced by higher traffic volumes on Old Northern Road at this time.

Table 4-1 shows the relevant industrial noise criteria for this project based on a rural area classification and a review of current and previous noise data. Note the amenity criterion relate to the whole daytime or night time periods.

Table 4-1 Industrial Noise Intrusiveness & Amenity Criteria

Receiver Area	Time Period	L_{90} (dBA)	Intrusiveness Criterion $L_{Aeq,15min}$ (dBA)	Amenity Criterion $L_{Aeq,period}$ (dBA)
A	Early Morning (7.00am–6.00pm)	42	47	40
	Daytime (7.00am–6.00pm)	32-36	37-41	50
B	Early Morning (7.00am–6.00pm)	38	43	40
	Daytime (7.00am–6.00pm)	34-36	39-41	50
C	Early Morning (7.00am–6.00pm)	41	46	40
	Daytime (7.00am–6.00pm)	34-38	39-43	50

For daytime period, the intrusive noise criterion is below the amenity criterion. For the early morning period, the intrusive criterion is above the amenity criterion (which is based on the whole night).

4.3 Existing Consent

Noise Management Plan

46. The Applicant shall prepare and implement a Noise Management Plan as part of the EMP.

The Noise Management Plan shall:

(a) identify existing and potential noise sources and their relative contribution to noise impacts from the development;
(b) specify appropriate intervals for noise monitoring to evaluate, assess and report noise emission levels due to construction and normal operations of the development under prevailing weather conditions;
(c) outline the methodologies to be used, including justification for monitoring intervals, weather conditions, seasonal variations, selecting locations, periods and times of measurements, the design of any noise modelling or other studies, including the means for determining the noise levels emitted by the development;
(d) specify measures to be taken to document any higher level of impacts or patterns of temperature inversions, and detail actions to quantify and ameliorate enhanced impacts if they occur;
(e) provide details of noise amelioration measures, including measures to be used to reduce the impact of intermittent, low frequency and tonal noise (including truck reversing alarms) and reactive management responses for particular noise sources; and
(f) contingency measures to be implemented should noise complaints be received.

Operational Noise Limits

47. Noise from the premises must not exceed:

- *an $L_{A10(15minute)}$ noise emission criterion of 45 dB(A) (7am to 6pm) Monday to Saturday*
- *an $L_{A10(15minute)}$ noise emission criterion of 40 dB(A) (6am and 7am) Monday to Saturday*
- *an $L_{A1minute}$ noise emission criterion of 50 dB(A) (6am and 7am) Monday to Saturday*

Noise from the premises is to be measured at any affected receptor to determine compliance with this Condition.

NOTE: Noise measurement
For the purpose of noise measures required in this Condition, the L_{A10} noise level must be measured or computed at any point as specified below over a period of 15 minutes using "FAST" response on the sound level meter.

For the purpose of the noise criteria in this Condition, 5dBA must be added to the measured level if the noise is substantially tonal or impulsive in character. The location or point of impact can be different for each development; for example, at the closest residential receiver or at the closest boundary of the development. Measurement locations can be:

- *1 metre from the façade of the residence for night time assessment;*
- *at the residential boundary;*
- *30 metres from the residence (rural situations) where boundary is more than 30 metres from residence.*

The noise emission limits identified in this Condition apply for prevailing meteorological conditions (winds up to 3m/s), except under conditions of temperature inversions. Noise impacts that may be enhanced by temperature inversions must be addressed by:

- *documenting noise complaints received to identify any higher level of impacts or patterns of temperature inversions;*
- *where levels of noise complaints indicate a higher level of impact then actions to quantify and ameliorate any enhanced impacts under temperature inversion conditions should be developed and implemented.* [11]

Road Noise Management Plan

48. The Applicant shall ensure that traffic noise from the development does not exceed $L_{Aeq,1hr}$ 55 dB(A) between 2am and 10pm and 50 dB(A) between 10pm and 7am at any affected residence under adverse weather conditions. Where ambient L_{eq} leve4ls already exceed these criteria, the Applicant shall ensure that traffic noise from the development does not result in an increase of more than 2 dB(A).

NOTE: Adverse weather conditions in the presence of winds up to 3 meters per second and/or temperature inversions of up to 4 degrees Centigrade per 100 metres.

49. The Applicant shall prepare a Road Noise Management Plan as part of the EMP. The Plan shall document measures to be taken to meet the criteria, including a monitoring, reporting and response program; and methods for educating drivers in the reduction of road noise impacts.

4.4 Project Specific Noise Levels

Project Specific Noise Levels (PSNL) have been set based on the range of available background data from the previous assessment, the current work and the previous conditions.

A single PSNL has been applied to all receivers to be consistent with the consent which applied the same criteria to all residences surrounding the site.

It is considered appropriate that noise criteria for the site should have the assessment parameter changed to $L_{Aeq,15min}$ rather than $L_{A10,15min}$ to bring it in line with the current *INP* approach to noise assessment.

If this project had been assessed in accordance with the *INP* when the previous background noise data was presented then we assume the noise criteria would have been expressed as $L_{Aeq,15min}$ and given the same numerical values as the current consent.

However, the background data at daytime shows background noise levels are lower than previously measured then it was considered appropriate to adjust the criteria down to reflect this difference.

A reduction of 2dBA at daytime was selected as this difference is also considered to be a typical difference between L_{A10} and L_{Aeq} levels from quarry operations, such that the new criteria would be no more onerous than the current consent for daytime. It is also possible the current consent conditions were based on what noise levels could be reasonably achieved from the proposed extraction.

It is not clear where the previous consent limit of 40dBA for the early morning period was derived, since the measured background levels were higher than 35dBA. However, 40dBA limit (as an L_{Aeq}) is considered a reasonable limit, allowing for background levels to also be lower at this time and also considering the amenity limits (albeit they are meant to apply to the whole night time period).

Similarly, the $L_{A1,1min}$ noise criteria remains unchanged.

The following limits are recommended;

- 7.00am to 6.00pm $L_{Aeq,15min}$ = 43dBA
- 6.00am to 7.00am $L_{Aeq,15min}$ = 40dBA
- 6.00am to 7.00am $L_{A1,1min}$ = 50dBA

5 OPERATIONAL NOISE ASSESSMENT

Noise modelling was conducted for both the existing operation and future scenarios including the approved areas for extraction. The existing operation was primarily modelled to validate the noise model to be satisfied it is appropriate to use for the future situation. This is because all the plant and equipment currently on site is not subject to change under proposed future operations.

Site related noise emissions were predominantly modeled using the ISO-9613 algorithm implemented in the "CadnaA" acoustic noise prediction software. Factors that are addressed in the modeling are:

- equipment sound level emissions and location;
- screening effects from buildings, stockpiles, topography;
- receiver locations;
- noise attenuation due to geometric spreading;
- directivity (where appropriate);
- ground effects;
- atmospheric absorption; and
- meteorology (wind and temperature gradients)

5.1 Meteorology

At distances from a noise source to receiver of several hundred metres or more, the resultant noise levels will be influenced by wind and temperature gradients.

When assessing potential noise impacts the *INP* requires that the effects of any weather conditions that are a feature of the area when the development operates need to be taken into consideration. The procedures described in the *INP* are directed toward finding a single set of meteorological conditions which represent general adverse conditions for noise propagation to be implemented in the noise assessment.

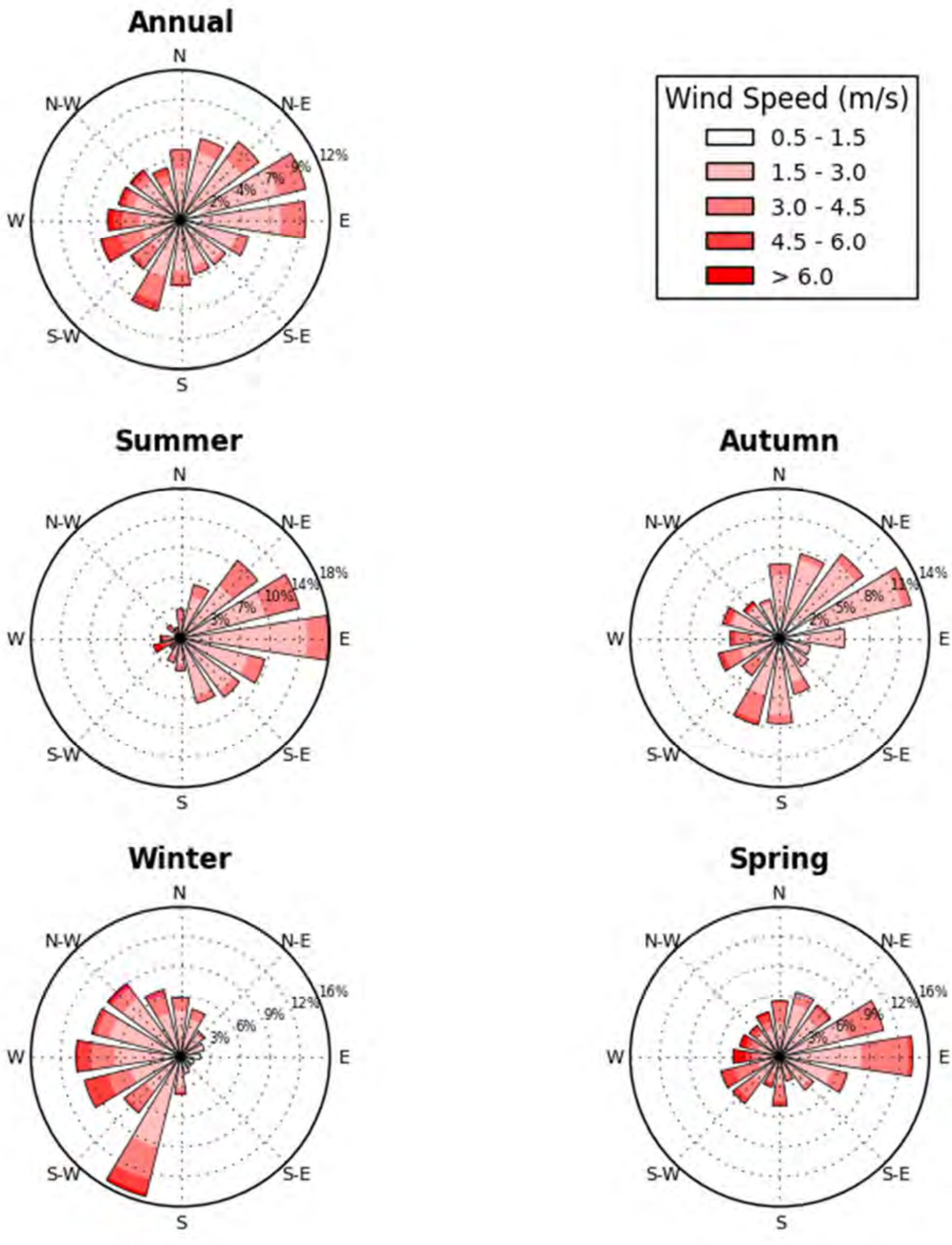
Since activities are predominantly daytime, only the prevalence of temperature inversions are generally considered low and are not required to be considered in this assessment.

Wind can increase noise at a receiver when it blows from the direction of the noise source. An increase in wind strength also results in a corresponding increase in wind noise at the receiver which often masks noise from the source under investigation.

The potential for increased noise levels due to wind should be considered when wind is a feature of the area under consideration. The *INP* defines this as where wind blows at speeds from 0.5m/s up to 3m/s for more than 30% of the time in any period (day, evening or night time) in and season.

Wind rose data showing wind direction and wind speed ranges (Figure 5-1) was analysed in accordance with the *INP* to determine the frequency of occurrence of seasonal winds for speeds from 0.5m/s up to 3m/s for the daytime period. There is no need to consider adverse conditions as the 30% scenario is not triggered. Results are presented for neutral conditions only.

Figure 5-1 Wind Rose Maroota



5.2 Operational Noise Sources

Noise levels associated with the extraction operations were measured previously as part of a site audit. A summary of the Sound Power Levels of the plant at the existing quarry site are presented in Table 5-1. These are noted to be typical of this type of plant. Some different plant was monitored on 11 September 2014

Table 5-1 Sound Power Levels of Existing Extraction Plant (Global Acoustics 2013)

Item	Sound Power Level dBLinear	Sound Power Level dBA
Volvo L150 loader Stationary	111	104
Volvo L150 loader Dynamic	115	105
Volvo L180E loader Stationary	114	103
Top screening plant Operating	105	96
Portostack TC80 engine Operating	112	90
Powerscreen commander screening plant Operating	117	105
Volvo A40D dump truck Dynamic forward	107	100
Volvo A40D dump truck Dynamic reverse	109	101
Hitachi Zaxis 330 excavator Stationary	106	93
Hitachi Zaxis 240 excavator Stationary	111	99
Komatsu 375A dozer Stationary	118	109

In addition, measurements were made on site on 11 September 2014 at various distances from operating equipment as shown in Table 5-2.

Table 5-2 Noise Levels of Existing Extraction Plant (11 September 2014)

Plant Items	Activity & Distance	Noise Level L_{Aeq} or L_{Amax} (dBA)
Volvo L180c Front End Loader	Tidying stockpile @ 15m	L_{Aeq} = 68, L_{Amax} = 73
Komatsu PC400LC Volvo A40D Dump Truck	Excavator Loading @ 80m	L_{Aeq} = 58
Volvo A40D uphill	passby at 10m	L_{Amax} = 78
Komatsu PC400LC	Winning material at 80m	L_{Aeq} = 55
Komatsu D375A Dozer	Pushing sand at 20m	L_{Aeq} = 76, L_{Amax} = 81
Hitachi 240LC Excavator	Tidying stockpile	L_{Aeq} = 67, L_{Amax} = 75
Volvo L180c Front End Loader Volvo A40D uphill	Loading Processing Plant 20-30m Tipping at stockpile	L_{Aeq} = 73, L_{Amax} = 83
Volvo A40D uphill	passby at 10m	L_{Amax} 80
Processing Plant	Normal operations fine sand 30m	L_{Aeq} = 66
Diesel Power Screen & Conveyer	Normal operations at 35m	L_{Aeq} = 67

5.3 Noise Modelling

5.3.1 Model Validation for Existing Situation

As short-term noise levels surrounding the extraction site have been monitored during our site visit, the estimated noise level contribution from extraction activity noise was compared with the predicted noise levels for the existing operations in order to validate the noise model. During the daytime measurements there was an intermittent gentle breeze from a westerly direction which increased slightly as the day progressed. The breeze wasn't considered significant enough to be included in the model with the exception of the last measurement period.

Table 5-3 presents the comparison of measured noise levels with predicted noise levels, based on our observations of what was occurring during that period.

Table 5-3 Comparison between Measured Results & Noise Model Predictions

Time	Operations	Measurement Location	Measured Contribution from Site dBA	Predicted Noise Level
11.55-12.00	Processing plant and associated activities	A	<35	35
		1	47	49
		2	47	46
15:10-15:15	Normal operation	A	36	35
		1	49	49
		2	47	46
15:25–15:30	Normal operation	B	40	40
		1	49	49
		2	47	46
15:35–15:45	Normal operation (westerly wind)	Nr C	Inaudible	34
		1	49	49
		2	47	46

As presented in Table 5-3, there is good correlation between the measured and predicted noise levels from the site, hence the noise model has been validated and is suitable for further modelling purposes.

5.3.2 Modelling of Future Operations

The extraction plan and excavation process is split into six future stages as shown in Figure 5-2. The quarry will develop further to the west and north for Stages 1-5 over a period of approximately 8 years, at which time the processing plant would be relocated to allow for the extraction of Stage 6 to include a cell near the northern boundary and the material beneath where the existing processing plant is located. It is noted that the lateral extent of the extraction will not exceed that of the approved development.

Operations also require further excavation and the emplacement of material to create the final landform. This would occur intermittently on a campaign basis, typically 2 weeks at a time, possibly once or twice per year, such that equipment / staff not needed to meet the supply of raw material would be utilised to haul material to the emplacement areas and an excavator to form the final landform. It is possible that some sandstone will need to be ripped in this area at RL195 and below. Noise levels from this activity are not considered to be any higher than that experienced to date.

Figure 5-2 Future Stages

The proposed extraction process requires an excavator and truck at surface level to remove the top soil and overburden which is initially formed into perimeter bunds and remaining material is stockpiled. From this point onwards, the excavator works occur from below the surface and is able to pull material down from above.

The excavator and truck are therefore only at surface level for a small proportion of time (< 10%) and most of this time it is operating behind a 5m bundwall relative to the nearest boundary.

With the exception of cells with suffix A, there is a need to rip Hawkesbury sandstone in the cells. The extraction operation includes the use of a dozer to rip. This occurs at RL195, with the exception of cells 4C and 6B where it will occur as high as RL205.

The extracted material then gets transported using a dump truck to the processing feed area, where a front end loader manages a few stockpiles to blend the different grades of sand as required before tipping into the power screen. Depending on the haul distance, either 1 or 2 dump trucks return to and from the processing plant area.

In relation to hauling product off site between 6.00am and 6.00pm, it is considered that the typical "worst case" operating scenario would be when 3 truck movements overlap in the same 15-minute period. This assumption incorporates 2 trucks arriving and one truck subsequently leaving the site. The selection of 3 truck movements is based on operational constraints as this is the maximum that can be loaded.

A summary of operating plant is provided in Table 5-4 for the various scenarios considered.

Table 5-4 Typical Scenarios and Plant Numbers

Scenario	Operating Equipment
Core Activities	1 Excavator at base of excavation 2 dump trucks continuously between face and processing area 1 Loader feeding processing plant managing stockpiles 1 Diesel Screen / Conveyers 1 Processing and Washing Plant / Conveyers 1 Loader loading haul trucks / managing stockpiles 3 Haul trucks in 15 minutes taking product off site
Dozer Extraction / Emplacement	Dozer at highest RL within extraction or emplacement area
Surface Extraction	1 Excavator (from base) repositioned at surface behind bund
Bund Construction	1 Excavator (from base) repositioned at surface building bund

The noise levels have been predicted using the Cadna modelling software to represent the worst case stages for the surrounding residences. The results are shown in Table 5-5 and include for typical operations which will occur most of the time (excavator at base of extraction area, haul to processing area, processing plant and associated two loaders and loading out of trucks) and then in addition, the short periods of time when a dozer is required to operate in the extraction area or in the emplacement area, plus the periods when an excavator would need to operate at the surface in the extraction area or emplacement area behind the perimeter bunds.

Table 5-5 Predicted $L_{Aeq,15min}$ Noise Levels (Neutral Meteorology)

Receiver	Worst Stage/s Core activities + either extraction area or emplacement area activities	Typical	With Dozer (Extraction or Emplacement)	With Surface operations behind bund (Extraction or Emplacement
A	1A + emplacement	37	40	48
B	1A + emplacement	42	43	45
B	5A+ extraction	43	-	45
C	6B+ extraction	38	44	43
D	5A + extraction	40	-	53
F	6B+ extraction	35	39	39
G	1A + emplacement	38	40	47
H	1A + emplacement	41	42	44

During typical operations, the predicted noise levels comply with the $L_{Aeq,15min}$ noise condition of 43dBA at all receivers. However, when dozers are required to operate in some areas and the excavation of top soil occurs at the beginning of each new cell, noise levels are predicted to exceed the criterion at some receivers.

Exceedances for surface extraction works are up to 1dBA only at Receiver C, typically for a total of 2-3 weeks during sandstone ripping within cells where rock is above approximately RL200.

Exceedances for dozer ripping works are up to 10dBA at Receiver D, 2dBA at receiver B and 1dBA at receiver H, typically for 3-4 weeks during the initial top soil and overburden extraction of each cell.

Exceedances during these periods for emplacement works are up to 5dBA at Receiver A, 4dBA at Receiver G, 2dBA at receiver B and 1dBA at receiver H, typically 3 weeks per year on average.

Since the plant on site is considered to be modern and well maintained, there are no feasible or reasonable mitigation measures which can be applied to further reduce noise levels.

In addition to the exceedances above, there are also periods of a few days when perimeter bunding is required to be built and will require an excavator to be located at the surface without any shielding by a bund for a few days at a time. Predicted noise levels from this activity at these times are up to 57dBA at Location D, 48dBA at Location C and 40dBA at Location F. At other locations, the contribution is less than 30dBA.

At three of the receivers (C, D and F) noise levels are expected to increase compared with current levels over the remainder of the project as operations move closer. Two of these receivers (D and F) are located within 30m of Old Northern Road and L_{Aeq} noise levels from traffic are expected to be over 55dBA and therefore more than 10dBA higher than typical L_{Aeq} noise levels from the site and similar or higher than noise levels in the short periods with an excavator at the surface. Negligible impact is therefore expected at these two receivers. These receivers are also located closer to other sand extraction activities on the other side of Old Northern Road.

Location C is set further back from Old Northern Road so ambient noise levels are lower, but still similar or higher than the predicted noise levels from the quarry of up to 44dBA during normal activities and 48dBA whilst the northern bund is being built.

5.3.3 Early Morning Shoulder Period

The existing arrangement allowing the loading of trucks between 6.00am to 7.00am is not proposed to change so no change in impact compared to the existing situation is expected. The potentially worst affected residence is Receiver B, closest to the site entrance on Roberts Road.

It is recommended a short section of 4m bund is constructed from the weighbridge to join with the existing bund adjacent to Roberts Road.

The predicted noise level from this activity is 37dBA which meets the amenity criterion of 40dBA.

6 TRAFFIC NOISE ASSESSMENT

The proposal does not include any increase in the approved truck numbers per day or operating hours, just an extension in time of the currently approved operations. Trucks access the site along Roberts Road from Old Northern Road. The closest residence is on the corner of Roberts Road and Old Northern Road, so there are no residences solely affected by traffic on Roberts Road. At the intersection the split of traffic on an annual basis is 90% to the south; however, on particular days, all traffic may head south.

Existing volumes on Old Northern Road were measured over a 12-hour period from 6.00am to 6.00pm and were approximately 1,500 vehicles and 17% heavy vehicles.

6.1 *Road Noise Policy*

For existing residences affected by additional traffic on existing freeways / arterial roads (Old Northern Road) generated by land use developments, the appropriate noise assessment criteria are set in the NSW *Road Noise Policy (RNP)*. The appropriate daytime assessment criterion is $L_{Aeq,15hr}$ 60dBA at 1m in front of the façade. The night time criterion is $L_{Aeq,15hr}$ 55dBA

In 1999 at the closest residences to Old Northern Road set back approximately 30m from the centreline, existing traffic noise levels were measured as 55dBA $L_{Aeq,15hr}$, which is 5dB below the daytime criterion of 60dBA. ADT traffic volumes (24 hour) were approximately 2,000 vehicles with 10% heavy vehicle content, so there hasn't been much change.

A secondary objective is to protect amenity as the result of a project by applying the relative increase criteria. The *RNP* deems an increase of up to 2dB represents a minor impact that is considered barely perceptible to the average person.

6.2 Assessment of Traffic Noise

The existing noise contribution of trucks associated with the proposal would result in an increase of less than 1dBA compared with the scenario without the quarry. The difference is not noticeable and negligible impact is therefore expected from the continuation of existing operations.

7 SUMMARY & CONCLUSION

Operational noise impacts associated with the continuation of material extraction at the Roberts Road Quarry have been assessed in general accordance with criteria recommended by the NSW *INP* and *RNP* for operational noise and traffic noise. It is recommended the noise condition in the existing approval is amended to reflect the current approach to using $L_{Aeq,15min}$ rather than $L_{A10,15min}$.

The existing site is already bunded at the perimeter. Mitigation in the form of additional perimeter bunding is proposed as part of the development. The extraction methodology is designed to minimise surface activities as much as possible, so equipment is either working behind a face or behind a surface bund; however, there is a need to construct these bunds so equipment is exposed for periods of a few days at a time intermittently through the operation

In relation to operational noise, compliance with the proposed condition is achieved for typical operations at all surrounding residences. However there are some short periods of time, generally from a few days to a few weeks, through the remaining quarry life (construction of bunds, surface extraction and use of a dozer) which results in exceedances of criteria.

The noise levels associated with building higher bunds to try and reduce these exceedances further would generate higher noise levels than the noise from activities they are designed to reduce.

It is considered the current plant to be modern and well maintained. No further mitigation is considered feasible and reasonable to reduce these exceedances.

There is no change in traffic noise generated by the development, which results in negligible noise impact at residences located along Old Northern Road.

Appendix 16

Groundwater Impact Assessment Report

Hodgson Quarry Groundwater Assessment, Roberts Road, Maroota

Prepared for Nexus Environmental Planning Pty Ltd

AGT 1355-14-NAN
9/4/2015

Australian Groundwater Technologies
AGT

"making water work"

Document Control

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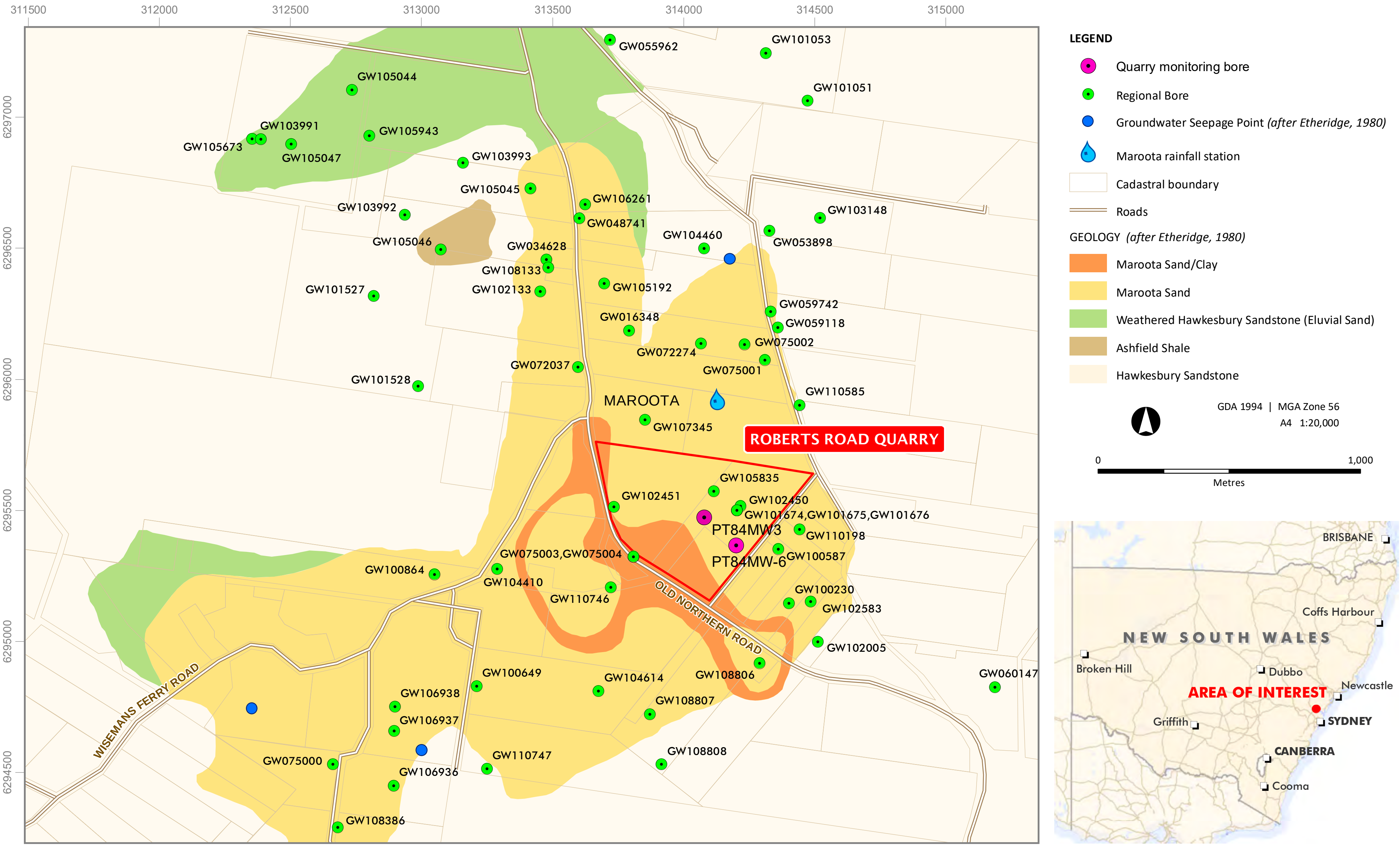
1 Introduction

The Hodgson Quarry at Roberts Road, Maroota, extracts sand material from the Tertiary aged Maroota Sands Palaeochannel. The quarry has been in operation for approximately 15 years. The original application was approved by the then Minister for Planning pursuant to an Environmental Impact Statement (EIS) prepared by Nexus Environmental Planning Pty Ltd. The approved quarry depth was to 182 mAHD which is 2 m above the approved 'wet weather elevation' for the Maroota Tertiary Sands Groundwater Resource. This elevation was defined from water levels at groundwater monitoring bores and near-site dams that monitor the regional Maroota Sands Aquifer.

It is proposed to modify the existing consent. The modification does not intend to deepen the approved quarry depth (182 mAHD) but to modify the extraction methods and extend the quarry life to 2025. The location of the quarry is on Lot 1 and 2, DP228308, Maroota and is presented in Figure 1.

Since quarrying commenced, policy changes have seen the introduction of the Greater Metropolitan Region Groundwater Sources Water Sharing Plan (WSP) (2011) and Aquifer Interference Policy (AIP) (2012). As part of the modification, the New South Wales Office of Water (NOW) requires evidence that the proposed modifications adhere to the above mentioned plans. For this reason Nexus Environmental Planning Pty Ltd (on behalf of the Hodgson Quarry) has commissioned Australian Groundwater Technologies (AGT) to undertake a groundwater assessment. The purpose of the assessment is to:

- Evaluate the approved depth (from the original EIS) in context of the proposed modification.
- Update the original groundwater assessment, including review of groundwater levels to confirm the extraction depth limit.
- Assess the quarry modifications against the Greater Metropolitan Region Water Sharing Plan (GMRWSP) and the aquifer interference policy (AIP).
- Outline a strategy for groundwater monitoring and management that will ensure compliance against the WSP / AIP.



Australian Groundwater Technologies AGT

Figure 1 | Location Map and Geology, Hodgson's Quarry

March, 2015 | P:\(NAN)_Nexus_Environmental\Projects\1355_Roberts_Rd_Maroota\GIS\Maps\location map - roberts rd quarry.mxd

2 Proposed modifications

The consent for the Roberts Road Quarry was approved on 31st May 2000, for a period of 15 years. The original approval was based on an operations plan and resource estimate outlined in the original EIS (reference). Since the original consent, the operators have identified that some extraction methods are inefficient and the resource estimate was underestimated (Nexus, 2014). For these reasons modification to the existing consent is sought to capture the updated quarrying methods and to extend the quarry life to 2025.

Figure 2a illustrates the current depth of the quarry as of 2014. It can be seen from the figure that except for historical excavations (to 180 mAHD), the majority of the quarry depth is at relative levels (RL) above 182 mAHD. This was recently confirmed by an on-site investigation in October 2014 that recorded the deepest RL at 183.7 mAHD (Thomson, 2014).

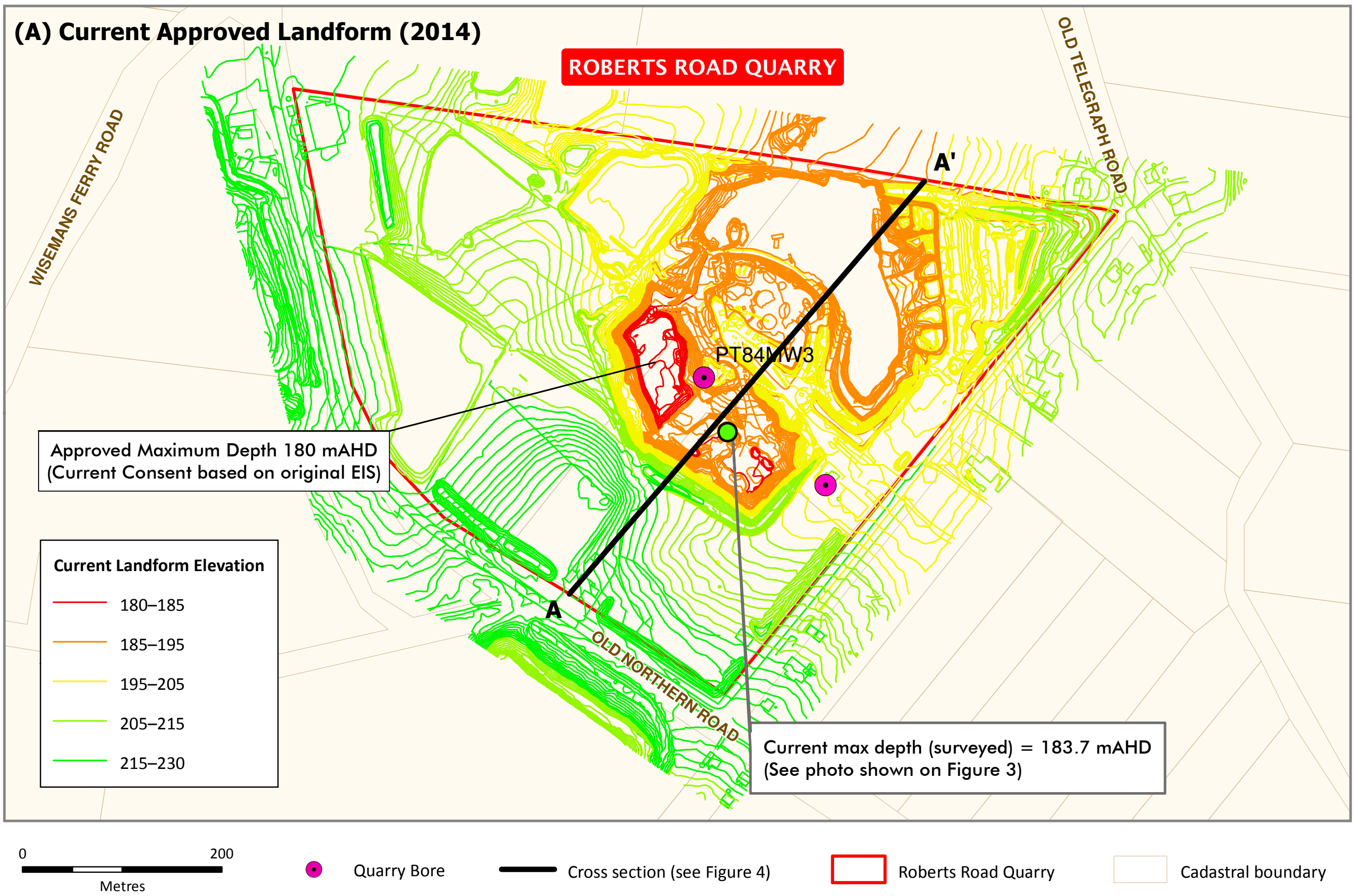
Figure 2b illustrates the final landform depth for the proposed modification (i.e. at year 2025). It can be seen from the figure that the final landform depth is 180 mAHD. Thus the proposed modifications will **not change** the final landform depth and remain within the conditions of the original consent. NOTE: Although the modification seeks approval to maintain extraction to the approved 180 mAHD, the recent inspection identified an unwanted clay band at a depth of 183.7 mAHD (Figure 3). The quarry owners have indicated that this is the lowest limit to be extracted.

2.1 Quarry Modifications

The following dot points summarise the proposed modifications to the current approval (Nexus, 2014). As seen most of the modifications are administrative in nature.

- The operators proposed to increase the duration of operations from 15 to 25 years. The proposed life of operations will extend to 31st May 2025 from the original expiry date of 31st May 2015.
- Condition 2 of the Consent will be updated to refer to the current Environmental Assessment (EA) in addition to the original EIS.
- Recent delineation drilling has updated the resource estimate from 2,144,000 m^3 to 4,607,822 m^3. This additional resources result from an underestimate of the bulk density of the rock, which has increased from 1.6 m^3/t to 2.0 m^3/t.
- It is proposed to construct the approved water supply dam in 3 stages, as opposed to the approved 2 stage construction. The dimensions of the dam will remain as per the original consent.
- The extraction method seeks to include the use of a dozer for ripping of hard sandstone layers. This differs from the original EIS that stipulates the use of an excavator only.

- The original EIS stipulates that sand won from excavation is fed directly to the mixing tank. The proposed modification proposes to include the use of a dump truck to cart the sand from the excavator to the mixing tank.



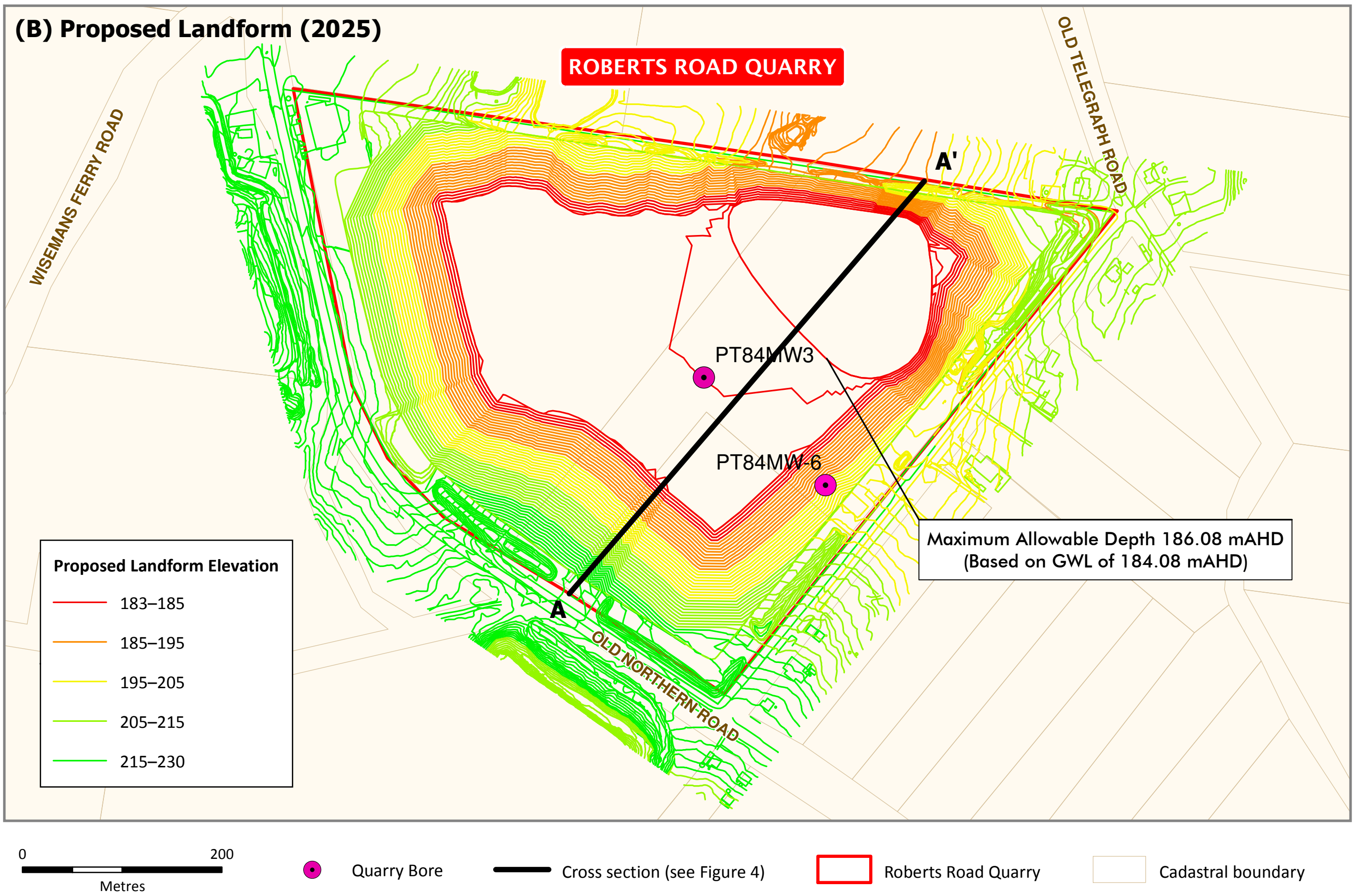


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Figure 2 | Current (2014) and Proposed (2025) Landform Contours

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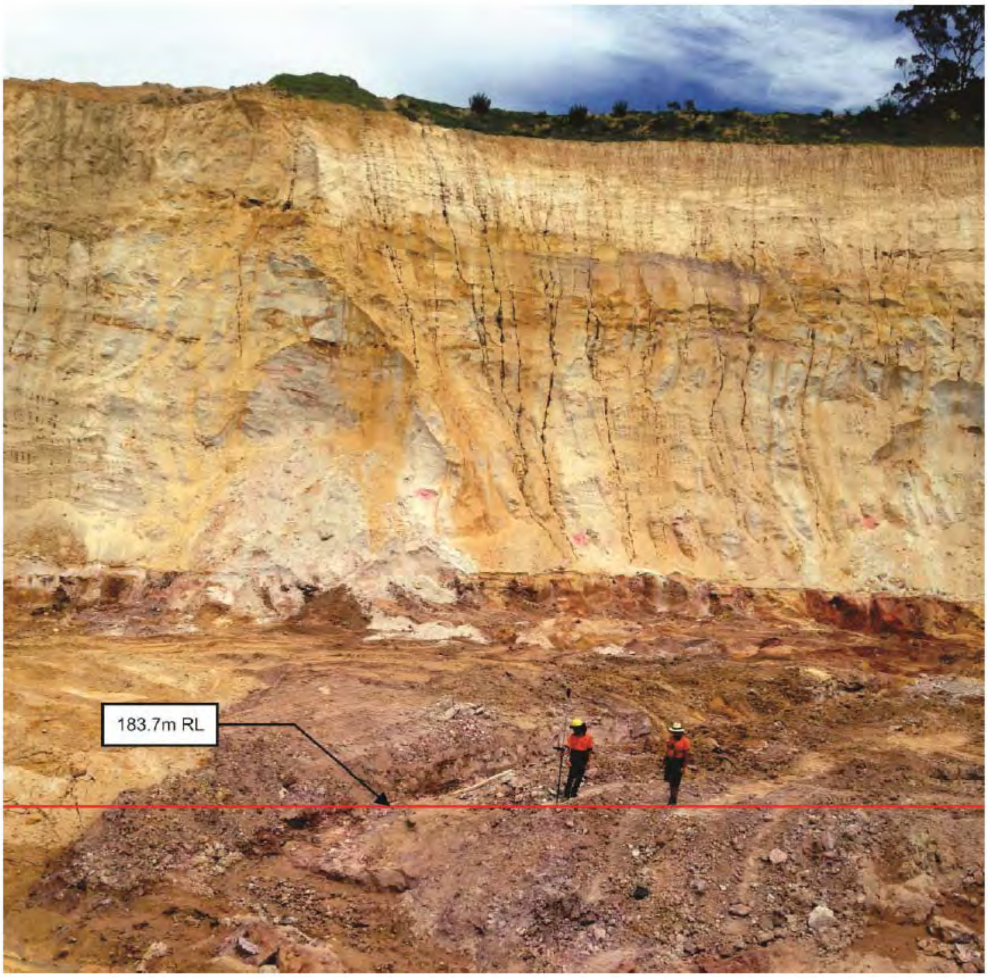

Figure 3. Quarry floor and clay base recorded at 183.7 mAHD (Thomson, 2014).

3 Project Background

The following information provides the geological and hydrogeological context for the proposed development modifications. Information is predominantly sourced from the groundwater investigation report by Woodward-Clyde (1999) which was undertaken as part of the EIS for the original application.

3.1 Geology

The Project is located in the Sydney Basin, a Permian to Triassic basin that extends from Batemans Bay in the south, to Port Stephens in the north. The Roberts Road quarry pits are south of Maroota and source material from the Maroota Sands Palaeochannel. The general stratigraphy of the area is presented in Table 1.

The local area was mapped by the Geological Survey of NSW (Etheridge, 1980) who identified outcropping rock sequences including the Hawkesbury Sandstone (Eluvial Sands) and Maroota Sands (Figure 1).

Table 1: Stratigraphic sequences at the project site (adapted from Woodward and Clyde (1999) after Etheridge (1980)).

Age	Unit	Lithology	Comment
Quaternary	Soils	Variable	
Tertiary	Unnamed	Basalt	-Not present at project site
	Maroota Sand	Sand, gravel, clayey sand and clay	-Reworked Hawkesbury Sandstone. -Palaeochannel sands including clay and ferricrete bands (ie cemented ironstone). -Outcrops at project site and is the target of quarry activities.
Triassic	Ashfield Shale	Shale and laminite	-Not present at project site
	Hawkesbury Sandstone	Quartzose sandstone with shale lenses	-Comprise weathered upper profile (Eluvial Sands) underlain by competent sandstone. -Eluvial Sands outcrops north and west of Project Site -Underlies project site but is not targeted for quarrying

3.2 Hydrogeology

The aquifers identified across the Maroota area incorporate the following hydrostratigraphic units:

- The Maroota Sands (MS) that constitutes the regional water table aquifer. Together with the upper part of the Hawkesbury Sandstone (Eluvial Sands) this unit forms the Maroota Tertiary Sands Groundwater Source (MTSGS).
- The Hawkesbury Sandstone, a regional fractured rock aquifer. The Hawkesbury Sandstone forms part of the Sydney Basin Central Groundwater Source (SBCGS). The unit is competent (lithified) with secondary fracturing the predominant mechanism for groundwater flow.

The MTSGS is recharged by direct rainfall infiltration and is subject to seasonal rainfall variations and longer term climatic cycles (Woodward and Clyde, 1999). At the project site, water well drilling has identified the MS to comprise thin layers of gravel, thick sequences of clay, and interbedded clays and sands (Woodward and Clyde, 1999; URS, 2013). These profiles are typical of palaeochannel sequences and represent the meandering nature of old river systems.

The Eluvial sands and Hawkesbury Sandstone underlie the project site and will not be targeted or intercepted during quarrying activities. As these units will not be intercepted they will not be discussed further in the context of this groundwater assessment.

3.3 Original EIS assessment

3.3.1 Potential Groundwater Impacts

In 1998, Woodward-Clyde conducted a groundwater impact assessment to support quarry extraction to 2 m above the ‘wet weather’ groundwater elevation. The study concluded that the average ‘wet weather’ groundwater elevation was 180 mAHD, allowing quarrying to a maximum depth of 182 mAHD (Woodward-Clyde, 1999). The assessment considered potential impacts including:

- reduced groundwater availability to users
- aquifer contamination
- reduced flow to streams
- increased turbidity to streams
- water table lowering.

The following summarise the outcomes from the assessment against the potential impact events. In addition, a provisional assessment has been conducted to highlight changes to the assessment for the proposed modification. This is discussed further in Section 7 and is assessed against principles in the AIP and WSP.

3.3.2 Reduced groundwater availability to users

Because the water table would not be intercepted, the original assessment concluded that there was low potential for a reduction in groundwater availability (ie quantity). In addition, the quarry was assessed as internally draining and with potential for pooling and recharge through the quarry excavations. This would have the effect of increasing, rather than decreasing groundwater levels.

Provisional Assessment
For the 2015 assessment the final landform is unchanged from the original depth of 182 mAHD. For this reason findings from the original assessment remain and a reduction in groundwater quantity and availability for existing users is not possible.

3.3.3 Aquifer Contamination

The original EIS identified the potential for aquifer contamination from fuel spillages principally from the operation of heavy machinery during quarry excavation. Woodward-Clyde (1999) assessed the risks from this activity as low provided adequate management strategies were in place ie appropriate fuel storages and implementation of a site management plan.

Provisional Assessment
There will be no change to fuel storage and management methods for the updated EA. For this reason findings from the original assessment remain valid, therefore risk profile is assessed as low.

3.3.4 Reduced flow to streams

The original assessment highlighted groundwater discharge points to streams where they intersect the Maroota Sands and Eluvial Sands of the Hawkesbury Sandstone. As illustrated in Figure 1, the groundwater discharge points are located near the perimeter of the Maroota Sands outcrop in lower parts of the landscape (Etheridge, 1980). These locations are between 1 and 2 km southwest, and 1 km north of the Hodgson's quarry, well away from the quarry footprint. The original EIS identified no credible risks to stream reduction from quarry activities as quarrying will not intercept the water table. As there is no groundwater extraction from on-site wells drawdown impacts to the MTSGS are not possible.

Provisional assessment
The 2015 quarry modifications are in line with the original assessment (i.e. maximum depth of 182 mAHD and internally draining site). The water table will not be intercepted nor lowered from groundwater pumping. For this reason impacts to the groundwater resource cannot occur and the risk profile is low.

3.3.5 Increased turbidity to streams

As the site is internally draining (Figure 2a, Figure 2b) there is no credible impact of enhanced turbidity to rivers or streams. Surface flow will remain almost entirely on site and turbid waters will be captured by the quarry pit footprint and on-site storage dams. This was highlighted in the original EIS and the situation has not changed for the current proposal.

3.3.6 Water table lowering

The original approval was for a landform depth to 182 mAHD, 2 m above the approved 'wet weather' groundwater elevation of 180 m AHD. Quarrying to this depth would not intercept the water table and lowering could not occur (Woodward-Clyde, 1999).

The current and future quarry depth will extend to a maximum depth of 182 mAHD consistent with the original consent. For this reason the assessment is unchanged and is deemed a low risk. Furthermore Woodward-Clyde (1999) highlighted that quarrying will enhanced recharge and increase groundwater levels due to clearing of vegetation and internal drainage towards the pit.

3.4 Wet weather groundwater elevation

In 1998 on-site monitoring bores were installed to characterise groundwater occurrence and levels within the MTSGS (Woodward-Clyde, 1999). Groundwater monitoring commenced in January 1999 using automated logging equipment and time series data was collected for 5 months. At the time, on-site monitoring data coupled with nearby 3rd party wells were reviewed to determine the *maximum wet weather groundwater elevation* as benchmarks for the permissible quarry depth. The following conclusions were drawn by Woodward-Clyde (1999):

- On site monitoring well PT84MW3 recorded a maximum groundwater elevation of 183.59 mAHD. Monitoring bore PT84MW3 was completed into the Maroota Sands, however subsequent investigation identifies this well as completed above an impermeable clay layer and not representative of the regional groundwater elevation.
- Private bore PF167MW1 (approx. 750 m south-west of the quarry boundary) recorded a groundwater elevation of 178.8 mAHD. This well was completed in the deeper MS and considered representative of the regional water table elevation.
- NSW Office of Water (NOW) Bores 75002/1 and 75002/2 (approx. 300 m northeast of the quarry boundary) recorded groundwater elevations of 180.59 and 178.58 mAHD. These wells were also completed in the deeper Maroota Sand and considered representative of the regional water table elevation.
- NOW bore 75000/1 (approx. 1300 m south-west of quarry boundary) recorded a groundwater elevation of 180.19 mAHD. This well was also completed in the deeper MS.
- Nearby dams excavated into the deeper parts of the Maroota Sand recorded water elevations between 177.0 and 180.29 mAHD.
- Based on the above, the wet weather groundwater elevation was proposed at 180 mAHD, with the maximum permissible quarry depth at 182 mAHD. This depth was accepted by the Department of Land and Water Conservation (DLWC) and incorporated into the original consent dated 31 May 2000.

Details of wells used to support the original quarry depth are presented in Table 2. Well locations are presented in Figure 1.

Table 2: Well and dam details used to determine the original "maximum wet weather groundwater elevation." Data sourced from Woodward-Clyde (1999).

Location	Well Name	Bore number	Aquifer monitored	Easting[1]	Northing[1]	Surface Elevation (mAHD)	Top of casing elevation (mAHD)	Total Depth (m BGL)	Total Depth (mAHD)	Screened interval (m AHD)	Maximum RSWL (mAHD)	Maximum RSWL date	Salinity (mg/L TDS)
Quarry Site	PT84MW-3		MS	314078	6295474	202.43	203.25	21.90	180.53	181.63 – 187.63	183.59	28/10/1998	266
Adjacent Landholdings. See Figure 1 for detail.		75000/1	MS (deeper)	314306	6296072	194.59	195.49	21.5	173.09		180.19	NA	79
		75002/1*	MS (deeper)	314227	6296134	187.59		12	177.59		180.59	NA^	207
		75002/2*	MS (deeper)	314227	6296134	187.78		23.0	164.78		178.58	NA^	54
		PF167MW1	MS (deeper)			187.64		22	165.64		178.64		
	Dam	Portion 167 SSW of site	MS (deeper)								179.5 min 177.0 max 181.3	NA^	
	Dam	Portion 84 Lot 2, DP228308	MS (deeper)								180.29	NA^	

*NOW observation wells. [1]Geodetic Datum of Australia 1994 Zone 56; mAHD – metres Australian Height Datum; m BGL – metres below ground level; RSWL – Reduced Standing Water level; TDS – total dissolved solids; ^not declared in EIS submission.

4 Quarry modification: proposed wet weather groundwater elevation

The proposed quarry modification presents an opportunity to review the maximum wet weather elevation for the MTSGS. As discussed in Section 3 the modification will not result in a deeper extraction limit from the original approval. The intent of this Section is to confirm that the original wet weather groundwater elevation approved in 2000 is appropriate for the remainder of quarry life (i.e. for quarrying until 2025).

Groundwater monitoring has been conducted from ~1999. This chapter provides a summary of water level and quality data collected since that time. Data presented incorporates information from on-site and other 3rd party wells owned by NOW and local landholders.

4.1 Current Monitoring Infrastructure

Quarry bores that target the deeper Maroota Sands are presented in Figure 4. The following general comments can be made with regard to these bores:

- PT84MW-6 (a replacement bore for PT84MW-3) was drilled in January 2015. The bore has been drilled to a total depth of 273.46 mAHD. Completion information is presented in Table 3.

4.1.1 Supporting Regional Bores

Groundwater monitoring information was collated from 3rd party bores located off site in the surrounding Maroota Area:

- Water level time series data was obtained from bore PF167MW-1 (GW100649) located on the quarry to the south-west (quarry owned by PF Formation, Figure 1).
- Standing water level was obtained from NOW bore GW75000/1. Readings from this well allow comparison with the original recordings taken prior to the original approval (Table 2).

Reduced standing water level (RSWL mAHD) from these bores are presented in Figure 5.

4.1.2 Quarry floor observations

On 28th October 2014 an in-pit investigation was conducted to determine whether groundwater inflows could be identified within the current pit footprint (Thomson, 2014). The investigation included in-pit surveys and observations from quarry faces. Rainfall for the month of October was recorded at 47.6 mm at the Old Telegraph Rainfall Station, Maroota (BoM station no 67014). The following observations were recorded during the investigation (Thomson, 2014):

- In-pit elevations were recorded between 215 and 183.7 mAHD.

- Inspection across the pit faces and quarry floor did not identify pit seepages or pooled water.
- An unwanted clay band was recorded at 183.7 m.

The following conclusions were drawn from the investigation:

- No groundwater inflow was occurring at the current extraction depth of 183.7 m.
- The unwanted clay band at 183.7 m is of low permeability and is classed as an aquitard. Based on data from observation well PT84MW-6 the regional MTSGS is located below this depth.

Figure 4: Monitoring wells, Hodgons Quarry.

Table 3. Completion information for bore PT84MW6.

Bore Name	License number	Aquifer monitored	Easting	Northing	Surface Elevation	Total Depth (m BGL)	Total Depth (mAHD)	Screen Interval (m	Screened interval (m	Collar Height	SWL (m bTOC)	RSWL (mAHD)
PT84MW-6	10BL605696	MS (deeper)	314200	6295366	202.46	29	173.46	24-29	173.46-177.46	203.13	20.03	183.10

4.2 Baseline Monitoring Data

4.2.1 Groundwater levels

Hydrographs of reduced standing water level (RSWL) and cumulative deviation from mean monthly rainfall are presented in Figure 5. The hydrographs incorporate RSWL readings from the commencement of quarrying representing approximately 14 years of data.

The following general comments can be made with regard to Figure 5:

- Recently installed PT84MW-6 recorded a RSWL of 183.10 mAHD on 3/03/2015. This well represents the most accurate recording for the MTSGR at the location in question and corresponds with a period of above average rainfall (Figure 5). Water level in the well remains below the current quarry depth (183.7 m) and is likely confined by the “unwanted clay band” (Section 4.1.2).
- Private monitoring well PF167MW-1 (GW100649) recorded RSWL between 179.50 and 182.50 mAHD. Groundwater levels fell during the period February 2002 and September 2004 coinciding with below average rainfall. The most recent water level was recorded at 180.10 mAHD on 13/4/2005.
- Recent groundwater monitoring at 75000/1 (22/9/2014), located 1.3 km to the SW recorded a water level of 181.09 mAHD. This level is marginally higher than that recorded during the original EIS (180.19 mAHD) recorded in January 1998. There is no time series data between the two readings but the data confirms that water levels have not significant deviated over a 15 years period.

The locations of the above monitoring bores are shown on Figure 1

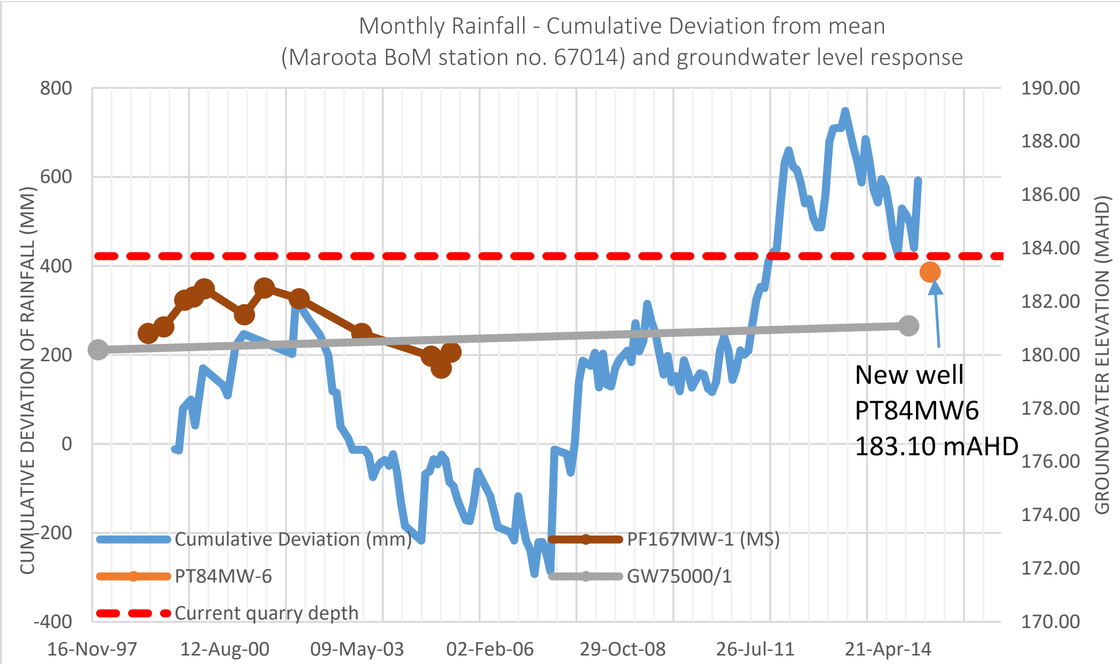

Figure 5: Groundwater hydrographs and cumulative deviation from the mean of monthly rainfall.

4.3 Proposed wet weather groundwater elevation

Based on well data (Figure 5), local and regional bores correlate with the water levels recorded from the EIS assessment (Woodward-Clyde, 1999). Monitoring from 1999 record water levels in the regional MTSGS between 178.64.5 and 184.23 mAHD.

A cross section showing the current landform and the proposed landform is presented as Figure 6. The wet weather elevation adopted by the original EIS assessment (existing consent) together with the revised wet weather elevation 2015 (this modification) are also shown on Figure 6 for comparison.

For the purpose of this assessment, PT84MW-6 is the most representative well and a maximum wet weather groundwater elevation is considered to be 183.10 mAHD. This would restrict the quarry pit depth to 185.10 mAHD. It should be noted however that the clay band identified at 183.7 mAHD locally confines the regional MTSGR, and quarrying to the preferred depth of 183.7 mAHD will not intersect groundwater.

In a recent submission to the Department of Planning and Environment (reference DA2671199 Mod 3), the NSW Office of Water stated that the highest water level measured beneath the site was 184.08 mAHD. We understand that this elevation was based on groundwater levels obtained from a historic bore known as PT84MW3, which no longer exists. Groundwater levels obtained from this bore were included in the original EIS (Woodward-Clyde, 1999) yet at this time, the approval to extract to 182 mAHD was based on a lower wet weather elevation of 180 mAHD recorded in other nearby bores.

The reason for neglecting the slightly higher groundwater elevation in PT84MW3 in the original EIS (and the original consent) was not clear, but as discussed under Section 3.4 above, a subsequent investigation indicated that the groundwater levels in PT84MW3 may be perched due to underlying clay layer and therefore water levels measured in PT84MW3 may not be representative of the MTSGR. It can be seen on Figure 6 that the bottom of PT84MW3 is completed above the bore screen of PT84MW6.

Given the uncertainty around PT84MW3, the groundwater level of 183.1 mAHD measured in monitoring bore PT84MW6 is considered to be the most reliable indication of groundwater elevation beneath the site and ongoing monitoring should be undertaken to confirm this. However, the groundwater level elevation of 184.08 mAHD and the extraction depth of 186.08 mAHD recommended by the NSW Office of Water should be adopted by Hodgson Quarry, and ongoing monitoring of the site bores (in particular PT84MW6) should be undertaken to confirm the groundwater elevations over time. The groundwater level monitoring data may be used to support changes to the extraction depth in the future.

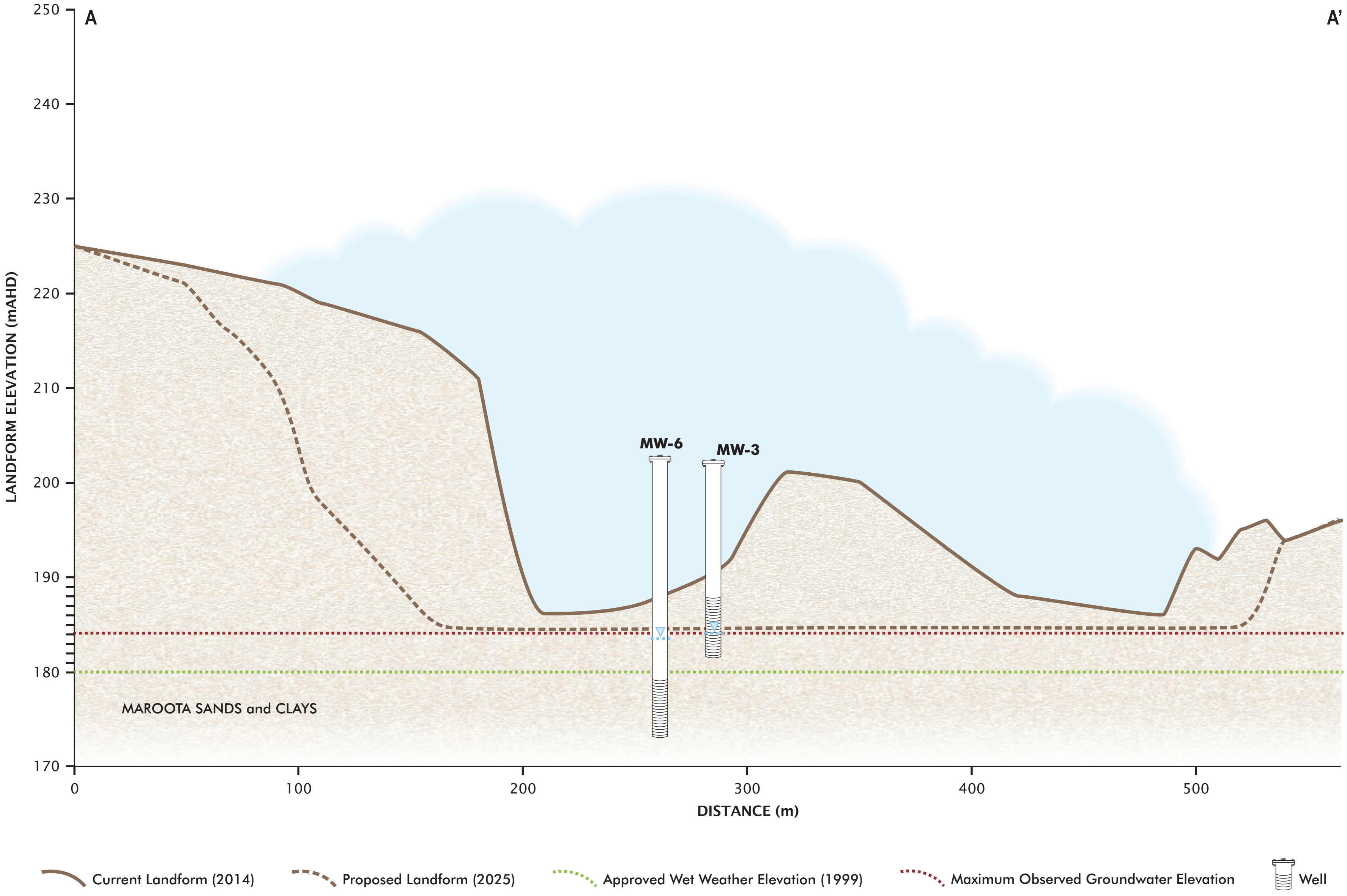

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Figure 6 | Representative Cross Section (for section line see Figure 2)

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5 Groundwater Monitoring

5.1 Existing Groundwater Monitoring Program

The location of the current groundwater monitoring bore (PTMW-6) is presented in Figure 4, with monitoring frequency presented in Table 4.

Table 4: Summary of existing groundwater monitoring program

Property	Bore	Monitoring	Installed	Monitoring data since	Water level frequency	Water quality frequency
Lot 2 DP228308	PT84MW-6	MTSGS	2015	January – March 2015	monthly	biannual

5.2 Proposed Groundwater Monitoring Program

Although quarrying will not intercept the regional groundwater (MTSGS), monitoring will be continued for the life of the project to detect any unforseen groundwater level or quality impacts, including any impacts to existing users. The ongoing monitoring program is summarised in Table 5. This program has been designed to detect changes in groundwater levels and groundwater quality. Key aspects include:

- Ongoing monitoring for SWL in the MTSGS.
- Water quality sampling on a biannual basis.
- Inspection of seepages across the quarry walls and floor. This will be correlated with rainfall records to assess whether groundwater or surface water inflows (surface runoff or incident rainfall) are likely. Any observed pooling or discharges should be quantified and analysed for salinity and major ions.

Table 5: Proposed groundwater monitoring program

During mining	Purpose	Weekly	Fortnightly	Monthly	Bi-annual
PT84MW-6	Ensure mining is maintained above the MTSGS			Water level (to verify automated pressure transducers)*	
	Monitor any unforseen water quality impacts, ensuring that there is no change in overall beneficial use category >40 m from site				Field Parameters EC,TSS, pH, Turbidity
	Monitor unforseen regional impacts, ensure there are no WL/WQ impacts to neighbouring private bores				
	Ongoing compliance with the WSP and AIP	No pit seepages are expected, but install a surveyed water level gauge in the unlikely event that measurable inflows occur.^ Water levels and quality to be quantified if seepage identified			
Post mining					
PT84MW-6	Monitoring of post mining water level and quality impacts and ensuring ongoing compliance with the WSP and AIP				Water level & Field Parameters

*PT84MW-6 will be fitted with an automatic pressure transducer. ^Inflows should be confirmed during dry periods to distinguish from internal surface drainage (i.e. from rainfall events). If pit seepages are detected, sample for field parameters, EC, TSS, pH and turbidity and present with rainfall records (cumulative deviation from mean monthly rainfall).

6 Management of Groundwater Impacts

6.1 Groundwater Management Strategy

The strategy for groundwater management is to minimise groundwater inflows from the MTSGS to the open cut and preservation of groundwater quality. It involves maintaining the depth of mining to an elevation which is at least 2 m above the 'wet weather' groundwater elevation. In this instance it could also be interpreted to extend to 2 m above the water cut, as the locally the MTSGS is confined by an impermeable clay layer (Thomson, 2014).

Aspects assessed to be at risk have been previously assessed by Woodward-Clyde (1999) and summarised in Section 3 of this report. Mitigation measures have been proposed for each potential impact including predicted and unpredicted impacts. As such the groundwater monitoring program specifically deals with:

- A mechanism for ensuring the project is compliant with the rules of the WSP and AIP (DPI, 2012).
- Unforseen impacts on groundwater levels on neighbouring properties and on any users of groundwater.
- Unforseen impacts on groundwater quality (including impacts from chemical storage areas).
- Periodic monitoring for local and regional impacts of the quarry on groundwater levels and quality during the project, and on a reduced basis for at least five years post quarrying.

Information gained from the monitoring program has been used to determine the pit extraction depth of 186.08 mAHD. This will ensure the pit floor remains at least 2 m above the 'wet weather' groundwater level of 184.08 m AHD, thereby mitigating any drawdown impact to the MTSGS.

It should be noted however that the current pit floor is approximately 183.7 mAHD with no observed in-pit seepages. The occurrence of the basal clay layer effectively precludes inflow from the underlying water table (it is an effective confining layer).This could form the basis of extending the extraction limit depth to 183.7 mAHD which would still be 1.7 m above the approved limited from the original EIS.

Regardless, ongoing groundwater monitoring serves to notify changes to the groundwater, quality or unforeseen discharges into the pit. Monitoring is necessary to indicate that abnormal conditions relating to quarrying have developed, as well as compliance with the rules of the WSP and AIP.

A Trigger Action Response Plan (TARP) for groundwater will be developed to focus upon appropriate trigger and response actions for the management or mitigation of impacts. The baseline monitoring program that is in place will have established triggers, which will be used to indicate levels of impact and trigger an appropriate response. The fundamental means of determining the magnitude of any impact and the need for further monitoring and/or remedial actions is based upon the impact assessment criteria detailed in Table 6. The responses (actions) documented in the table are proposed to ensure the timely and adequate management of impacts outside of the established trigger levels.

Table 6: Trigger Action and Response Plan

Impact	Observation	Strategy for Mitigation	Monitoring	Monitoring Action	Response
Groundwater level	Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the water sharing plan.	Baseline GWL data has been used to ensure depth of mining remains above the Maroota Tertiary Sands Groundwater Source. Regular review of monitoring data to ensure mining is maintained above the elevation of the regional water table.	PT84MW-6	**Water level**: If water level monitoring indicates increasing trends or confirmed pit inflows, increase monitoring frequency to weekly to establish trend	Investigate potential contributing factors: -Confirm trends or anomalies by repeating water level or quality sampling as required -Compare exceedance with climatic conditions -Engage a hydrogeologist to undertake a preliminary investigation and report on any identified changes. Where investigations determine that impacts are the result of Hodgsons Quarry operations or may potentially impact on adjacent bores or surface water users implement Section 6.2 of this report, which may include: Modify mine plan or obtain groundwater licence to offset impact;
Groundwater quality	Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Ensure all spillages are contained, diversion of dirty water into settling ponds, maintenance of machinery to be undertaken in work shop areas. Monitoring of pit will be undertaken as a first line of defence to detect & control the risk of groundwater contamination	PT84MW-6, In-pit surface expressions	**Water Quality**: Repeat sampling of bore and in pit water to confirm contamination event.	
Groundwater users	Reported decrease in yield or GWL outside of climatic variations. Reported decrease in water quality parameter outside of baseline variation	Baseline GWL data has been used to ensure depth of mining remains above the Maroota Tertiary Sands Groundwater Source. Regular review of monitoring data to ensure mining is maintained above the elevation of the regional water table.	PT84MW-6	**Water level**: Increase monitoring frequency to weekly to establish trend	
Pit inflows	Observed seepages from pit wall	Regular review of monitoring data to ensure mining is maintained above the elevation of the Maroota Tertiary Sands Groundwater Source. Monitoring of water quality in pit will be undertaken as a first line of defence to control the risk of groundwater contamination	PT84MW-6	**Water level**: Increase monitoring of bores to weekly to establish trend. **Water quality:** obtain comprehensive analysis from pit seepages. **Volume:** weekly record of pit seepages	

6.2 Hodgsons Quarry Responsible Impacts Procedure

Where investigations detailed in the TARP determine that groundwater impacts are the result of Hodgson's Quarry operations or may potentially impact on adjacent bores, the following procedure is actioned:

- Inform landholders adjacent to streams and/or private bore owners, and the NSW Office of Water of preliminary investigation outcomes, as appropriate.
- Undertake a detailed investigation and assess possible mitigation measures in consultation with the landowner and the NSW Office of Water.
- If deemed necessary prepare and implement a site mitigation/action plan to the satisfaction of the Department of Primary Industries (DPI), in consultation with the landowner and the NSW Office of Water.
- Conduct a review of results from the follow up investigation.

Further, the timing of the above includes, but is not limited to:

- Results of preliminary investigation reported within one week of completion.
- Commence preparation of detailed investigation including assessment of possible mitigation measures immediately.
- Commence preparation of mitigation/action within one week of the need being identified.

6.3 Notification of Significant Impact

Where a significant, confirmed impact to the environment or private landowner has occurred according to the TARPs, relevant agencies will be contacted immediately.

7 Assessment against the AIP and WSP

7.1 Aquifer Interference Policy (2012)

As detailed in this report, the depth of the development will not extend to the depth of the groundwater level for the MTSGR and the final landform depth will be restricted to **186.08 mAHD**. For this reason aquifer interference will not occur and the project is compliant with the rules of the AIP. For clarity however, all of the rules and requirements stipulated in the AIP have been summarised in Table 7 with reasons why rules are satisfied. Table 8 provides additional data to support the assessment of “minimal impact” as stipulated in the AIP (see page 26 of AIP, 2012).

Note: the Maroota Tertiary Sands aquifer falls under the category of a *highly productive alluvial aquifer* based on its characteristic geology (ie palaeochannel sands) and comprising groundwater of less than 1,500 mg/L total dissolved solids (TDS).

Table 7: Minimal impact considerations for aquifer interference activities. NB Table based on Table 1 of AIP (2012)

	Highly Productive Groundwater Sources					
	Water Table	**Summary of impact and monitoring**	**Water Pressure**	**Summary of impact and monitoring**	**Water Quality**	**Summary of impact and monitoring**
1. Alluvial Water Sources	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2 m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies(6) will need to demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2 m decline cumulatively at any water supply work then make good provisions should apply.	**Mitigation Measure:** Quarrying will be maintained 2 m above the wet weather regional groundwater level for the MTSGS. There will be no groundwater extraction or mine inflows during or post quarrying activities from the regional water table. This will mitigate any drawdown impact to high priority GDE's or culturally significant assets. **Monitoring**: Groundwater monitoring will be conducted on and off site. These wells will monitor groundwater level trends and detect any unforeseen impacts including detection of impacts > 40 m from the site.	1. A cumulative pressure head decline of not more than 40% of the "post water sharing plan" pressure head above the base of the water source to a maximum of a 2 m decline at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1.(a) above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	**Mitigation Measure:** Quarrying will be restricted to the MTSGS unit and will maintained 2 m above the wet weather regional groundwater level. The confined fractured rock Sydney Basin Central Groundwater Source is at depth and will not be intercepted or extracted during quarry activities. For this reason this principle is not applicable. **Monitoring**: Deep monitoring bores are already on site (GW75003, GW75004) that monitor the Sydney Basin Central Groundwater Source. These bores will be monitored and maintained during quarry operations to detect any unforseen groundwater impacts. This will be in addition to the shallow monitoring bore that targets the MTSGS.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity. 2. If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	**Mitigation Measure:** Quarrying will be maintained 2 m above the wet weather regional groundwater level for the MTSGS. There are no water quality impacts as a result of the project. Mitigation measures such as those listed in Table 6 will be implemented to prevent contamination to the groundwater source. There are no GDE or Water supply works identified in the greater area that could be impacted. **Monitoring**: Suitably constructed monitoring bores will be maintained on to detect any unforeseen groundwater quality impacts.

Table 8: Summary of AIP requirements to support notion of "minimal impact" from quarry activities

Requirement	Summary of compliance	Reference of compliance
Establishment of baseline groundwater conditions including groundwater depth, quality and flow based on sampling of all existing bores in the area potentially affected by the activity, any existing monitoring bores and any new monitoring bores that may be required under an authorisation issued under the Mining Act 1992 or the Petroleum (Onshore) Act 1991	Baseline groundwater and quality data has been captured since 1998 for shallow and deep bores, over a range of climatic variations	Section 4 of this report; Woodward-Clyde (1999);
A strategy for complying with any water access rules applying to relevant categories of water access licences, as specified in relevant water sharing plans. For example, returning water of an acceptable quality to the affected water source during periods when flows are at levels below which water users are not permitted to pump	Project is in accordance with the rules of the WSP, in particular meets the criteria stipulated for both the MTSGS and The Sydney Basin Central Groundwater Source.	Section 4 and 5 of this report.
Details of potential water level, quality or pressure drawdown impacts on nearby water users who are exercising their right to take water under a basic landholder right. Consideration will need to be given to any relevant distance restriction requirements that may be specified in any relevant water sharing plan or any remediation measures to address these impacts	No impact to existing users as the MTSGS will not be intercepted as part of mining activities, nor will the Sydney Basin Central Groundwater Source.	Section 4 and 5 of this report.
Details of potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources	No impact to existing users as the MTSGS will not be intercepted as part of mining activities, nor will the Sydney Basin Central Groundwater Source.	Section 4 and 5 of this report.
Details of potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems	No GDE's identified in the study area	Woodward-Clyde (1999); Section 3.3 (this report).
Details of potential for increased saline or contaminated water inflows to aquifers and highly connected river systems	Mitigation measures for contamination are in place	Section 6, Table 6 of this report
Details of the potential to cause or enhance hydraulic connection between aquifers	Quarrying will be above the MSTGS, therefore there is no opportunity for hydraulic connection to the underlying Sydney Basin Central Groundwater Source.	Section 4 of this report
Details of the potential for river bank instability, or high wall instability or failure to occur	Mining will not be carried out near any creek or river.	Woodward-Clyde, 1999
Details of the method for disposing of extracted water (in the case of coal seam gas activities)	N/A	N/A

7.2 Compliance with Water Sharing Plan (2011)

The MTSGS and the Sydney Basin Central Groundwater Source are the gazetted groundwater resources underlying the development area. Geological mapping conducted the Geological Survey of NSW (Etheridge, 1980 as cited in Woodward-Clyde, 1999) confirms that the proposed development is fully encapsulated by outcropping Maroota Sands, with the Hawkesbury Sandstone located further to the west (see Figure 1) and at depths beyond the proposed final landform depth. For this reason rules in the Plan have only been considered against the Maroota Tertiary Sands Groundwater Source as detailed in Table 6.

Table 9: Summary spreadsheet of WSP rules and compliance for the MTSGS.

Access Rules	Relevance for this Development	Reason why rule is not applicable	Reference
Granting of access licenses may be considered for a listed number of activities	Not applicable	-The proposed work modifications do not seek an application license because the regional Maroota Sands aquifer will not be intercepted. Excavations from quarrying will extend to a maximum depth of 185.10 mAHD, 2 m above the approved 'wet weather' groundwater elevation (183.10 mAHD).	Section 4
Rules for managing water allocation accounts			
Carryover	Not applicable	-no application license is being sought therefore amendments to license conditions are not required -The Maroota Tertiary Sands Groundwater Source will not be intercepted during site operations.	Section 4
Rules for Managing Access Licenses			
Managing surface and groundwater connectivity	Not applicable	-the existing pit is >40 m from the high bank of any river or creek as indicated in Figure 1 of this report. -The nearest groundwater seepage points are over 1 km to the south-west and north-east	Groundwater seepage points are

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Access Rules	Relevance for this Development	Reason why rule is not applicable	Reference
		of the quarry site. -the MTSGS will not be intercepted over the life of quarrying therefore surface water impacts from groundwater related activities cannot occur. -groundwater is not abstracted as part of site operations. Water use is restricted to surface run-off captured in dams.	located on Figure 1 of this report
Rules for granting or amending water supply works approvals			
to minimise interference with neighbouring water supply networks	Not applicable	for the above reasons interference with neighbouring bores cannot occur.	
To protect bores located near contamination		-No application licence is being sought; -The development does not intercept or abstract groundwater and therefore will not impact hydraulic gradients, or facilitate the mobilization of any contamination in the vicinity; -The development remains entirely in the unsaturated zone. -No areas of contamination have been identified within 500m of DP 228308 and DP 312327;	

Access Rules	Relevance for this Development	Reason why rule is not applicable	Reference
To protect bores located near sensitive environmental areas	Not applicable	-No groundwater supply works are being carried out as part of the development; -No interception of the groundwater source will take place. Groundwater will not be intercepted or taken during quarrying either through pumping or inflows from open voids. -The development remains entirely above the 'wet weather' groundwater elevation and will not impact on any discharges to / from sensitive environmental areas.	Figure 1 shows the nearest environmental receptors are > 1 km from the quarry site.
To protect groundwater dependent culturally significant sites	Not applicable	-No groundwater supply works are being carried out as part of the development; -No interception of the groundwater source will take place. Groundwater will not be intercepted or taken during quarrying either through pumping or inflows from open voids. -The development remains entirely above the 'wet weather' groundwater elevation and will not impact on any discharges to / from sensitive environmental areas.	
Rules for replacement groundwater supply works	Not applicable	- groundwater replacement works are not being conducted. The proposed work modifications relate specifically to the mining plan, extraction methods and the estimated mine life.	
Rules for the use of water supply works approvals			

Access Rules	Relevance for this Development	Reason why rule is not applicable	Reference
To manage bores located near contaminated sites	Not applicable	-The proposed work modification does not involve groundwater extraction or interception of gazetted groundwater sources for any purpose. -no contaminated site exists within 500 m of the proposed operation	
To manage the use of bores within restricted distances	Not applicable	-The proposed work modification does not involve groundwater extraction or interception of gazetted groundwater sources for any purpose.	
To manage the impacts of extraction	Not applicable	-The proposed work modification does not involve groundwater extraction or interception of gazetted groundwater sources for any purpose.	
Limits to the availability of water			
Available water determinations (AWD's)	Not applicable	-The proposed work modification does not involve groundwater extraction or interception of gazetted groundwater sources for any purpose.	

References

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NSW Office of Water (2011). Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources. http://www.legislation.nsw.gov.au/viewtop/inforce/subordleg+111+2011+cd+0+N/. Electronically accessed 19/9/2014.

Woodward-Clyde (1999). *Lots 1 and 2, DP228308, Lot 2, DP312327, Maroota, Development Application. Groundwater Impact Assessment.*

Appendix 17

Modified Final Landform Plan

Plan of:	Hodgson Maroota Quarry Final Landform	Location:	Hodgson Maroota Quarry, Maroota	Source:	Photomapping	Our Ref:	V:Jobs_HMA Maroota\2014DA 2014\Figures\Fig 6(VB)
Figure:	SIX	Council:	Hills Shire Council	Survey:	December 2013	Plan By:	TO
Sheet:	1 of 1	Tenures:	N/A	Projection:	Plan	Project Manager:	GVT
Version/Date:	VB 02/09/2015	Client:	Hodgson Quarry Products Pty Ltd	Contour Interval:	1m	Office:	Thornton Scale: