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GEOLOGICAL & ENVIRONMENTAL CONSULTANTS

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7 June 2019

Ms Genevieve Seed
Department of Planning and Environment
320 Pitt Street
SYDNEY NSW 2001

Sent by email to:
genevieve.seed@planning.nsw.gov.au

Dear Genevieve,

Re: Brandy Hill Quarry Extension Project (SSD 5899) – Response to EPA Comments dated 14 February 2019

This correspondence and attached report provide a response to comments received from the NSW Environment Protection Authority (EPA) (dated 14 February 2019 – reference DOC19/119005, EF13/3278) regarding the Brandy Hill Quarry Extension Project (the Project). The comments and requests have been reviewed by consultants from Vipac Engineers and Scientists (Vipac) who prepared the Air Quality Assessment Report (AQA Report). I have enclosed an Addendum to the AQA Report prepared by Vipac (**Attachment 1**). The Addendum to the AQA Report addresses each of the EPA comments and provides a response to each comment. The outcomes of remodelling undertaken for each operating scenario is also provided. In order to address the EPA queries regarding technical assumptions for modelling, comprehensive information regarding modelling calculations, assumptions and emission estimates have been provided.

Vipac has consulted with the EPA in preparing a response to the queries regarding the use and justification of data applied for modelling of predictive dust dispersion for the Project. During this consultation the EPA expressed a preference that the air quality impact assessment continue to apply the assumed background data sourced from the Beresfield monitoring station. This required that the assessment continue to assume high particulate matter concentrations, which in some cases approaches or exceeds the non-discretionary assessment criteria. A Level 2 Contemporaneous Assessment was therefore required for both 24-hr PM_{10} and 24-hr $PM_{2.5}$ in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016).

In summary, the assessment has reaffirmed previous conclusions relating to potential air quality impacts, that being, the proposed Project was unlikely to result in exceedances of air quality assessment criteria.

Vipac has remodelled all operational stages and confirmed the following general conclusions.

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- Average annual TSP – Including the assumed annual average background concentration of 41.8µg/m^3, the cumulative annual average TSP is predicted to be less than 48.0µg/m^3 at all residences, which is below the criterion of 90.0µg/m^3.
- 24-Hour PM_{10} – Under all stages of the Project no additional exceedances of the 24-Hour PM_{10} criteria would occur. The highest incremental contribution to 24-Hour PM_{10} would be 21.7µg/m^3 under worst-case scenario conditions.
- Average annual PM_{10} – Under all stages of the Project the annual average PM_{10} concentrations would not exceed 23.8µg/m^3, which is below the assessment criteria of 25.0µg/m^3.
- 24-Hour $PM_{2.5}$ – Under all stages of the Project no additional exceedances of the 24-Hour $PM_{2.5}$ criteria would occur. The highest incremental contribution to 24-Hour $PM_{2.5}$ would be 5.0µg/m^3 under worst-case scenario conditions.
- Annual average $PM_{2.5}$ – The background data at the Beresfield monitoring station has recorded high annual average $PM_{2.5}$ concentrations and therefore the assumed background concentration of 8.1µg/m^3 already exceeds the criteria of 8.0µg/m^3. The incremental change in $PM_{2.5}$ under all stages of the Project did not exceed 0.93 µg/m^3. It is concluded that the Project contribution to annual average $PM_{2.5}$ would be minor.
- Respirable Crystalline Silica (RCS) – Under all stages of the Project the annual average RCS concentrations would not exceed 0.73µg/m^3, which is below the adopted assessment criteria of 3.0µg/m^3.
- Deposited Dust – The maximum incremental increase in dust deposition would be 0.3g/m^2/month and the cumulative monthly level of deposited dust is 2.4g/m^2/month, which complies with the cumulative deposited dust criterion of 4g/m^2/month.

Vipac is confident that each of the comments provided by the EPA have been addressed comprehensively. Should you have any questions on the above, please feel free to address them to myself or to Andrew Driver at Hanson.

Yours sincerely

Nick Warren
Principal Environmental Consultant

Enclosed: Attachment 1 – Brandy Hill Quarry Expansion Project Air Quality Addendum (Vipac Engineers and Scientists)

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Attention:	Andrew Driver	Date:	2019-06-03
Company:	Hanson Construction Materials	Pages:	1 of 29
Email:	Andrew.Driver@hanson.com.au		
From:	Steve Thomas	Document No:	29N-14-0060 -8551052-0-V1
Subject:	Brandy Hill Quarry Air Quality Addendum - Brandy Hill Quarry Expansion		

This correspondence is Commercial-in-Confidence.

Dear Andrew,

Vipac Engineers and Scientists Ltd (Vipac) provides the following Addendum to the Air Quality Assessment (AQA) Report for the Brandy Hill Quarry Expansion.

1. INTRODUCTION

This Addendum addresses the comments from the NSW Department of Planning & Environment (DPE) and the NSW Environmental Protection Authority (EPA) regarding the Air Quality Assessment (AQA) Report (Vipac document 29N-14-0060-TRP-517221-11, dated 11 December 2018, hereafter referred to as the AQA Report) for the Brandy Hill Quarry Expansion Project.

The EPA outlined comments regarding:

- Inconsistent or inaccurate data in the emissions inventory;
- Model assumptions underestimating emissions;
- Comparison of CALMET data to observational data
- Validation of CALMET model using the same data to drive TAPM;
- Practicality of measures in the Air Quality Management Plan; and
- Justification of removing exceedances of the background 24-hour average PM_{10} data.

The following subsections provide a response to the issues raised by the EPA and DPE. Additional information regarding emissions input data and justification of the meteorological data used in the model are provided as appendices to this Addendum.

The EPA has requested that Vipac continue to apply the previously assumed background dust levels based on publicly available monitoring records at Beresfield. The updated impact assessment has therefore retained the very conservative estimates of background dust levels in order to satisfy the comments from the EPA. The outcomes of updated dust dispersion modelling are presented in Appendix B.

The updated impact assessment (Appendix B) demonstrates that the Brandy Hill Quarry Expansion Project is predicted to satisfy air quality assessment criteria in each of the modelled operational stages.

2. INCONSISTENT OR INACCURATE DATA IN THE EMISSIONS INVENTORY

The EPA recommends the proponent resolves the issues with the emissions inventory, including reviewing and providing calculations for emissions. Further, the scenarios assessed should be justified and include the worst-case emissions over the life of the project. Peak daily emissions are to be modelled for each scenario.

The EPA also provided examples of source types for which it was unable to replicate the estimated emissions including:

- Haul trucks
- Wind erosion of pits
- Conveyors
- Product trucks
- Blasting and drilling
- Mobile plant

For the majority of these source types, Vipac provided annual average production data in the AQA Report to estimate the worst-case emissions, rather than peak hourly data extrapolated to a whole day. Each of the scenarios have been remodeled applying peak hourly data based on a maximum attainable production flow of 450 t/h for the future Stage scenarios. Flow rates at the equipment and on conveyors have been adjusted accordingly. The outcomes of the remodeled scenarios are provided in Appendix B to this addendum.

The following sections briefly provide examples of the calculations for the source types specified above for the Current Stage Scenario which is modelled based on the annual average extraction rate of 0.7Mtpa. Further details of the input data used for the calculations of all of the Stage scenarios are provided in Appendix A.

2.1. Haul Trucks

The dust emission rate from haul roads has been calculated using the following equation:

$$Emissions = \left(\frac{0.4536}{1.6093}\right) x\ k\ x\ \left(\frac{s_{(\%)}}{12}\right)^{\alpha} x\ \left(\frac{W_{(t)}}{3}\right)^{0.45} x\ (1\text{-}CE/100)$$ kg /VKT

For example, for the Current Stage TSP emissions for the main haul road:

k = 4.9 for TSP
s(%) = surface material silt content (7.5%)
W = vehicle weight (93 tonnes laden and 39 tonnes unladen)
a = 0.7 for TSP
VKT = 9.1 VKT/day laden and 9.1 VKT/day unladen
CE = Control efficiency (50% for level 1 watering)

Therefore, total TSP Emissions for the main haul road = 0.43 g/s

2.2. Wind erosion

The emission rate for dust from stockpiles and pits has been calculated using the following equation for TSP:

$$Emissions = 1.9\ x\ \left(\frac{s_{(\%)}}{1.5}\right)\ x\ 365\ x\ \left(\frac{365-p}{235}\right)\ x\ \left(\frac{f_{(\%)}}{15}\right)\ x\ (1\text{-}CE/100)$$ kg /ha /yr

For example, for the Current Stage TSP emissions:

s(%) = silt content (7.5%).
p = 97 days where rainfall is greater than 0.25 mm.
$f_{(\%)}$ = 7.9%.
ha = 10.6 Ha (pits) + 2.23 Ha (stockpiles) = 12.83 Ha
CE = Control efficiency (0% for Current Stage activities)

Therefore, total TSP Emissions = 0.85 g/s.

No controls are considered practical for wind erosion from pits and are therefore not modelled. However, it is proposed that the stockpiles are controlled by watering (i.e. a 50% control efficiency).

2.3. Conveyors

The dust emission rate from the individual conveyor transfer points has been calculated using the following equation:

$$Emissions = k\ x\ 0.0016\ \frac{\left(U/2.2\right)^{1.3}}{\left(M/2\right)^{1.4}}\ x\ (1\text{-}CE/100)$$ kg /tonnes transferred

For example, for the Current Stage TSP emissions for the truck to screen conveyor:

k = 0.74 for TSP,
U = mean wind speed (2.4 m/s)
M = material moisture content (1%)
Tonnes transferred = 80 t/hr
CE = Control efficiency (0% for current stage activities)

Therefore, Current Stage TSP emissions for the truck to screen conveyor = 0.078 g/s.

2.4. Product trucks

Dust emissions from the product truck haulage were estimated in the same manner as dust emissions from haul roads (Section **Error! Reference source not found.**), however, it is noted that an incorrect vehicle weight was adopted for the estimations in the AQA Report. The recalculated emissions, which are less than the emissions previously adopted, for all pollutants have been incorporated into remodeled scenarios.

$$Emissions = \left(\frac{0.4536}{1.6093}\right)\ x\ k\ x\ \left(\frac{s_{(\%)}}{12}\right)^{\alpha}\ x\ \left(\frac{W_{(t)}}{3}\right)^{0.45}\ x\ (1\text{-}CE/100)$$ kg /VKT

For example, for the Current Stage TSP emissions from the stockpile to weighbridge:

k = 4.9 for TSP
$s_{(\%)}$ = surface material silt content (7.5%)
W = vehicle weight (99 tonnes laden and 33 tonnes unladen)
a = 0.7 for TSP
VKT = 5.5 VKT/day laden and 5.5 VKT/day unladen
CE = Control efficiency (50% for level 1 watering)

Therefore, total TSP Emissions from the stockpile to weighbridge = 0.254 g/s.

2.5. Blasting and drilling

As noted by the EPA, the modelling of blasting and drilling has assumed emissions are averaged over every hour of the year. However, blasting and drilling are discrete events and take place once/week and once/day respectively. The blasting and drilling emissions have therefore been re-estimated as discrete events for ½ hour per week and, since blasting is typically undertaken at 12pm on Fridays the emissions have been modelled at 12pm.

Blasting drilling TSP Emissions have been recalculated as:

- 6.22 g/s for the Current Stage; and
- 5.535 g/s for the three future stages modelled (including a 70% control efficiency for drilling).

2.6. Mobile plant

The mobile crusher will be enclosed for all future stages. The mobile crusher has been included in the modelling results for the Current Stage as reported in the Appendix B of this Addendum.

The dust emissions from dump tuck activities are accounted for in the stockpiles loading and unloading.

3. MODEL ASSUMPTIONS UNDERESTIMATING EMISSIONS

The three future stages of expansion were selected as those which can achieve the maximum attainable production flow and a worst case for proximity or potential impact of activities to the nearest sensitive receptors. The modelled scenarios are also consistent with those adopted for the noise assessment. The Current Stage scenario has also been modelled for comparison.

4. COMPARISON OF CALMET DATA TO OBSERVATIONAL DATA

As discussed in Section 7.1 of the AQA Report, the meteorological dataset developed as input for dispersion modelling has been shown to be representative of long term local conditions at the Tocal BoM Station. It is correctly noted by the EPA that data from this Station was used for assimilation in the generation of the TAPM data.

Appendix C of this Addendum compares the modelled dataset with measured meteorological data at the Beresfield Monitoring Station. As discussed in Appendix C the modelled dataset is considered representative of expected conditions at the site.

Further justification for the selection of the 2013 dataset by comparison with five consecutive years of measured meteorological data at the Beresfield Monitoring Station has also been provided in Appendix E of the AQA Report.

5. PRACTICALITY OF MEASURES IN THE DRAFT AIR QUALITY MANAGEMENT STRATEGY

Inconsistencies between the modelled mitigation measures and those proposed in the AQMP have been addressed in the emissions estimation and impact assessment results. In particular, in relation to the watering of haul roads which is and will be undertaken continuously onsite.

6. JUSTIFICATION OF REMOVING EXCEEDANCES OF THE BACKGROUND 24-HOUR AVERAGE PM10 DATA

Background data which exceeded the relevant Approved Methods criteria was removed in the AQA Report to demonstrate that no additional exceedances of the criteria were caused by the proposed expansion activities. Inclusion of this data was considered to provide confusing results for lay person review as the exceedances were not caused by the Quarry operations but related to background levels. As requested by the EPA, the results of the modelling in this Addendum (Appendix B) are now provided including the exceedances.

It should be noted that incremental concentrations represent dust generated by the Quarry and demonstrate that Quarry contributions are well below assumed background levels.

We trust that this sufficiently addresses DPE's and EPA's comments, and additional clarification can be provided if required.

Yours sincerely,

VIPAC ENGINEERS & SCIENTISTS LTD

Steve Thomas
Principal

AUTHORISED BY:

Jackson Yu MAAS
Team Leader

Appendix A : EMISSIONS INPUT DATA

A.1 ACTIVITY OVERVIEW

A.1.1 OPERATING HOURS

Extraction and processing of material has been modelled as 24 hours per day whilst the construction of the bund has been modelled as 12 hours per day.

A.1.2 EXTRACTION RATES

The current extraction rate is 0.7 Mtpa and this expansion proposes a future extraction rate of 1.5 Mtpa for Stages 1, 2 and 4.

Table A-1: Extraction Rates Modelled

Activity	Modelling Scenario			
	Current	Stage 1	Stage 2	Stage 4
Annual Extraction Rate (Mtpa)	0.7	1.5	1.5	1.5
Daily Extraction Rate (tonnes)	1,918	4,110	4,110	4,110

A.1.3 BARRIER CONSTRUCTION

The construction of amenity barrier will occur in Stage 1. This equates to 24,198 m3 of overburden per annum moved to create the bund. One excavator will be active on the barrier during construction.

A.1.4 HAUL ROADS

Haul road locations for each scenario were provided by Hanson and incorporated into the model.

Table A-2: Haul Road Lengths Modelled

Total Haul Road Length	Modelling Scenario			
	Current	Stage 1	Stage 2	Stage 4
Extraction Pit (km)	1.4	0.7	0.7	0.7
Processing Area (km)	1.8	1.8	1.8	0.9

A.1.5 SILT CONTENT

Silt content data for the quarry was provided by Hanson for particulates > 75 and < 2 um. Using the data the following silt content percentages were derived 7.5% for TSP, 4.5% for PM_{10} and 2% $PM_{2.5}$.

A.1.6 PRODUCTION RATES

The current production rate is 0.7 Mtpa and this expansion including improved production efficiencies will allow for a maximum production rate of 450tph.

Table A-3: Production Rates Modelled

Activity	Modelling Scenario (tph)			
	Current	Stage 1	Stage 2	Stage 4
Grizzley Scalper Screen 1	80	450	450	450
Jaques Toggle Jaw	62	347	347	347
Screen 2	72	407	407	407
Scalpes	13	74	74	74
Jaques 4'HITX	63	354	354	354
Screen 3	75	420	420	420
Barmac surge pile	15	84	84	84
barmac	15	84	84	84
main surgepile	52	292	292	292
allis CSS	51	287	287	287
kawasaki 1200l css	15	82	82	82
screen 4	80	452	452	452
screen 5	35	197	197	197

A.1.7 CONVEYING AND TRANSFER RATES

Table A-4 provides the transfer rates modelled in order to achieve the maximum production rates outlined in Table A-3.

Table A-4: Transfer Rates Modelled

Activity	Modelling Scenario (tph)			
	Current	Stage 1	Stage 2	Stage 4
truck to screen 1	79.9	450.0	450.0	450.0
screen 1 to screen 2	79.9	450.0	450.0	450.0
screen 2 to scalps	13.1	74.0	74.0	74.0
screen 2 to screen 3	7.6	43.0	43.0	43.0
screen 2 (via jaques) to screen 3	62.9	354.0	354.0	354.0
screen 3 to saramat surge pile	14.9	84.0	84.0	84.0
Barmac surgepile to barmac 7000	14.9	84.0	84.0	84.0
main surge pile	51.9	292.0	292.0	292.0
baramac x2	14.9	84.0	84.0	84.0
main surge pile to allis	46.2	260.0	260.0	260.0
allis to kawaski	80.4	453.0	453.0	453.0
screen 4 to feed	19.4	109.0	109.0	109.0
screen 4 to screen 5	35.0	197.0	197.0	197.0

A.1.8 STOCKPILE LOADING

Table A-5 provides the stockpile rates modelled in order to achieve the maximum production rates outlined in Table A-3.

Table A-5: Stockpile Loading Rates Modelled

Stockpile	Modelling Scenario (tph)			
	Current	Stage 1	Stage 2	Stage 4
14mm	12.4	70	70	70
10mm	10.3	58	58	58
7mm	7.6	43	43	43
dust1	4.4	25	25	25
20mm	16.9	95	95	95
dust2	9.2	52	52	52
Barmac surgepile	14.9	84	84	84
main surgepile	51.9	292	292	292
Scalpes	13.1	74	74	74

Table A-6 and Table A-7 outline the emission factors and key parameters applied in the emissions estimation.

Table A-6: Source type Emission Factors applied

Source type	TSP Emission factor	PM_{10}/TSP ratio	$PM_{2.5}$/TSP ratio	Units
Pit Activities				
Excavator on Overburden	0.025	0.48	0.105	kg/t
Dozer on overburden	0.025	0.48	0.105	kg/t
Grader	0.19	0.31	0.02	kg/VKT
Blasting/drilling:				
Drilling	0.59	0.52	0.052	kg/hole
Blasting	9.43	0.52	0.052	kg/blast
Wind erosion:				
stockpiles/pits/haul roads	0.24	0.3	0.067	kg/ha/h
Processing & Handling:				
Conveying/Transfers	0.0035	0.47	0.07	kg/t
Crushing	n/a	-	-	
Screening	0.0125	0.34	0.05	kg/t
Loading stockpiles	0.0001	0.5	0.075	kg/t
Unloading stockpiles	0.03	0.42	0.07	kg/t
Trucks dumping overburden	0.012	0.35	0.02	kg/t
Loading to trucks	0.0001	0.5	0.075	kg/t
Wheel generated dust:				
Unpaved main and pit haul roads (laden)	4.86	0.175	0.0085	kg/VKT

Source type	TSP Emission factor	PM_{10}/TSP ratio	$PM_{2.5}$/TSP ratio	Units
Unpaved main and pit haul roads (unladen)	3.31	0.175	0.0085	kg/VKT
Unpaved processing haul roads (laden)	5.01	0.175	0.0085	kg/VKT
Unpaved processing haul roads (unladen)	2.93	0.175	0.0085	kg/VKT
Concrete batching:				
	0.1	0.5	0.075	kg/t

Table A-7: Parameters applied in emissions estimation

Parameter ID	Value	Units	Description	Data source
U	2.4	m/s	mean wind speed	BoM meteorological data set
W	99	t	Truck laden weight	client supplied
W	30	t	Truck unladen weight	client supplied
W	93	t	Truck laden weight	client supplied
W	39	t	Truck unladen weight	client supplied
p	97	days	rainfall > 0.25mm	BoM data
f	7.9	%	% time winds > 5.4m/s	BoM data
Holes	6	Holes/day	Holes drilled per day	Client supplied
A	1225	m^2/blast	Area blasted	Client supplied
B	1	Blast/week	Blasts per week	Client supplied
s	6	%	Silt content	Client supplied
Wind erosion area:				
Stage 1	1.5×10^5	m^2	area	Derived from plans
Stage 2	2.2×10^5	m^2	area	Derived from plans
Stage 4	3.4×10^5	m^2	area	Derived from plans
Concrete batching	36,000	t/year	Concrete production	Client supplied
Concrete washout	20,000	t/year	Recycled concrete	Client supplied

A.2 EMISSION CONTROLS APPLIED

Table A-8 outlines the control efficiencies were applied to each modelling scenario.

Table A-8: Control Efficiencies Applied to Emission Estimation

Activity	Modelling Scenario			
	Current	Stage 1	Stage 2	Stage 4
Haul Roads	Watering Level 1 (50%)	Watering Level 2 (75%) & < 44kmh speeds (44%)	Watering Level 2 (75%) & < 44kmh speeds (44%)	Watering Level 2 (75%) & < 44kmh speeds (44%)
Crushing	-	Enclosed (100%)	Enclosed (100%)	Enclosed (100%)
Screening	-	Enclosed (100%)	Enclosed (100%)	Enclosed (100%)
Loading Stockpiles	Water Sprays (50%)	Water Sprays (50%)	Water Sprays (50%)	Water Sprays (50%)
In-Pit Retention	-	-	-	NPI reductions
Conveyors	-	Enclosure (70%)	Enclosure (70%)	Enclosure (70%)
Construction Barrier Wind Erosion	-	-	Revegetation (99%)	Revegetation (99%)

A.3 EMISSION ESTIMATION SUMMARY

Tables A-9 to A-12 provide a tabulated summary of the activity data and emissions estimates for each source type.

Table A-9: Summary of Emissions Estimation – Current Stage

Source	Length	Area	Activity		Control Factor (%)	Emission (g/s)		
	(m)	(m^2)	Value	Units		TSP	PM_{10}	$PM_{2.5}$
Excavator			719	t/day	0	0.208	0.100	0.022
Excavator			719	t/day	0	0.208	0.100	0.022
Blasting			1	Blast/week	0	5.24	2.73	0.27
Drilling			6	Holes/day	0	0.98	0.52	0.052
Front End Loader			719	t/day	0	0.208	0.100	0.022
Front End Loader			719	t/day	0	0.208	0.100	0.022
Wind erosion Pit1		66009			0	0.436	0.130	0.030
Wind erosion Pit2		40028			0	0.262	0.080	0.018
Dump Truck			80	t/hr	0	1.1E-03	5.5E-04	8.3E-05
Dump Truck			80	t/hr	0	1.1E-03	5.5E-04	8.3E-05
Hauling (laden & unladen)	1193		5.5	VKT/day	50	0.254	0.045	0.002
Hauling (laden & unladen)	375		1.7	VKT/day	50	0.08	0.014	0.001
Hauling (laden & unladen)	213		1	VKT/day	50	0.045	0.008	0.001
Hauling (laden & unladen)	685		9.1	VKT/day	50	0.432	0.076	0.004
Hauling (laden & unladen)	770		10.3	VKT/day	50	0.485	0.085	0.004
Front End Loader			60	t/hr	0	0.208	0.100	0.022
Front End Loader			60	t/hr	0	0.208	0.100	0.022
Crushers 1 to 5			205	t/hr	100	0	0	0
Mobile Crusher			2.3	t/hr	0	0.019	0.008	0.0004
Screen 1			80	t/hr	0	0.277	0.095	0.014
Screen 2			72	t/hr	0	0.251	0.086	0.013
Screen 3			75	t/hr	0	0.259	0.089	0.013
Screen 4			80	t/hr	0	0.279	0.096	0.014
Screen 5			35	t/hr	0	0.121	0.042	0.006
Loading stockpiles 1			13	t/hr	50	1.83E-04	9.13E-05	1.83E-04
Loading stockpiles 2			15	t/hr	50	2.07E-04	1.04E-04	2.07E-04
Loading stockpiles 3			52	t/hr	50	7.20E-04	3.60E-04	7.20E-04
Loading stockpiles 4			12	t/hr	50	1.73E-04	8.63E-05	1.73E-04
Loading stockpiles 5			10	t/hr	50	1.43E-04	7.15E-05	1.43E-04
Loading stockpiles 6			8	t/hr	50	1.06E-04	5.30E-05	1.06E-04
Loading stockpiles 7			4	t/hr	50	6.17E-05	3.08E-05	6.17E-05
Loading stockpiles 8			17	t/hr	50	2.34E-04	1.17E-04	2.34E-04
Loading stockpiles 9			9	t/hr	50	1.28E-04	6.41E-05	1.28E-04
Loading stockpiles 10			15	t/hr	50	2.07E-04	1.04E-04	2.07E-04
Stockpile wind erosion 1 to 10		22391			0	0.148	0.044	0.007
Conveyors 1 to 19			631	t/hr	0	0.613	0.290	0.044

Table A-10: Summary of Emissions Estimation –Stage 1

Source	Length	Area	Activity		Control Factor (%)	Emission (g/s)		
	(m)	(m^2)	Value	Units		TSP	PM_{10}	$PM_{2.5}$
Excavator			4050	t/day	0	1.172	0.563	0.123
Excavator			4050	t/day	0	1.172	0.563	0.123
Blasting			1	Blast/week	0	5.24	2.73	0.27
Drilling			6	Holes/day	70	0.295	0.155	0.015
Front End Loader			4050	t/day	0	1.172	0.563	0.123
Front End Loader			4050	t/day	0	1.172	0.563	0.123
Wind erosion Pit1		104076			0	0.688	0.206	0.046
Wind erosion Pit2		47671			0	0.314	0.094	0.020
Dump Truck			225	t/hr	0	0.006	0.003	0.0005
Dump Truck			225	t/hr	0	0.006	0.003	0.0005
Hauling (laden & unladen)	1193		31	VKT/day	86	0.401	0.038	0.002
Hauling (laden & unladen)	375		10	VKT/day	86	0.126	0.022	0.001
Hauling (laden & unladen)	213		6	VKT/day	86	0.072	0.013	0.001
Hauling (laden & unladen)	770		116	VKT/day	86	1.53	0.269	0.013
Front End Loader			225	t/hr	0	1.563	0.750	0.164
Front End Loader			225	t/hr	0	1.563	0.750	0.164
Crushers			1154	t/hr	100	0	0	0
Screens 1 to 5			1926	t/hr	100	0	0	0
Loading stockpiles 1			74	t/hr	50	1.03E-03	5.14E-04	7.71E-05
Loading stockpiles 2			84	t/hr	50	1.17E-03	5.83E-04	8.75E-05
Loading stockpiles 3			292	t/hr	50	4.06E-03	2.03E-03	3.04E-04
Loading stockpiles 4			70	t/hr	50	9.72E-04	4.86E-04	7.29E-05
Loading stockpiles 5			58	t/hr	50	8.06E-04	4.03E-04	6.04E-05
Loading stockpiles 6			43	t/hr	50	5.97E-04	2.99E-04	4.48E-05
Loading stockpiles 7			25	t/hr	50	3.47E-04	1.74E-04	2.60E-05
Loading stockpiles 8			95	t/hr	50	1.32E-03	6.60E-04	9.90E-05
Loading stockpiles 9			52	t/hr	50	7.22E-04	3.61E-04	5.42E-05
Loading stockpiles 10			84	t/hr	50	1.17E-03	5.83E-04	8.75E-05
Stockpile wind erosion 1 to 10		22391			50	0.074	0.022	0.003
Conveyors 1 to 19			3554	t/hr	70	1.04	0.49	0.074
Front End Loader - Bund			712	t/yr	0	5.64E-04	2.71E-04	5.92E-05
Trucks unloading- Bund			712	t/yr	0	2.26E-06	1.13E-06	1.69E-07
Wind erosion – Bund1		15920			50	0.053	0.016	0.004
Wind erosion – Bund2		7600			50	0.025	0.008	0.002

Table A-11: Summary of Emissions Estimation – Stage 2

Source	Length	Area	Activity		Control Factor (%)	Emission (g/s)		
	(m)	(m^2)	Value	Units		TSP	PM_{10}	$PM_{2.5}$
Excavator			4050	t/day	0	1.172	0.563	0.123
Excavator			4050	t/day	0	1.172	0.563	0.123
Blasting			1	Blast/week	0	5.24	2.73	0.27
Drilling			6	Holes/day	70	0.295	0.155	0.015
Front End Loader			4050	t/day	0	1.172	0.563	0.123
Wind erosion Pit1		78719			0	0.520	0.156	0.035
Wind erosion Pit2		141257			0	0.933	0.280	0.062
Dump Truck			225	t/hr	0	0.006	0.003	0.0005
Dump Truck			225	t/hr	0	0.006	0.003	0.0005
Hauling (laden & unladen)	1193		31	VKT/day	86	0.401	0.038	0.002
Hauling (laden & unladen)	375		10	VKT/day	86	0.126	0.022	0.001
Hauling (laden & unladen)	213		6	VKT/day	86	0.072	0.013	0.001
Hauling (laden & unladen)	1167		66.6	VKT/day	86	0.882	0.155	0.007
Front End Loader			225	t/hr	0	1.563	0.750	0.164
Front End Loader			225	t/hr	0	1.563	0.750	0.164
Crushers			1154	t/hr	100	0	0	0
Screens 1 to 5			1926	t/hr	100	0	0	0
Loading stockpiles 1			74	t/hr	50	1.03E-03	5.14E-04	7.71E-05
Loading stockpiles 2			84	t/hr	50	1.17E-03	5.83E-04	8.75E-05
Loading stockpiles 3			292	t/hr	50	4.06E-03	2.03E-03	3.04E-04
Loading stockpiles 4			70	t/hr	50	9.72E-04	4.86E-04	7.29E-05
Loading stockpiles 5			58	t/hr	50	8.06E-04	4.03E-04	6.04E-05
Loading stockpiles 6			43	t/hr	50	5.97E-04	2.99E-04	4.48E-05
Loading stockpiles 7			25	t/hr	50	3.47E-04	1.74E-04	2.60E-05
Loading stockpiles 8			95	t/hr	50	1.32E-03	6.60E-04	9.90E-05
Loading stockpiles 9			52	t/hr	50	7.22E-04	3.61E-04	5.42E-05
Loading stockpiles 10			84	t/hr	50	1.17E-03	5.83E-04	8.75E-05
Stockpile wind erosion 1 to 10		22391			50	0.074	0.022	0.003
Conveyors 1 to 19			3554	t/hr	70	1.04	0.49	0.074
Front End Loader - Bund			712	t/yr	0	5.64E-04	2.71E-04	5.92E-05
Trucks unloading- Bund			712	t/yr	0	2.26E-06	1.13E-06	1.69E-07
Wind erosion – Bund1		15920			99	1.05E-03	3.15E-04	7.01E-05
Wind erosion – Bund2		7600			99	5.02E-04	1.51E-04	3.35E-05

Table A-12: Summary of Emissions Estimation – Future Stage 4

Source	Length	Area	Activity		Control Factor (%)	Emission (g/s)		
	(m)	(m^2)	Value	Units		TSP	PM_{10}	$PM_{2.5}$
Excavator			4050	t/day	0	1.172	0.563	0.123
Excavator			4050	t/day	0	1.172	0.563	0.123
Blasting			1	Blast/week	0	5.24	2.73	0.27
Drilling			6	Holes/day	70	0.295	0.155	0.015
Front End Loader			4050	t/day	0	1.172	0.563	0.123
Front End Loader			4050	t/day	0	1.172	0.563	0.123
Wind erosion Pit1		54319			0	0.359	0.108	0.024
Wind erosion Pit2		280153			0	1.85	0.555	0.123
Dump Truck			225	t/hr	0	0.006	0.003	0.0005
Dump Truck			225	t/hr	0	0.006	0.003	0.0005
Hauling (laden & unladen)	270		7	VKT/day	86	0.09	0.016	0.001
Hauling (laden & unladen)	460		12	VKT/day	86	0.154	0.027	0.001
Hauling (laden & unladen)	180		5	VKT/day	86	0.060	0.011	0.001
Hauling (laden & unladen)	770		44	VKT/day	86	0.548	0.115	0.008
Front End Loader			225	t/hr	0	1.563	0.750	0.164
Front End Loader			225	t/hr	0	1.563	0.750	0.164
Crushers			1154	t/hr	100	0	0	0
Screens 1 to 5			1926	t/hr	100	0	0	0
Loading stockpiles 1			74	t/hr	50	1.03E-03	5.14E-04	7.71E-05
Loading stockpiles 2			84	t/hr	50	1.17E-03	5.83E-04	8.75E-05
Loading stockpiles 3			292	t/hr	50	4.06E-03	2.03E-03	3.04E-04
Loading stockpiles 4			70	t/hr	50	9.72E-04	4.86E-04	7.29E-05
Loading stockpiles 5			58	t/hr	50	8.06E-04	4.03E-04	6.04E-05
Loading stockpiles 6			43	t/hr	50	5.97E-04	2.99E-04	4.48E-05
Loading stockpiles 7			25	t/hr	50	3.47E-04	1.74E-04	2.60E-05
Loading stockpiles 8			95	t/hr	50	1.32E-03	6.60E-04	9.90E-05
Loading stockpiles 9			52	t/hr	50	7.22E-04	3.61E-04	5.42E-05
Loading stockpiles 10			84	t/hr	50	1.17E-03	5.83E-04	8.75E-05
Stockpile wind erosion 1 to 10		22391			50	0.074	0.022	0.003
Conveyors 1 to 19			3554	t/hr	70	1.04	0.49	0.074
Front End Loader - Bund			712	t/yr	0	5.64E-04	2.71E-04	5.92E-05
Trucks unloading- Bund			712	t/yr	0	2.26E-06	1.13E-06	1.69E-07
Wind erosion – Bund1		15920			99	1.05E-03	3.15E-04	7.01E-05
Wind erosion – Bund2		7600			99	5.02E-04	1.51E-04	3.35E-05

Appendix B : IMPACT ASSESSMENT

B.1 INTRODUCTION

This Appendix presents the results of the air quality impact assessment for predicted ground level concentrations of TSP, PM_{10}, $PM_{2.5}$, RCS and dust deposition for the proposed operations at varying stages.

The results of the dispersion modelling include individual sensitive receptors (including four potential future sensitive receptor locations[1]) that are indicative of ground-level concentrations. This impact assessment provides the results in terms of the cumulative impact (incremental plus background) for the 100th percentile (i.e. maximum value) in units as per the criterion and time periods. For 24-hour average PM_{10} and $PM_{2.5}$ predictions, the contemporaneous concentrations are the predicted pollutant concentrations added to the daily monitoring results from the Beresfield Monitoring Station.

B.2 TOTAL SUSPENDED PARTICULATES

The predicted cumulative annual average TSP is presented in Table B-1 for each assessment stage. It can be seen that, when the annual average background concentration of 41.8 µg/m^3 is applied to the model predictions, the maximum cumulative annual average TSP is predicted to be 48 µg/m^3, which is below the criterion of 90 µg/m^3. The highest incremental increases will occur at 1189 Clarence Town Road during Stage 2 (6.51 µg/m^3).

The assessment has referred that the TSP emissions from BHQ are not predicted to adversely impact upon sensitive receptors.

[1] As requested by EPA (DOC19/119005), corresponding to vacant lands that may be subject to future development.

Table B-1: Predicted Annual Average Cumulative TSP Concentrations (µg/m^3) [Criteria - 90 µg/m^3]

Receptor	Background (µg/m^3)	Predicted Annual Average Cumulative TSP Concentrations (µg/m^3)			
		Current	Stage 1	Stage 2	Stage 4
122B Duns Creek Road	41.80	41.92	42.03	42.03	41.93
16 Uffington Road	41.80	41.85	41.89	41.89	41.85
60 Green Wattle Creek Road	41.80	41.98	42.17	42.19	42.01
34 Timber Top Road	41.80	41.90	41.99	41.99	41.89
35 Timber Top Road	41.80	41.89	41.98	41.98	41.89
36 Timber Top Road	41.80	41.89	41.98	41.98	41.89
13 Mooghin Rd	41.80	43.17	44.52	44.27	43.38
14 Mooghin Rd	41.80	42.82	43.96	43.60	42.81
13 Giles Road	41.80	42.87	44.40	44.24	43.02
13B Giles Road	41.80	43.05	44.15	44.66	43.40
866 Clarence Town Road	41.80	42.81	43.45	43.56	42.94
994 Clarence Town Road	41.80	42.58	43.11	43.23	43.05
1034 Clarence Town Road	41.80	42.59	43.26	43.29	43.01
1060 Clarence Town Road	41.80	42.64	43.25	43.35	43.02
1094 Clarence Town Road	41.80	42.49	43.16	43.37	43.19
1189 Clarence Town Road	41.80	45.52	48.04	48.31	45.11
1203 Clarence Town Road	41.80	44.76	46.74	46.88	44.43
Potential Future Receptor 1	41.80	43.02	43.82	43.87	43.24
Potential Future Receptor 2	41.80	42.49	43.17	43.37	43.24
Potential Future Receptor 3	41.80	41.96	42.10	42.11	41.97
Potential Future Receptor 4	41.80	41.99	42.14	42.15	41.98

B.3 PM_{10}

B.3.1 24-HOUR AVERAGE

Table B-2 provides the maximum cumulative concentrations at each receptor including contemporaneous background concentrations and associated number of exceedances of the criteria for the modelled year.

The results can be summarized as follows:

- No additional exceedances of the cumulative PM_{10} criteria are predicted to occur at any of the receptors modelled for any of the scenarios modelled.
- A maximum prediction of 64 µg/m^3 as a 24 hour average PM_{10} concentration is predicted to occur at 13 Giles Road during Stage 2 operations. This evidence is driven by conservatively assumed background conditions (background of 44.6 µg/m^3 and incremental Quarry contribution of 19.4 µg/m^3).

The maximum predicted contemporaneous 24-hour average PM_{10} is presented in Table B-2 for each assessment stage. The contemporaneous concentrations are the predicted pollutant concentrations added to the daily monitoring results from Beresfield (more information on this approach is provided in Section 6.3 of the AQA Report). For each receptor location, the highest predicted concentration occurs at different times, therefore the background concentrations vary. The incremental increase for each sensitive receptor is presented in Table B-3.

For each individual day the maximum concentrations at each sensitive receptor depend on the following:

- Daily varying background concentrations as presented in ***Section 6*** of the AQA Report; and
- Quarry emissions averaged over 24-hour periods based on wind speed, direction and other meteorological parameters.

In addition, the differences between each scenario (i.e. addition/location of sources, different production rates etc.) may affect the day upon which the maximum concentration from the quarry operations are predicted at each receptor due to the weather conditions.

The highest 24-hour average incremental increase is 21.7 µg/m^3 at 13B Giles Road Road during Stage 2. The primary emission source contribution to the predicted incremental increase are the dust generated by haul truck movements. These emissions can be effectively managed by watering of the haul roads (as modelled) and regulating vehicle speeds to less than 44 km/h (as modelled and recommended).

High concentrations at receptors along Clarence Town Road during Stage 1 are driven by the emissions from the temporary construction of the amenity barrier, which when complete will protect the sensitive receptors from dust emissions. It should also be noted that working on the amenity barrier will not occur every day, therefore these activities can be managed to occur when wind is not blowing towards the receptors of concern. As the impacts will be temporary in nature and dust suppression and management techniques will be applied, the high PM_{10} levels are considered a worst-case concentration.

During Stage 4, predicted decreases in PM_{10} impacts at the sensitive receptors are a result of the relocation of the processing plant, with adopted mitigation measures. The PM_{10} impacts during Stage 4 are predicted to be similar to the current Stage impacts.

Table B-2: Maximum Cumulative 24-Hour Average PM_{10} Concentrations and Daily Exceedances (µg/m³) [Criteria - 50 µg/m³, Number of exceedances by background – 5]

Receptor	Predicted Max 24-Hour PM_{10} Concentrations (µg/m³) with Daily Exceedances							
	Current Scenario		Stage 1 Scenario		Stage 2 Scenario		Stage 4 Scenario	
	Total	No. of Exceedances	Total	No. of Exceedances	Total	No. of Exceedances	Total	No. of Exceedances
122B Duns Creek Road	55.3	5	55.3	5	55.3	5	55.3	5
16 Uffington Road	55.3	5	55.3	5	55.3	5	55.3	5
60 Green Wattle Creek Road	55.3	5	55.4	5	55.3	5	55.3	5
34 Timber Top Road	55.3	5	55.3	5	55.3	5	55.3	5
35 Timber Top Road	55.3	5	55.3	5	55.3	5	55.3	5
36 Timber Top Road	55.3	5	55.3	5	55.3	5	55.3	5
13 Mooghin Rd	55.4	5	55.4	5	55.4	5	55.5	5
14 Mooghin Rd	55.5	5	55.5	5	55.5	5	55.4	5
13 Giles Road	56.7	5	58.6	5	64.0	5	59.8	5
13B Giles Road	57.0	5	57.9	5	58.4	5	56.5	5
866 Clarence Town Road	56.7	5	57.1	5	56.4	5	57.1	5
994 Clarence Town Road	55.3	5	55.3	5	55.5	5	55.4	5
1034 Clarence Town Road	55.4	5	56.0	5	56.1	5	56.2	5
1060 Clarence Town Road	55.5	5	56.4	5	57.2	5	57.3	5
1094 Clarence Town Road	56.5	5	57.7	5	57.5	5	56.4	5
1189 Clarence Town Road	55.4	5	55.5	5	55.6	5	55.7	5
1203 Clarence Town Road	55.4	5	55.4	5	55.4	5	55.5	5
Potential Future Receptor 1	57.5	5	56.3	5	55.6	5	56.7	5
Potential Future Receptor 2	56.2	5	57.7	5	57.6	5	56.7	5
Potential Future Receptor 3	55.4	5	55.5	5	55.5	5	55.4	5
Potential Future Receptor 4	55.4	5	55.5	5	55.4	5	55.4	5

Table B-3: Predicted Max 24-Hour Incremental PM_{10} Concentrations (µg/m^3)

Receptor	Predicted 24-Hour Average Incremental PM_{10} Concentrations (µg/m^3)			
	Current	Stage 1	Stage 2	Stage 4
122B Duns Creek Road	0.9	1.9	1.9	1.6
16 Uffington Road	0.9	2.2	2.2	1.1
60 Green Wattle Creek Road	1.3	2.4	2.8	2.4
34 Timber Top Road	1.0	2.2	3.5	1.5
35 Timber Top Road	1.0	2.7	2.9	1.4
36 Timber Top Road	1.0	2.5	3.3	1.4
13 Mooghin Rd	5.6	9.1	8.0	5.3
14 Mooghin Rd	5.7	9.0	10.1	6.5
13 Giles Road	12.0	19.9	19.4	12.4
13B Giles Road	7.5	20.1	21.7	15.4
866 Clarence Town Road	6.3	10.9	11.0	5.1
994 Clarence Town Road	5.5	9.3	11.0	5.9
1034 Clarence Town Road	6.6	15.0	14.7	9.5
1060 Clarence Town Road	8.9	13.7	12.9	7.2
1094 Clarence Town Road	3.7	8.8	8.9	4.4
1189 Clarence Town Road	11.6	18.3	19.9	8.4
1203 Clarence Town Road	8.9	18.0	20.0	6.8
Potential Future Receptor 1	5.5	9.3	8.6	6.0
Potential Future Receptor 2	4.9	7.6	7.2	4.2
Potential Future Receptor 3	1.0	2.2	2.8	1.8
Potential Future Receptor 4	1.8	3.4	3.8	2.0

B.3.2 ANNUAL AVERAGE

The PM_{10} annual average criterion of 25 µg/m^3 has been adopted for this assessment. Table B-4 presents the predicted total PM_{10} concentrations at sensitive receptors for each assessment stage. Background PM10 concentration of 20.9 µg/m^3 are included in the predictions.

It can be seen from Table B-4 that the annual average PM_{10} concentration will be less than the 25 µg/m^3 criterion at all sensitive receptor locations for all Stages. The highest annual average PM_{10} concentration during the proposed future stage development is 23.75 µg/m3 which will occur at 1189 Clarence Town Road during Stages 1 and 2. This concentration is dominated by the adopted background of 20.9 µg/m^3. High concentrations at receptors along Clarence Town Road during Stage 1 are driven by the emissions from the temporary construction of the amenity barrier and in Stage 2 by haul truck movements.

As such the annual PM_{10} emissions from BHQ are not predicted to adversely impact upon the sensitive receptors.

Table 6-1: Predicted Total Annual Average PM_{10} Concentrations (µg/m³) [Criteria - 25 µg/m³]

Receptor	Background (µg/m³)	Predicted Incremental Annual Average PM_{10} Concentrations (µg/m³)				Predicted Total Annual Average PM_{10} Concentrations with Background Concentrations (µg/m³)			
		Current	Stage 1	Stage 2	Stage 4	Current	Stage 1	Stage 2	Stage 4
122B Duns Creek Road	20.90	0.05	0.11	0.11	0.06	20.95	21.01	21.01	20.96
16 Uffington Road	20.90	0.02	0.05	0.05	0.03	20.92	20.95	20.95	20.93
60 Green Wattle Creek Road	20.90	0.07	0.17	0.19	0.10	20.97	21.07	21.09	21.00
34 Timber Top Road	20.90	0.04	0.09	0.09	0.04	20.94	20.99	20.99	20.94
35 Timber Top Road	20.90	0.03	0.08	0.09	0.04	20.93	20.98	20.99	20.94
36 Timber Top Road	20.90	0.04	0.09	0.09	0.04	20.94	20.99	20.99	20.94
13 Mooghin Rd	20.90	0.51	1.21	1.12	0.71	21.41	22.11	22.02	21.61
14 Mooghin Rd	20.90	0.39	0.98	0.84	0.46	21.29	21.88	21.74	21.36
13 Giles Road	20.90	0.40	1.15	1.12	0.56	21.30	22.05	22.02	21.46
13B Giles Road	20.90	0.44	0.99	1.29	0.72	21.34	21.89	22.19	21.62
866 Clarence Town Road	20.90	0.34	0.68	0.76	0.46	21.24	21.58	21.66	21.36
994 Clarence Town Road	20.90	0.26	0.52	0.6	0.45	21.16	21.42	21.50	21.35
1034 Clarence Town Road	20.90	0.26	0.57	0.62	0.44	21.16	21.47	21.52	21.34
1060 Clarence Town Road	20.90	0.28	0.57	0.64	0.44	21.18	21.47	21.54	21.34
1094 Clarence Town Road	20.90	0.22	0.52	0.63	0.49	21.12	21.42	21.53	21.39
1189 Clarence Town Road	20.90	1.28	2.6	2.85	1.38	22.18	23.50	23.75	22.28
1203 Clarence Town Road	20.90	1.01	2.04	2.21	1.08	21.91	22.94	23.11	21.98
Potential Future Receptor 1	20.90	0.41	0.83	0.89	0.58	21.31	21.73	21.79	21.48
Potential Future Receptor 2	20.90	0.22	0.52	0.63	0.50	21.12	21.42	21.53	21.40
Potential Future Receptor 3	20.90	0.06	0.13	0.14	0.07	20.96	21.03	21.04	20.97
Potential Future Receptor 4	20.90	0.07	0.15	0.16	0.08	20.97	21.05	21.06	20.98

B.4 $PM_{2.5}$

B.4.1 24-HOUR AVERAGE

Table B-5 provides the maximum cumulative $PM_{2.5}$ concentrations at each receptor including contemporaneous background concentrations and associated number of exceedances of the criteria. Table B-6 provides the incremental increase for each sensitive receptor. Analysis of the daily predictions has identified the maximum 24-hour concentration at each receptor and the number of daily exceedances of the criteria.

The results can be summarized as follows:

- There are no additional exceedances of the relevant 24 hour average $PM_{2.5}$ criteria of 25 µg/m^3 at any of the receptors modelled.
- The maximum predicted cumulative future concentration is 41.5 µg/m^3 at 13B Giles Road Road during Stage 2 operations. This exceedance is driven by conservatively assumed background conditions (background of 36.5 µg/m^3 and incremental Quarry contribution of 5.0µg/m^3).
- The two exceedances (40.8 µg/m^3 and 25.1 µg/m^3) of the criteria of 25.0µg/m^3 are driven by background conditions. Excluding the two exceedances, the next highest result is 24.3 µg/m^3.
- The highest incremental contribution to 24-hour $PM_{2.5}$ from the Quarry is 5.0 µg/m^3.

As such the 24 hour average $PM_{2.5}$ emissions from BHQ are not predicted to adversely impact upon the sensitive receptors.

B.4.2 ANNUAL AVERAGE

The $PM_{2.5}$ annual average criterion of 8 µg/m3 has been adopted for this assessment. Table B-7 presents the predicted cumulative $PM_{2.5}$ concentrations at sensitive receptors for each assessment stage. A background $PM_{2.5}$ concentration of 8.1 µg/m^3 is included in the predictions. As previously noted, this background concentration already exceeds the criteria and therefore consideration of incremental contribution to cumulative impacts is appropriate.

It can be seen from Table B-7 that the predicted incremental changes in $PM_{2.5}$ concentration are low compared with background, with contributions of around 10% of the background concentrations.

As such the annual $PM_{2.5}$ emissions from BHQ are not predicted to adversely impact upon the sensitive receptors.

Table B-5: Maximum 24-Hour Average $PM_{2.5}$ Concentrations and Daily Exceedances (µg/m³) [Criteria - 25 µg/m³ Number of exceedances by background – 2]

Receptor	Predicted Max 24-Hour $PM_{2.5}$ Concentrations (µg/m³) with Daily Exceedances							
	Current Scenario		Stage 1 Scenario		Stage 2 Scenario		Stage 4 Scenario	
	Total	No. of Exceedances	Total	No. of Exceedances	Total	No. of Exceedances	Total	No. of Exceedances
122B Duns Creek Road	40.8	2	40.8	2	40.8	2	40.8	2
16 Uffington Road	40.8	2	40.8	2	40.8	2	40.8	2
60 Green Wattle Creek Road	40.8	2	40.8	2	40.9	2	40.8	2
34 Timber Top Road	40.8	2	40.8	2	40.8	2	40.8	2
35 Timber Top Road	40.8	2	40.8	2	40.8	2	40.8	2
36 Timber Top Road	40.8	2	40.8	2	40.8	2	40.8	2
13 Mooghin Rd	40.8	2	40.8	2	40.8	2	40.9	2
14 Mooghin Rd	40.8	2	40.9	2	40.9	2	40.9	2
13 Giles Road	40.9	2	41.3	2	41.3	2	41.0	2
13B Giles Road	41.1	2	41.3	2	41.5	2	41.1	2
866 Clarence Town Road	41.0	2	41.2	2	41.0	2	41.2	2
994 Clarence Town Road	40.8	2	40.8	2	40.8	2	40.8	2
1034 Clarence Town Road	40.8	2	40.8	2	40.8	2	40.8	2
1060 Clarence Town Road	40.8	2	40.8	2	40.8	2	40.8	2
1094 Clarence Town Road	40.8	2	40.8	2	40.8	2	40.8	2
1189 Clarence Town Road	40.8	2	40.8	2	40.8	2	40.9	2
1203 Clarence Town Road	40.8	2	40.8	2	40.8	2	40.9	2
Potential Future Receptor 1	41.1	2	41.0	2	40.9	2	41.1	2
Potential Future Receptor 2	40.8	2	40.8	2	40.8	2	40.8	2
Potential Future Receptor 3	40.8	2	40.9	2	40.9	2	40.8	2
Potential Future Receptor 4	40.8	2	40.9	2	40.9	2	40.8	2

Table B-6: Predicted Max 24-Hour Incremental $PM_{2.5}$ Concentrations (µg/m³)

Receptor	Predicted 24-Hour Average Incremental PM_{10} Concentrations (µg/m³)			
	Current	Stage 1	Stage 2	Stage 4
122B Duns Creek Road	0.2	0.8	0.8	0.7
16 Uffington Road	0.2	0.6	0.6	0.3
60 Green Wattle Creek Road	0.3	0.8	1.0	0.9
34 Timber Top Road	0.2	0.5	0.9	0.4
35 Timber Top Road	0.2	0.7	0.8	0.4
36 Timber Top Road	0.2	0.6	0.9	0.4
13 Mooghin Rd	1.0	2.8	2.5	1.8
14 Mooghin Rd	0.9	2.8	2.1	1.7
13 Giles Road	1.9	4.9	4.9	3.3
13B Giles Road	1.3	4.2	5.0	4.0
866 Clarence Town Road	1.0	2.1	2.3	1.4
994 Clarence Town Road	0.8	1.6	1.8	1.6
1034 Clarence Town Road	1.1	2.9	3.1	4.2
1060 Clarence Town Road	1.4	2.9	2.8	2.1
1094 Clarence Town Road	0.6	1.8	1.9	1.9
1189 Clarence Town Road	1.8	4.3	5.0	2.1
1203 Clarence Town Road	1.7	4.1	4.8	1.9
Potential Future Receptor 1	0.9	1.9	2.0	1.7
Potential Future Receptor 2	0.8	1.5	1.5	2.1
Potential Future Receptor 3	0.2	0.5	0.6	0.5
Potential Future Receptor 4	0.3	0.7	0.9	0.6

Table B-7: Predicted Total Annual Average $PM_{2.5}$ Concentrations ($\mu g/m^3$) [Criteria - 8 $\mu g/m^3$]

Receptor	Background ($\mu g/m^3$)	Predicted Incremental Annual Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)				Predicted Total Annual Average $PM_{2.5}$ Concentrations with Background Concentrations ($\mu g/m^3$)			
		Current	Stage 1	Stage 2	Stage 4	Current	Stage 1	Stage 2	Stage 4
122B Duns Creek Road	8.10	0.01	0.03	0.04	0.02	8.11	8.13	8.14	8.12
16 Uffington Road	8.10	0	0.01	0.01	0.01	8.10	8.11	8.11	8.11
60 Green Wattle Creek Road	8.10	0.02	0.05	0.06	0.03	8.12	8.15	8.16	8.13
34 Timber Top Road	8.10	0.01	0.02	0.03	0.01	8.11	8.12	8.13	8.11
35 Timber Top Road	8.10	0.01	0.02	0.03	0.01	8.11	8.12	8.13	8.11
36 Timber Top Road	8.10	0.01	0.03	0.03	0.01	8.11	8.13	8.13	8.11
13 Mooghin Rd	8.10	0.15	0.42	0.44	0.29	8.25	8.52	8.54	8.39
14 Mooghin Rd	8.10	0.12	0.34	0.34	0.2	8.22	8.44	8.44	8.30
13 Giles Road	8.10	0.09	0.3	0.31	0.17	8.19	8.40	8.41	8.27
13B Giles Road	8.10	0.09	0.24	0.35	0.21	8.19	8.34	8.45	8.31
866 Clarence Town Road	8.10	0.07	0.18	0.22	0.16	8.17	8.28	8.32	8.26
994 Clarence Town Road	8.10	0.05	0.13	0.15	0.14	8.15	8.23	8.25	8.24
1034 Clarence Town Road	8.10	0.05	0.13	0.15	0.15	8.15	8.23	8.25	8.25
1060 Clarence Town Road	8.10	0.05	0.13	0.15	0.13	8.15	8.23	8.25	8.23
1094 Clarence Town Road	8.10	0.04	0.13	0.16	0.16	8.14	8.23	8.26	8.26
1189 Clarence Town Road	8.10	0.29	0.69	0.83	0.46	8.39	8.79	8.93	8.56
1203 Clarence Town Road	8.10	0.22	0.53	0.63	0.36	8.32	8.63	8.73	8.46
Potential Future Receptor 1	8.10	0.09	0.22	0.26	0.19	8.19	8.32	8.36	8.29
Potential Future Receptor 2	8.10	0.04	0.12	0.16	0.17	8.14	8.22	8.26	8.27
Potential Future Receptor 3	8.10	0.01	0.03	0.04	0.02	8.11	8.13	8.14	8.12
Potential Future Receptor 4	8.10	0.01	0.04	0.04	0.02	8.11	8.14	8.14	8.12

B.5 RESPIRABLE CRYSTALLINE SILICA

The RCS annual average criterion of 3 µg/m3 has been adopted for this assessment. Table B-8 presents the predicted total RCS concentrations at sensitive receptors for each assessment stage. A background RCS of 0.7 µg/m^3 is included in the predictions.

It can be seen from Table B-8 that the highest future predicted RCS concentration is 0.73 µg/m^3, which will occur during Stage 2 at 1189 Clarence Town Road.

Overall, the RCS concentration is below the criterion and is not expected to impact on the nearby sensitive receptors.

Table B-8: Predicted Total Annual Average RCS Concentrations (µg/m³) [Criteria – 3 µg/m³]

Receptor	Background (µg/m³)	Predicted Incremental Annual Average RCS Concentrations (µg/m³)				Predicted Total Annual Average RCS Concentrations (µg/m³)			
		Current	Stage 1	Stage 2	Stage 4	Current	Stage 1	Stage 2	Stage 4
122B Duns Creek Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
16 Uffington Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
60 Green Wattle Creek Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
34 Timber Top Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
35 Timber Top Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
36 Timber Top Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
13 Mooghin Rd	0.70	0	0.01	0.01	0.01	0.70	0.71	0.71	0.71
14 Mooghin Rd	0.70	0	0.01	0.01	0.01	0.70	0.71	0.71	0.71
13 Giles Road	0.70	0	0.01	0.01	0.01	0.70	0.71	0.71	0.71
13B Giles Road	0.70	0	0.01	0.01	0.01	0.70	0.71	0.71	0.71
866 Clarence Town Road	0.70	0	0.01	0.01	0.01	0.70	0.71	0.71	0.71
994 Clarence Town Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
1034 Clarence Town Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
1060 Clarence Town Road	0.70	0	0	0	0	0.70	0.70	0.70	0.70
1094 Clarence Town Road	0.70	0	0	0.01	0.01	0.70	0.70	0.71	0.71
1189 Clarence Town Road	0.70	0.01	0.02	0.03	0.01	0.71	0.72	0.73	0.71
1203 Clarence Town Road	0.70	0.01	0.02	0.02	0.01	0.71	0.72	0.72	0.71
Potential Future Receptor 1	0.70	0	0.01	0.01	0.01	0.70	0.71	0.71	0.71
Potential Future Receptor 2	0.70	0	0	0.01	0.01	0.70	0.70	0.71	0.71
Potential Future Receptor 3	0.70	0	0	0	0	0.70	0.70	0.70	0.70
Potential Future Receptor 4	0.70	0	0	0	0	0.70	0.70	0.70	0.70

B.6 DUST DEPOSITION

The predicted incremental and cumulative increase in monthly average dust deposition is presented in Table B-9 for each assessment stage. The assessment criterion for dust deposition is a maximum incremental increase of 2 g/m^2/month and cumulative increase of 4 g/m^2/month. It can be seen that the highest incremental increase in dust deposition is 0.36 g/m^2/month, which will occur at 13 Mooghin Road during Stage 4.

When the background dust deposition level of 2.1 g/m^2/month is applied to the predictions, the highest dust deposition monthly average is 2.46 g/m^2/month, which complies with the total dust deposition criterion of 4 g/m^2/month.

Overall, the predicted levels comply with the incremental and cumulative increase dust deposition criteria and therefore dust is not expected to be a nuisance for sensitive receptors.

Table B-9: Predicted Monthly Average Cumulative Dust Deposition (g/m^2/month) [Criteria – Incremental 2 g/m^2/month, Cumulative 4 g/m^2/month]

Receptor	Background (g/m^2/month)	Predicted Annual Average Incremental Dust Deposition (g/m^2/month)				Predicted Annual Average Cumulative Dust Deposition (g/m^2/month)			
		Current	Stage 1	Stage 2	Stage 4	Current	Stage 1	Stage 2	Stage 4
122B Duns Creek Road	2.10	0.01	0.01	0.01	0.02	2.11	2.11	2.11	2.12
16 Uffington Road	2.10	0.01	0.01	0.01	0.01	2.11	2.11	2.11	2.11
60 Green Wattle Creek Road	2.10	0.01	0.01	0.02	0.03	2.11	2.11	2.12	2.13
34 Timber Top Road	2.10	0.02	0.02	0.02	0.02	2.12	2.12	2.12	2.12
35 Timber Top Road	2.10	0.01	0.02	0.02	0.02	2.11	2.12	2.12	2.12
36 Timber Top Road	2.10	0.02	0.02	0.02	0.02	2.12	2.12	2.12	2.12
13 Mooghin Rd	2.10	0.21	0.34	0.23	0.36	2.31	2.44	2.33	2.46
14 Mooghin Rd	2.10	0.15	0.25	0.17	0.27	2.25	2.35	2.27	2.37
13 Giles Road	2.10	0.04	0.09	0.08	0.11	2.14	2.19	2.18	2.21
13B Giles Road	2.10	0.01	0.02	0.03	0.04	2.11	2.12	2.13	2.14
866 Clarence Town Road	2.10	0.02	0.03	0.03	0.04	2.12	2.13	2.13	2.14
994 Clarence Town Road	2.10	0.01	0.02	0.02	0.04	2.11	2.12	2.12	2.14
1034 Clarence Town Road	2.10	0.01	0.02	0.02	0.03	2.11	2.12	2.12	2.13
1060 Clarence Town Road	2.10	0.01	0.02	0.02	0.03	2.11	2.12	2.12	2.13
1094 Clarence Town Road	2.10	0.01	0.02	0.02	0.07	2.11	2.12	2.12	2.17
1189 Clarence Town Road	2.10	0.18	0.02	0.20	0.30	2.28	2.12	2.30	2.40
1203 Clarence Town Road	2.10	0.08	0.26	0.10	0.19	2.18	2.36	2.20	2.29
Potential Future Receptor 1	2.10	0.02	0.13	0.03	0.04	2.12	2.23	2.13	2.14
Potential Future Receptor 2	2.10	0.01	0.03	0.02	0.08	2.11	2.13	2.12	2.18
Potential Future Receptor 3	2.10	0.00	0.01	0.00	0.01	2.10	2.11	2.10	2.11
Potential Future Receptor 4	2.10	0.00	0.00	0.00	0.01	2.10	2.10	2.10	2.11

Appendix C : **METEOROLOGICAL DATA JUSTIFICATION**

Figure C-1 shows the comparison of wind roses developed for the 2013 measurement data at Beresfield Monitoring Station and the TAPM-CALMET derived data from the closest location. As shown in the figure, both wind roses feature a prevailing wind direction from the north-west with very little winds from any other direction.

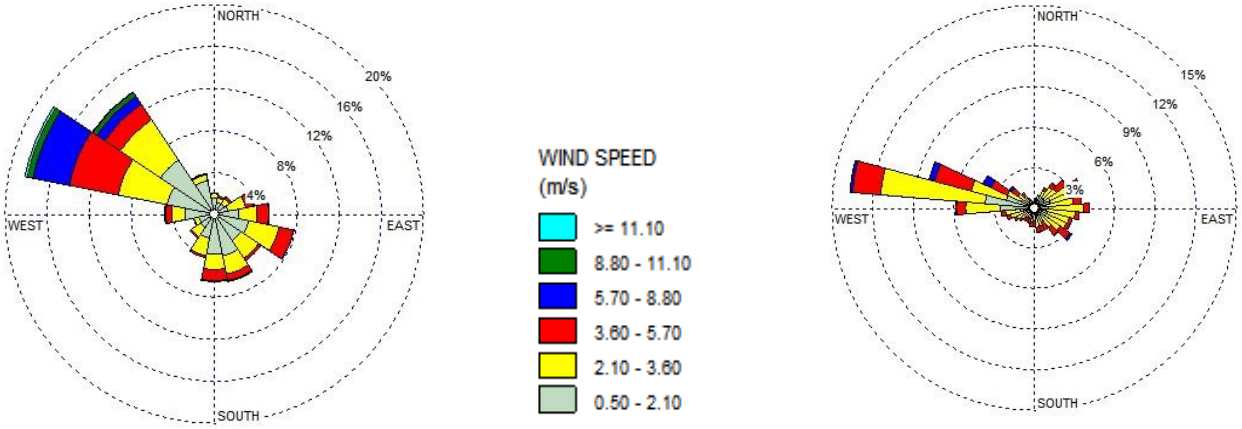

Figure C-1: Comparison of Wind Roses Developed for 2013 Measurement Data at Beresfield Monitoring Station (left) and the Modelled Data for the Same Year (right)