APPENDICES

(No. of pages excluding this page = 40)

***Note: A copy of these appendices are available on the Project CD**

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Appendix 1

Detailed receptor information

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Receptor ID	MGA (mE)	MGA (mN)	Ownership
1	648928	6408374	Agreed Contract (Call Option)
2	649518	6407265	Agreed Contract (Call Option)
3	652919	6405355	Agreed Contract (Call Option)
4	654256	6404770	Private
6	649063	6403861	Private
7	648900	6404627	Private
8A	647353	6405878	Private
8B	646110	6403927	Private
10	648912	6408743	Private
18	645287	6406011	Private
19	646858	6407722	Private
20	647417	6407975	Private
21	645269	6409946	Private
22	648629	6409049	Private
23	648720	6409174	Private
24	648654	6409412	Private
25	648771	6409589	Private
26	648196	6410327	Private
27	646929	6412257	Private
28A	646768	6412362	Private
28B	646708	6412616	Private
30A	648935	6413224	Private
30B	649289	6413736	Private
31A	647191	6413882	Private
31B	647510	6414186	Private
32	648447	6413958	Private
35A	652513	6415246	Private
35B	652904	6415188	Private
38	654940	6415361	Private
36	653575	6414152	Private
40	654414	6413943	Private
42	655986	6414235	Private
43	657580	6412249	Private
46	657040	6409630	Private
48	654081	6409619	Applicant owned
49A	654356	6409008	Applicant owned
49B	654559	6409064	Applicant owned
50	652119	6409225	Potential future residence
51	650362	6409786	Agreed Contract (Call Option)
54	649753	6409460	Applicant owned
55	649851	6409552	Agreed Contract (Put Option)
56	649784	6409367	Applicant owned
58	650031	6409679	Agreed Contract (Put & Call Option)
61	656734	6404316	Private

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Appendix 2

CALMET and TAPM input file parameters

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Table 1: Meteorological Parameters used for TAPM and CALMET

TAPM (v 4.0.4)	
Number of grids (spacing)	3 (30 km, 10 km, 3 km)
Number of grid points	25 x 25 x 35
Year of analysis	January 2008 to December 2008
Centre of analysis	Project Boundary (32°26.5' S, 148°37.0' E)
CALMET (v. 6.327)	
Meteorological inner grid domain	25 km x 34 km
Meteorological inner grid resolution	0.25 km (fine resolution)
Surface meteorological stations	Toongi Met station - Wind speed - Wind direction - Temperature - Relative humidity Dubbo Airport AWS (Bureau of Meteorology, Station No.065070) - Wind speed - Wind direction - Temperature - Relative humidity - Cloud Amount - Cloud Height - Sea Level Pressure
Upper air	Prognostic three dimensional data file extracted from TAPM at 3 km grid

Table 2: CALMET Model Options

Flag	Descriptor	Default	Value Used
IEXTRP	Extrapolate surface wind observations to upper layers	Similarity theory	Similarity theory
BIAS (NZ)	Relative weight given to vertically extrapolated surface observations vs upper air data	NZ * 0	-1 for first layer, -0.5 for second layer, 0.25 for third layer. 0 for all other layers.
TERRAD	Radius of influence of terrain	No default (typically 5-15km)	5 km
RMAX1 and RMAX2	Maximum radius of influence over land for observations in layer 1 and aloft	No Default	2 km
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind fields are weighted equally	No Default	1 km

Table 3: CALPUFF Model Options used

Flag	Flag Descriptor	Value Used	Value Description
MCHEM	Chemical Transformation	0	Not modelled
MDRY	Dry Deposition	1	Yes
MTRANS	Transitional plume rise allowed?	1	Yes
MTIP	Stack tip downwash?	1	Yes
MRISE	Method to compute plume rise	1	Numerical plume rise
MSHEAR	Vertical wind Shear	0	Vertical wind shear not modelled
MPARTL	Partial plume penetration of elevated inversion?	1	Yes
MSPLIT	Puff Splitting	0	No puff splitting
MSLUG	Near field modelled as slugs	0	Not used
MDISP	Dispersion Coefficients	3	PG coefficient for rural areas
MPDF	Probability density function used for dispersion under convective conditions	0	No
MROUGH	PG sigma y,z adjusted for z	0	No
MCTADJ	Terrain adjustment method	3	Partial Plume Adjustment
MBDW	Method for building downwash	1	Prime method

Appendix 3

Emission Inventory Calculations

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Dubbo Zirconia Project

The dust emission inventories have been prepared using the operational description of the Dubbo Zirconia Project (the Proposal).

Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the assessment are described below for TSP only. The same assumptions have been adopted in the PM_{10} and $PM_{2.5}$ emission estimate equations. A copy of the emissions inventory for each modelled scenario and particulate matter parameter is provided at the end of this Appendix.

Mining activities have been restricted to the proposed hours of operation between 7am and 6pm, with the exception of blasting that would operate between 9am and 5pm.

Dust from wind erosion is assumed to occur over 24-hours per day, however, wind erosion is also assumed to be proportional to the third power of wind speed. This will mean that most wind erosion occurs during the day when wind speeds are highest.

Scraper stripping topsoil

Emissions from scrapers stripping topsoil have been calculated using the US Environmental Protection Authority (EPA) emission factor equation given in Equation 1 (US EPA, 1985 and updates).

Equation 1

$$E_{TSP} = 0.029\ kg/tonne$$

Drilling overburden and ore

The emission factor used for drilling has been taken to be 0.59 kg/hole (US EPA, 1985 and updates).

Blasting overburden and coal

TSP emissions from blasting were estimated using the US EPA (1985 and updates) emission factor equation given in Equation 3.

Equation 3

$$E_{TSP} = 0.00022 \times A^{1.5} \qquad \text{kg/blast}$$

Where,

A = area to be blasted in m^2

The area to be blasted for overburden and ore is 1,400m^2.

Loading material / dumping overburden and ore

Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. Equation 4 shows the relationship between these variables.

Equation 4

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \ \text{kg/t}$$

Where: k = 0.74 for TSP

U = wind speed (m/s)

M = moisture content (%)

(where 0.25≤M≤2.8)

The moisture content of overburden was given to be 10% for overburden and 5% for ore.

Hauling material / product on unsealed surfaces

The emission estimate of wheel generated dust s based the US EPA AP42 emission factor for unpaved surfaces at industrial sites shown below in Equation 5:

Equation 5

$$E_{TSP} = 0.2819 \times \left[4.9 \times \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{\frac{W}{1.1023}}{3} \right)^{0.45} \right] (kg|VKT)$$

Where:

EF_{TSP} = TSP emission factor from wheel generated dust

s = silt content of road surface

W = mean vehicle weight

The adopted silt content (s) for the Project was 3%.

The mean vehicle weight used in the emissions estimates is an average of the loaded and unloaded gross vehicle mass, to account for one empty trip and one loaded trip. A capacity of 61 t was used for haulage of materials.

A control factor of 75 % has been applied for watering and the use of water sprays on unpaved roads.

Dozers working on overburden

Emissions from dozers on overburden have been calculated using the US EPA emission factor equation given in Equation 1 (US EPA, 1985 and updates).

A conservative estimate was adopted in assuming the silt content for the overburden was 10% and 5% for ore. The respective moisture contents were assumed to be 4% and 7%.

Crushing of ore

Four stages of crushing are included at the processing plant. The emission factor used for crushing of metallic minerals has been taken from US EPA (1985 and updates). The following list the adopted emissions factors for TSP:

- Primary crushing: 0.01 kg/tonne
- Secondary crushing: 0.03 kg/tonne

- Tertiary crushing: 0.03 kg/tonne
- Quaternary crushing:0.03 kg/tonne

It has been assumed that the moisture content of greater than 4% would be achieved through use of spray curtains.

Dry grinding

The emission factor used for dry grinding of metallic minerals has been taken from US EPA (1985 and updates). The adopted TSP emission factor for dry grinding is 1.2 kg/tonne of ore processed. It has been assumed that the moisture content of greater than 4% would be achieved through use of spray curtains.

Miscellaneous transfers

The emission factor used for miscellaneous transfers has been taken from US EPA (1985 and updates). The adopted TSP emission factor for dry grinding is 0.005 kg/tonne of ore processed. It has been assumed that there would be three miscellaneous transfers.

Wind erosion from exposed areas

The latest wind erosion equation made available from the US EPA (1985 and updates) requires information on the threshold frictional velocity for the surface of the exposed area.

As this information is not available the default emission factor of 0.1 kg/ha/h (US EPA (1985 and updates)) has been used to estimate TSP emissions for wind erosion. For active stockpiles a TSP emission rate of 5.9 kg/ha/h has been calculated.

A control factor of 30% has been applied to the SRSF to account for the high moisture level of the solid waste that would be deposited at the site.

Grading roads

Estimates of TSP emissions from grading roads have been made using the US EPA (1985 and updates) emission factor equation (Equation 8).

Equation 8

$$E_{TSP} = 0.0034 \times S^{2.5} \qquad \text{kg/VKT}$$

Where,

S = speed of the grader in km/h (taken to be 8 km/h)

The following tables present the calculated emissions for each modelled year of the project and which correspond to the sources allocations as represented in **Table 21** and **Table 22**.

ACTIVITY	TSP emission for Year 5 (kg/y)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Topsoil Removal - Stripping topsoil - in waste rock emplacement area	1,244	42,900	t/yr	0.029	kg/t											0	% control
Topsoil Removal - Stripping topsoil at new LRSF in north	-	-	t/yr	0.029	kg/t											0	% control
OB - Drilling	792	4,473	holes/y	0.59	kg/hole											70	% Control
OB - Blasting	239	21	blasts/y	12	kg/blast	1,400	Area of blast in square metres									0	% Control
OB - Sh/Ex/FELs loading OB to trucks at Pit	95	116,829	t/y	0.0008	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% Control
OB - Hauling OB from Pit to emplacement area	1,956	116,829	t/y	0.066976	kg/t	38	t/load	61	Vehicle gross mass (t)	1.2	km/return trip	2.1	kg/VKT	3	% silt content	75	% control
OB - Trucks emplacing OB at emplacement area	95	116,829	t/y	0.0008	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% control
OB - Dozers on D1 north dump	5,024	739	h/y	6.8	kg/h	10	silt content in %	4	moisture content in %							0	% control
OB - Dozers on SRSF	5,024	739	h/y	6.8	kg/h	10	silt content in %	4	moisture content in %							0	% control
ORE - Dozers ripping/pushing/clean-up in pit	1,057	739	h/y	1.4	kg/h	5	silt content in %	7	moisture content in %							0	% control
ORE - Drilling	6,833	38,604	holes/y	0.6	kg/hole											70	% Control
ORE - Blasting	2,066	179	blasts/y	12	kg/blast	1,400	Area of blast in square metres									0	% Control
ORE - Loading ore from Pit to trucks	376	1,008,330	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
ORE - Hauling ore from Pit to ROM Pad	123,811	1,008,330	t/y	0.4912	kg/t	38	t/load	61	Vehicle gross mass (t)	8.8	km/return trip	2.1	kg/VKT	3	% silt content	75	% control
ORE - Unloading ore from truck to ROM pad	376	1,008,330	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
Ore - Primary crushing	10,083	1,008,330	t/y	0.01	kg/t											0	% control
Ore - Secondary crushing	30,250	1,008,330	t/y	0.03	kg/t											0	% control
Ore - Tertiary crushing	30,250	1,008,330	t/y	0.03	kg/t											0	% control
Ore - Quaternary crushing	30,250	1,008,330	t/y	0.03	kg/t											0	% control
Ore - Dry grinding	205,699	1,008,330	t/y	1.20	kg/t											83	% control
Ore - Miscellaneous transfers	20,167	4,033,320	t/y	0.005	kg/t											0	% control
WE - Stripped topsoil area at new LRSF in north	-	-	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Waste emplacement	8,935	10.2	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Pit	15,856	18.1	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Stockpiles other - SRSF	17,599	28.7	ha	0.1	kg/ha/h	8,760	h/y									30	% Control
WE - ROM stockpiles	108,610	2.1	ha	5.9	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - Stockpiles other - soil stockpiles	-	-	ha	5.9	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - Stockpiles other - Salt encapsulation cells	-	-	ha	5.9	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
Grading roads	11,439	37,171	km	0.62	kg/km	8	speed of graders in km/h	4,646	grader hours							50	% Control
Total TSP emissions for Year 5 (kg/yr)	**638,126**																

ACTIVITY	TSP emission for Year 5 (kg/y)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6
Topsoil Removal - Stripping topsoil at salt encapsulation ce	4,000	137,940	t/yr	0.029	kg/t											0
Topsoil Removal - Stripping topsoil at waste rock emplace	1,474	50,820	t/yr	0.029	kg/t											0
OB - Drilling	792	4,473	holes/y	0.59	kg/hole											70
OB - Blasting	239	21	blasts/y	12	kg/blast	1,400	Area of blast in square metres									0
OB - Sh/Ex/FELs loading OB to trucks at Pit	219	268,212	t/y	0.0008	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0
OB - Hauling OB from Pit to emplacement area	4,491	268,212	t/y	0.066976	kg/t	38	t/load	61	Vehicle gross mass (t)	1.2	km/return trip	2.1	kg/VKT	3	% silt content	75
OB - Trucks emplacing OB at emplacement area	219	268,212	t/y	0.0008	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0
OB - Dozers on D1 north dump	5,024	739	h/y	6.8	kg/h	10	silt content in %	4	moisture content in %							0
OB - Dozers on SRSF	5,024	739	h/y	6.8	kg/h	10	silt content in %	4	moisture content in %							0
ORE - Dozers ripping/pushing/clean-up in pit	1,057	739	h/y	1.4	kg/h	5	silt content in %	7	moisture content in %							0
ORE - Drilling	6,833	38,604	holes/y	0.6	kg/hole											70
ORE - Blasting	2,066	179	blasts/y	12	kg/blast	1,400	Area of blast in square metres									0
ORE - Loading ore from Pit to trucks	372	998,558	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0
ORE - Hauling ore from Pit to ROM Pad	122,612	998,558	t/y	0.4912	kg/t	38	t/load	61	Vehicle gross mass (t)	8.8	km/return trip	2.1	kg/VKT	3	% silt content	75
ORE - Unloading ore from truck to ROM pad	372	998,558	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0
Ore - Primary crushing	9,986	998,558	t/y	0.01	kg/t											0
Ore - Secondary crushing	29,957	998,558	t/y	0.03	kg/t											0
Ore - Tertiary crushing	29,957	998,558	t/y	0.03	kg/t											0
Ore - Quaternary crushing	29,957	998,558	t/y	0.03	kg/t											0
Ore - Dry grinding	203,706	998,558	t/y	1.20	kg/t											83
Ore - Miscellaneous transfers	19,971	3,994,232	t/y	0.01	kg/t											0
WE - Stripped topsoil area at salt encapsulation cell	18,308	20.9	ha	0.1	kg/ha/h	8,760	h/y									0
WE - Waste emplacement	14,804	16.9	ha	0.1	kg/ha/h	8,760	h/y									0
WE - Pit	34,690	39.6	ha	0.1	kg/ha/h	8,760	h/y									0
WE - Stockpiles other - SRSF	28,882	47.1	ha	0.1	kg/ha/h	8,760	h/y									30
WE - ROM stockpiles	108,610	2.1	ha	5.9	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0
WE - soil stockpiles	-	-	ha	0.1	kg/ha/h	8,760	h/y									0
WE - Salt encapsulation cells	7,709	8.8	ha	0.1	kg/ha/h	8,760	h/y									0
Grading roads	11,439	37,171	km	0.62	kg/km	8	speed of graders in km/h	4,646	grader hours							50
Total TSP emissions for Year 5 (kg/yr)	**702,768**															

ACTIVITY	TSP emission for Year 5 (kg/y)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Topsoil Removal - Stripping topsoil - in waste rock emplacement area	1,244	42,900	t/yr	0.029	kg/t											0	% control
Topsoil Removal - Stripping topsoil at new LRSF in north	-	-	t/yr	0.029	kg/t											0	% control
OB - Drilling	412	4,473	holes/y	0.31	kg/hole											70	% Control
OB - Blasting	124	21	blasts/y	6.0	kg/blast	1,400	Area of blast in square metres									0	% Control
OB - Sh/Ex/FELs loading OB to trucks at Pit	45	116,829	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% Control
OB - Hauling OB from Pit to emplacement area	454	116,829	t/y	0.0155	kg/t	38	t/load	61	Vehicle gross mass (t)	1.2	km/return trip	0.5	kg/VKT	3	% silt content	75	% control
OB - Trucks emplacing OB at emplacement area	45	116,829	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% control
OB - Dozers on D1 north dump	1,133	739	h/y	1.5	kg/h	10	silt content in %	4	moisture content in %							0	% control
OB - Dozers on SRSF	1,133	739	h/y	1.5	kg/h	10	silt content in %	4	moisture content in %							0	% control
ORE - Dozers ripping/pushing/clean-up in pit	183	739	h/y	0.2	kg/h	5	silt content in %	7	moisture content of coal in %							0	% control
ORE - Drilling	3,553	38,604	holes/y	0.31	kg/hole											70	% Control
ORE - Blasting	1,074	179	blasts/y	6	kg/blast	1,400	Area of blast in square metres									0	% Control
ORE - Loading ore from Pit to trucks	178	1,008,330	t/y	0.0002	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
ORE - Hauling ore from Pit to ROM Pad	28,724	1,008,330	t/y	0.1139	kg/t	38	t/load	61	Vehicle gross mass (t)	8.8	km/return trip	0.5	kg/VKT	3	% silt content	75	% control
ORE - Unloading ore from truck to ROM pad	178	1,008,330	t/y	0.0002	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
Ore - Primary crushing	4,033	1,008,330	t/y	0.004	kg/t											0	% control
Ore - Secondary crushing	12,100	1,008,330	t/y	0.012	kg/t											0	% control
Ore - Tertiary crushing	10,083	1,008,330	t/y	0.010	kg/t											0	% control
Ore - Quaternary crushing	10,083	1,008,330	t/y	0.010	kg/t											0	% control
Ore - Dry grinding	27,427	1,008,330	t/y	0.160	kg/t											83	% control
Ore - Miscellaneous transfers	8,067	4,033,320	t/y	0.002	kg/t											0	% control
WE - Stripped topsoil area at new LRSF in north	-	-	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Waste emplacement	4,468	10.2	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Pit	7,928	18.1	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Stockpiles other - SRSF	8,799	28.7	ha	0.1	kg/ha/h	8,760	h/y									30	% Control
WE - ROM stockpiles	54,305	2.1	ha	3.0	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - Stockpiles other - soil stockpiles	-	-	ha	3.0	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - Stockpiles other - Salt encapsulation cells	-	-	ha	3.0	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
Grading roads	3,997	37,171	km	0.22	kg/km	8	speed of graders in km/h	4,646	grader hours							50	% Control
Total PM10 emissions for Year 5 (kg/yr)	**189,769**																

ACTIVITY	TSP emission for Year 5 (kg/y)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Topsoil Removal - Stripping topsoil at salt encapsulation cell	4,000	137,940	t/yr	0.029	kg/t											0	% control
Topsoil Removal - Stripping topsoil at waste rock emplacement area	1,474	50,820	t/yr	0.029	kg/t											0	% control
OB - Drilling	412	4,473	holes/y	0.31	kg/hole											70	% Control
OB - Blasting	124	21	blasts/y	6.0	kg/blast	1,400	Area of blast in square metres									0	% Control
OB - Sh/Ex/FELs loading OB to trucks at Pit	104	268,212	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% Control
OB - Hauling OB from Pit to emplacement area	1,042	268,212	t/y	0.015538	kg/t	38	t/load	61	Vehicle gross mass (t)	1.2	km/return trip	0.5	kg/VKT	3	% silt content	75	% control
OB - Trucks emplacing OB at emplacement area	104	268,212	t/y	0.0004	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% control
OB - Dozers on D1 north dump	1,133	739	h/y	1.5	kg/h	10	silt content in %	4	moisture content in %							0	% control
OB - Dozers on SRSF	1,133	739	h/y	1.5	kg/h	10	silt content in %	4	moisture content in %							0	% control
ORE - Dozers ripping/pushing/clean-up in pit	183	739	h/y	0.2	kg/h	5	silt content in %	7	moisture content of coal in %							0	% control
ORE - Drilling	3,553	38,604	holes/y	0.31	kg/hole											70	% Control
ORE - Blasting	1,074	179	blasts/y	6	kg/blast	1,400	Area of blast in square metres									0	% Control
ORE - Loading ore from Pit to trucks	176	998,558	t/y	0.0002	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
ORE - Hauling ore from Pit to ROM Pad	28,446	998,558	t/y	0.1139	kg/t	38	t/load	61	Vehicle gross mass (t)	8.8	km/return trip	0.5	kg/VKT	3	% silt content	75	% control
ORE - Unloading ore from truck to ROM pad	176	998,558	t/y	0.0002	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
Ore - Primary crushing	3,994	998,558	t/y	0.004	kg/t											0	% control
Ore - Secondary crushing	11,983	998,558	t/y	0.012	kg/t											0	% control
Ore - Tertiary crushing	9,986	998,558	t/y	0.010	kg/t											0	% control
Ore - Quaternary crushing	9,986	998,558	t/y	0.010	kg/t											0	% control
Ore - Dry grinding	27,161	998,558	t/y	0.160	kg/t											83	% control
Ore - Miscellaneous transfers	7,988	3,994,232	t/y	0.002	kg/t											0	% control
WE - Stripped topsoil area at salt encapsulation cell	9,154	20.9	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Waste emplacement	7,402	16.9	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Pit	17,345	39.6	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Stockpiles other - SRSF	14,441	47.1	ha	0.1	kg/ha/h	8,760	h/y									30	% Control
WE - ROM stockpiles	54,305	2.1	ha	3.0	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - soil stockpiles	-	-	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
WE - Salt encapsulation cells	3,854	8.8	ha	0.1	kg/ha/h	8,760	h/y									0	% Control
Grading roads	3,997	37,171	km	0.22	kg/km	8	speed of graders in km/h	4,646	grader hours							50	% Control
Total PM10 emissions for Year 5 (kg/yr)	**224,728**																

ACTIVITY	TSP emission for Year 5 (kg/y)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Topsoil Removal - Stripping topsoil - in waste rock emplacement area	1,244	42,900	t/yr	0.029	kg/t											0	% control
Topsoil Removal - Stripping topsoil at new LRSF in north	-	-	t/yr	0.029	kg/t											0	% control
OB - Drilling	24	4,473	holes/y	0.02	kg/hole											70	% Control
OB - Blasting	7	21	blasts/y	0.3	kg/blast	1,400	Area of blast in square metres									0	% Control
OB - Sh/Ex/FELs loading OB to trucks at Pit	7	116,829	t/y	0.0001	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% Control
OB - Hauling OB from Pit to emplacement area	45	116,829	t/y	0.001554	kg/t	38	t/load	61	Vehicle gross mass (t)	1.2	km/return trip	0.0	kg/VKT	3	% silt content	75	% control
OB - Trucks emplacing OB at emplacement area	7	116,829	t/y	0.0001	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% control
OB - Dozers on D1 north dump	528	739	h/y	0.7	kg/h	10	silt content in %	4	moisture content in %							0	% control
OB - Dozers on SRSF	528	739	h/y	0.7	kg/h	10	silt content in %	4	moisture content in %							0	% control
ORE - Dozers ripping/pushing/clean-up in pit	111	739	h/y	0.2	kg/h	5	silt content in %	7	moisture content of coal in %							0	% control
ORE - Drilling	205	38,604	holes/y	0.0177	kg/hole											70	% Control
ORE - Blasting	62	179	blasts/y	0.35	kg/blast	1,400	Area of blast in square metres									0	% Control
ORE - Loading ore from Pit to trucks	27	1,008,330	t/y	0.0000	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
ORE - Hauling ore from Pit to ROM Pad	2,872	1,008,330	t/y	0.0114	kg/t	38	t/load	61	Vehicle gross mass (t)	8.8	km/return trip	0.0	kg/VKT	3	% silt content	75	% control
ORE - Unloading ore from truck to ROM pad	27	1,008,330	t/y	0.0000	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
Ore - Primary crushing	302	1,008,330	t/y	0.0003	kg/t											0	% control
Ore - Secondary crushing	907	1,008,330	t/y	0.0009	kg/t											0	% control
Ore - Tertiary crushing	907	1,008,330	t/y	0.0009	kg/t											0	% control
Ore - Quaternary crushing	907	1,008,330	t/y	0.0009	kg/t											0	% control
Ore - Dry grinding	6,171	1,008,330	t/y	0.0360	kg/t											83	% control
Ore - Miscellaneous transfers	605	4,033,320	t/y	0.0002	kg/t											0	% control
WE - Stripped topsoil area at new LRSF in north	-	-	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
WE - Waste emplacement	670	10.2	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
WE - Pit	1,189	18.1	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
WE - Stockpiles other - SRSF	1,320	28.7	ha	0.0	kg/ha/h	8,760	h/y									30	% Control
WE - ROM stockpiles	8,146	2.1	ha	0.4	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - Stockpiles other - soil stockpiles	-	-	ha	0.4	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - Stockpiles other - Salt encapsulation cells	-	-	ha	0.4	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
Grading roads	355	37,171	km	0.02	kg/km	8	speed of graders in km/h	4,646	grader hours							50	% Control
Total PM2.5 emissions for Year 5 (kg/yr)	**27,174**																

ACTIVITY	TSP emission for Year 5 (kg/y)	Intensity	Units	Emission Factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Topsoil Removal - Stripping topsoil at salt encapsulation cell	4,000	137,940	t/yr	0.029	kg/t											0	% control
Topsoil Removal - Stripping topsoil at waste rock emplacement area	1,474	50,820	t/yr	0.029	kg/t											0	% control
OB - Drilling	24	4,473	holes/y	0.02	kg/hole											70	% Control
OB - Blasting	7	21	blasts/y	0.3	kg/blast	1,400	Area of blast in square metres									0	% Control
OB - Sh/Ex/FELs loading OB to trucks at Pit	16	268,212	t/y	0.0001	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% Control
OB - Hauling OB from Pit to emplacement area	104	268,212	t/y	0.001554	kg/t	38	t/load	61	Vehicle gross mass (t)	1.2	km/return trip	0.0	kg/VKT	3	% silt content	75	% control
OB - Trucks emplacing OB at emplacement area	16	268,212	t/y	0.0001	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	4	moisture content in %							0	% control
OB - Dozers on D1 north dump	528	739	h/y	0.7	kg/h	10	silt content in %	4	moisture content in %							0	% control
OB - Dozers on SRSF	528	739	h/y	0.7	kg/h	10	silt content in %	4	moisture content in %							0	% control
ORE - Dozers ripping/pushing/clean-up in pit	111	739	h/y	0.15	kg/h	5	silt content in %	7	moisture content of coal in %							0	% control
ORE - Drilling	205	38,604	holes/y	0.018	kg/hole											70	% Control
ORE - Blasting	62	179	blasts/y	0.35	kg/blast	1,400	Area of blast in square metres									0	% Control
ORE - Loading ore from Pit to trucks	27	998,558	t/y	0.0000	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
ORE - Hauling ore from Pit to ROM Pad	2,845	998,558	t/y	0.0114	kg/t	38	t/load	61	Vehicle gross mass (t)	8.8	km/return trip	0.0	kg/VKT	3	% silt content	75	% control
ORE - Unloading ore from truck to ROM pad	27	998,558	t/y	0.0000	kg/t	1.82	average of (wind speed/2.2)^1.3 in m/s	7	moisture content in %							0	% Control
Ore - Primary crushing	300	998,558	t/y	0.000	kg/t											0	% control
Ore - Secondary crushing	899	998,558	t/y	0.001	kg/t											0	% control
Ore - Tertiary crushing	899	998,558	t/y	0.001	kg/t											0	% control
Ore - Quaternary crushing	899	998,558	t/y	0.001	kg/t											0	% control
Ore - Dry grinding	6,111	998,558	t/y	0.036	kg/t											83	% control
Ore - Miscellaneous transfers	599	3,994,232	t/y	0.000	kg/t											0	% control
WE - Stripped topsoil area at salt encapsulation cell	1,373	20.9	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
WE - Waste emplacement	1,110	16.9	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
WE - Pit	2,602	39.6	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
WE - Stockpiles other - SRSF	2,166	47.1	ha	0.0	kg/ha/h	8,760	h/y									30	% Control
WE - ROM stockpiles	8,146	2.1	ha	0.4	kg/ha/h	8,760	h/y	3.28	m/s (annual average ws)							0	% Control
WE - soil stockpiles	-	-	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
WE - Salt encapsulation cells	578	8.8	ha	0.0	kg/ha/h	8,760	h/y									0	% Control
Grading roads	355	37,171	km	0.02	kg/km	8	speed of graders in km/h	4,646	grader hours							50	% Control
Total PM2.5 emissions for Year 5 (kg/yr)	**36,007**																

Appendix 4

DZP Odour Monitoring Report

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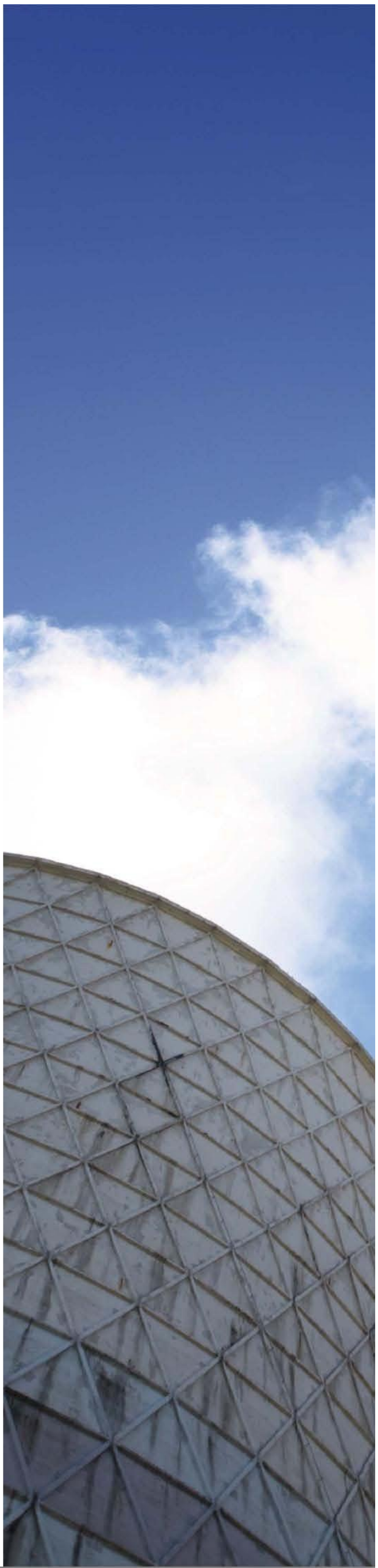

REPORT

ODOUR MONITORING FOR THE PROPOSED DUBBO ZIRCONIA PROJECT

R.W. Corkery & Co. Pty Limited

Job No: 6622

26 February 2013

www.pacific-environment.com

PROJECT TITLE:	**ODOUR MONITORING FOR THE PROPOSED DUBBO ZIRCONIA PROJECT**
JOB NUMBER:	**6622**
PREPARED FOR:	**R.W. CORKERY & CO. PTY LIMITED**
PREPARED BY:	Ronan Kellaghan
APPROVED FOR RELEASE BY:	Damon Roddis
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VERSION	**DATE**	**PREPARED BY**	**REVIEWED BY**
D1	26/02/13	R. Kellaghan	D. Roddis

Pacific Environment Operations Pty ABN 86 127 101 642

SYDNEY:
Suite 1, Level 1
146 Arthur Street,
North Sydney NSW 2060
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

YEERONGPILLY:
Unit 1, 22 Varley Street
Yeerongpilly, Qld 4105
Ph: +61 7 3004 6460

SOUTH BRISBANE:
Level 1, La Melba,
59 Melbourne Street
South Brisbane Qld 4101
PO Box 3306
South Brisbane Qld 4101
Ph: +61 7 3004 6400
Fax: +61 7 3844 5858

MELBOURNE:
Suite 62, 63 Turner Street,
Port Melbourne, Vic 3207
PO Box 23293, Docklands Vic 8012
Ph: +61 3 9681 8551
Fax: +61 3 9681 3408

PERTH:
Level 1/Unit 3, 34 Queen Street
Perth WA 6000
Ph: +61 8 9481 4961

ADELAIDE:
35 Edward St, Norwood SA, 5067
PO Box 3187, Norwood SA, 5067
Ph: +61 8 8391 4032

GLADSTONE:
Suite 2, 36 Herbert St
Gladstone Qld 4680
Ph: +61 7 3004 6400

Website: **www.pacific-environment.com**

Pacific Environment Limited

CONTENTS

LIST OF TABLES

1 INTRODUCTION

Australian Zirconia Ltd (AZL), a wholly owned subsidiary of Alkane Resources Ltd, are seeking approval for the development, mining and processing of Zirconium, Yttrium, Rare Earth Elements (REEs) and Niobium resources at a site located near Toongi, approximately 25km south of Dubbo.

Pacific Environment has been commissioned by R.W. Corkery & Co. Pty Ltd (RWC) to complete an Air Quality Impact Assessment (AQIA) for proposed Dubbo Zirconia Project.

As part of the AQIA for the project, an assessment of the potential for odour impacts from the waste steams is required. To facilitate this assessment, Pacific Environment have completed odour monitoring on 6 December 2012 and 12 February 2013 on samples of the waste streams generated by process.

The waste streams were obtained from a pilot processing plant operated by ANSTO at Lucas Heights, NSW and are described as:

- A solid residue which may contain specific wastes with elevated sulphide concentration.
- A liquid residue stream which may contain some residues containing ammonia.
- A compound waste stream.

The objective of the monitoring is to derive site specific odour emission rates (OERs) for input into an atmospheric dispersion model, allowing assessment of potential for off-site odour impact from the full scale facility.

The intent is to emulate conditions that could occur onsite and as such the potential exists for both fresh waste and previously placed (aged) waste to be stored at the site. Monitoring has therefore been conducted on both fresh and aged waste.

Sampling and analysis is conducted in accordance with:

- "Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales" (NSW DEC, 2005).
- Australian Standard AS/NZS 4323.4:2009 "Stationary source emissions. Method 4 Area Source sampling – Flux chamber method".
- Australian Standard AS/NZS 4323.3:2001 "Determination of Odour Concentration by Dynamic Olfactometry".

2 METHODOLOGY

Solid and liquid waste streams from the pilot plant were prepared by ANSTO.

For sampling on 6 December 2012, the solid waste was prepared in advance and stored in a sealed drum at ANSTO prior to sampling. The liquid waste was prepared immediately prior to sampling.

For sampling on 12 February 2013, a fresh solid waste sample was prepared immediately prior to sampling. The sample of the previously prepared solid waste was left exposed in a ventilated space, and used to characterise 'aged' waste.

Additionally, an odour sample was taken for a compound waste stream prepared immediately prior to sampling.

All waste streams were transferred to plastic trays to facilitate samples being collected. The potential for odour contamination from the sample trays was considered to be minimal. A sufficient volume of waste material was transferred to the trays to ensure adequate surface area cover for monitoring.

Representative odour samples from the surface of the solid and liquid waste streams were taken using an isolation flux hood (IFH). Samples are measured in accordance with Australian Standard AS/NZS 4323.4:2009 "Area source sampling – Flux chamber technique" and the method described in the US EPA technical report "EPA/60068-86/008".

A seal is formed between the IFH and each waste stream and odour-free air or nitrogen is forced into the hood via odour free Teflon tubing until it has reached equilibrium. The nitrogen flow (5 L/min) purges the flux hood with a residence time of 4 times the chamber volume occurring before sampling begins (24 minutes). The odorous sample is then drawn at a sample rate of approximately 2-3 L/min over a period of 30 minutes into a single use, odour-free Nalophan sample bag, secured inside a drum kept under vacuum using a pump.

Following collection, odour samples are analysed at a NATA accredited laboratory using dynamic olfactometry[a] (in accordance with AS/NZS 4323.3:2001 "Determination of Odour Concentration by Dynamic Olfactometry".

---

[a] *There are no instrument-based methods that can measure an odour response in the same way as the human nose and "dynamic olfactometry" is therefore the preferred method for odour analysis. Dynamic olfactometry is the measurement of odour by presenting a sample of odorous air to a panel of people with decreasing quantities of clean odour-free air. The panellists then note when the smell becomes detectable. The correlations between the known dilution ratios and the panellists' responses are then used to calculate the number of dilutions of the original sample required to achieve the odour detection threshold. The units for odour measurement using dynamic olfactometry are "odour units" (OU) which are dimensionless and are effectively "dilutions to threshold".*

3 RESULTS

The results of the odour monitoring are presented in **Table 3.1** for both solid (ALZN cake), liquid and compound waste streams. Odour Monitoring Certificates of Analysis are shown in **Appendix A.**

Specific Odour Emission Rates (SOERs) (expressed as OU.m^3/m^2/s) are also presented[b]. As seen in **Table 3.1**, the odour character reported in the analysis suggests that the fresh waste does have a sulphide character, indicated by the rotten eggs descriptor (which is typically used to describe H_2S).

Table 3.1: Odour Monitoring Results

Sample	Sample Description	Date / Time	Odour Concentration (OU)	Specific Odour Emission Rate (SOER) (OU.m^3/m^2/s)	Odour Character
ALZN Cake – "Fresh"	Prepared immediately prior to sampling	12/02/2013 10:30	1,450	0.86	Rotten Eggs
ALZN Cake	Prepared in advance and stored in a sealed drum	6/12/2012 14:30	223	0.13	Musty / Stale Water
ALZN Cake – "Aged"	Left exposed to atmosphere for 5 days	12/02/2013 09:24	91	0.05	Musty / Stale Water
Liquid Waste Stream	Prepared immediately prior to sampling	6/12/2012 15:10	256	0.15	Musty / Stale Water
Compound Waste Stream	Prepared immediately prior to sampling	12/02/2013 11:28	128	0.08	Musty / Stale Water

4 CONCLUSION

Odour monitoring was conducted on 6 December 2012 and 12 February 2013 for solid, liquid and compound waste streams produced at an AZL pilot plant operated by ANSTO at Lucas Heights, NSW.

Odour emission rates are derived for input into a dispersion model to assess of the potential for odour impacts at the proposed full scale processing plant at Dubbo, NSW.

5 REFERENCES

Australian Standard AS/NZS 4323.4:2009 Area source sampling – Flux chamber technique.

Australian Standard AS/NZS 4323.3:2001 Determination of Odour Concentration by Dynamic Olfactometry

NSW DEC (2005) "Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales". August, 2005

US EPA method (EPA/600/8-86/008) Measurement of Gaseous Emissions Rates from Land Surfaces Using an Emissions Isolation Flux Chamber Users Guide.

[b] SOERs are calculated from the measured odour concentration (OC), based on the area of the IFH (A) and the chamber flow rate (Q), according to equation 1:

$$SOER = OC \times \frac{Q}{A} \qquad \text{equation 1}$$

APPENDIX A – MONITORING CERTIFICATES

THE ODOUR UNIT

THE ODOUR UNIT

Aust. Technology Park
Locomotive Workshop
Suite 16012
2 Locomotive Street
Eveleigh NSW 2015

Phone: +61 2 9209 4420
Facsimile: +61 2 9209 4421
Email: tschulz@odourunit.com.au
Internet: www.odourunit.com.au
ABN: 53 091 165 061

NATA
Accreditation Number: 14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	Pacific Environment	Telephone	(02) 9870 0900
Contact	Ronan Kellaghan	Facsimile	-
Sampling Site	Undisclosed	Email	Ronan.Kellaghan@pacific-environment.com
Sampling Method	Undisclosed	Sampling Team	Pacific-Environment

Order details:

Order requested by	R. Kellaghan	Order accepted by	J. Schulz
Date of order	5/12/2012	TOU Project #	N1840R
Order number	6622-NSW01	Project Manager	J. Schulz
Signed by	Refer to correspondence	Testing operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian Standard 'Determination of Odour Concentration by Dynamic Olfactometry AS/NZS4323.3:2001. The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained between 22°C and 25°C.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: ODORMAT SERIES V04
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V04: r = 0.3234 (September 2012) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V04: A = 0.1995 (September 2012) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

Date: Tuesday, 18 December 2012

Panel Roster Number: SYD20121207_099

J. Schulz
NSW Laboratory Coordinator

A. Schulz
Authorised Signatory

THE ODOUR UNIT PTY LIMITED

Accreditation Number: 14974

Odour Sample Measurement Results
Panel Roster Number: SYD20121207_099

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m^3/m^2/s)
ALZN CAKE	SC12641	06/12/2012 1430hrs	07/12/2012 1019hrs	5	10	-	-	223	223	N/A
2 Liquid Waste	SC12642	06/12/2012 1510hrs	07/12/2012 1051hrs	5	10	-	-	256	256	N/A

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

THE ODOUR UNIT PTY LIMITED

Accreditation Number: 14974

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	SYD20121207_099	50,000	$20 \leq \chi \leq 80$	955	52	Yes

Comments None.

Disclaimer Parties, other than TOU, responsible for collecting odour samples hereby certify that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.

Note This report shall not be reproduced, except in full, without written approval of The Odour Unit Pty Ltd. Any attachments to this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.

END OF DOCUMENT

THE ODOUR UNIT

THE ODOUR UNIT

Aust. Technology Park
Locomotive Workshop
Suite 16012
2 Locomotive Street
Eveleigh NSW 2015

Phone: +61 2 9209 4420
Facsimile: +61 2 9209 4421
Email: tschulz@odourunit.com.au
Internet: www.odourunit.com.au
ABN: 53 091 165 061

NATA
Accreditation Number:
14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	Pacific Environment	Telephone	+61 2 9870 0900
Contact	R. Kellaghan	Facsimile	
Sampling Site	Undisclosed	Email	Ronan.Kellaghan@pacific-environment.com
Sampling Method	Drum & Pump AS4323.3:2001	Sampling Team	PEL

Order details:

Order requested by	R. Kellaghan	Order accepted by	J. Schulz
Date of order	07/02/2013	TOU Project #	N1867R.03
Order number	6622C-NSW01.	Project Manager	M. Assal
Signed by	R. Kellaghan	Testing operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian Standard 'Determination of Odour Concentration by Dynamic Olfactometry AS/NZS4323.3:2001. The odour perception characteristics of the panel within the presentation series for the samples were analogous to that for butanol calibration. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained between 22°C and 25°C.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: ODORMAT SERIES V04
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V04: $r = 0.3234$ (September 2012) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V04: $A = 0.1995$ (September 2012) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

Date: Friday, 15 February 2013

Panel Roster Number: SYD20130213_011

J. Schulz
NSW Laboratory Coordinator

A. Schulz
Authorised Signatory

THE ODOUR UNIT

THE ODOUR UNIT PTY LIMITED

Accreditation Number: 14974

Odour Sample Measurement Results
Panel Roster Number: SYD20130213_011

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate ($ou.m^3/m^2/s$)
AL2 Cake	SC13084	12/02/2013 09:24 hrs	13/02/2013 10:29 hrs	5	10	-	-	91	91	N/A
AL2 Cake Fresh	SC13085	12/02/2013 10:30 hrs	13/02/2013 11:07 hrs	5	10	-	-	1,450	1,450	N/A
Compound Waste	SC13086	12/02/2013 11:28 hrs	13/02/2013 11:39 hrs	5	10	-	-	128	128	N/A

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

THE ODOUR UNIT PTY LIMITED

Accreditation Number: 14974

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	SYD20130213_011	50,000	$20 \le \chi \le 80$	832	60	Yes

Comments None.

Disclaimer Parties, other than TOU, responsible for collecting odour samples hereby certify that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.

Note This report shall not be reproduced, except in full, without written approval of The Odour Unit Pty Ltd. Any attachments to this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.

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Appendix 5

Greenhouse gas emission calculations

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Diesel

GHG emissions from diesel consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of GHG from diesel combustion	($t\ CO_2$-e)
Q	=	Estimated combustion of diesel	(GJ)[1]
EF	=	Emission factor (scope 1 or scope 3) for diesel combustion	(kg CO_2-e/GJ)[2]

[1] GJ = Gigajoules
[2] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The quantity of diesel consumed in GJ is calculated using an energy content factor for diesel of 38.6 gigajoules per kilolitre (GJ/kL). Greenhouse gas emission factors and energy content for diesel were sourced from the NGA Factors (DCCEE, 2012). As discussed in Section 2.4 there are three transport options that would use a combination of road and rail to transport materials to and from the Proposal. The Scope 3 emissions for all three scenarios have been calculated. The estimated annual and project total GHG emissions from diesel usage are presented in **Table 1**.

Table 1: Estimated CO_2-e (tonnes) for Diesel Consumption

Phase	**Fuel Usage (kL)**	**Emission Factor (kg CO_2-e/GJ**		**Energy Content (GJ/kL)**	**Emissions (t CO_2-e)**		**Total**
		Scope 1	**Scope 3**		**Scope 1**	**Scope 3**	
Transport Option A	8,921	69.9	5.3	38.6	4,278	1,501	**5,778**
Transport Option B	7,090	69.9	5.3	38.6	4,278	1,126	**5,404**
Transport Option C	6,996	69.9	5.3	38.6	4,278	1,107	**5,385**
Total Diesel Option A	**178,423**	**69.9**	**5.3**	**38.6**	**85,552**	**30,015**	**115,567**
Total Diesel Option B	**141,799**	**69.9**	**5.3**	**38.6**	**85,552**	**22,523**	**108,075**
Total Diesel Option C	**139,928**	**69.9**	**5.3**	**38.6**	**85,552**	**22,140**	**107,692**

Liquefied Petroleum Gas

Greenhouse gas emissions from Liquefied Petroleum Gas (LPG) consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

E_{CO2-e}	=	Emissions of GHG from LPG combustion	($t\ CO_2$-e)
Q	=	Estimated combustion of LPG	(GJ)[1]
EF	=	Emission factor (scope 1) for LPG combustion	(kg CO_2-e/GJ)[2]

[1] GJ = giga joules
[2] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The quantity of LPG consumed in GJ is calculated using an energy content factor for LPG of 26.2 gigajoules per kilolitre (GJ/kL). Greenhouse gas emission factors and energy content for LPG were sourced from the NGA Factors (DCCEE, 2012). The estimated annual and Proposal total GHG emissions from LPG usage are presented in **Table 2**.

Table 2: Estimated CO_2-e (tonnes) for LPG Consumption

Phase	Fuel Usage (kL)	Emission Factor (kg CO_2-e/GJ	Energy Content (GJ/kL)	Emissions (t CO_2-e)	Total
		Scope 1		Scope 1	
Average operational year	26,000	60.8	26.2	41	**41**
20 year life of Proposal	**520,000**	**60.8**	**26.2**	**828**	**828**

Compressed Natural Gas

Greenhouse gas emissions from Compressed Natural Gas (CNG) consumption were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

$E_{CO2\text{-}e}$	=	Emissions of GHG from CNG combustion	(t CO_2-e)
Q	=	Estimated combustion of CNG	(GJ)[1]
EF	=	Emission factor (scope 1) for CNG combustion	(kg CO_2-e/GJ)[2]

[1] GJ = giga joules
[2] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

The quantity of CNG consumed in GJ is calculated using an energy content factor for CNG of 0.039 gigajoules per kilolitre (GJ/m^3). Greenhouse gas emission factors and energy content for CNG were sourced from the NGA Factors (DCCEE, 2012). The estimated annual and Proposal total CNG emissions from CNG usage are presented in **Table 3**.

Table 3: Estimated CO_2-e (tonnes) for CNG Consumption

Phase	Fuel Usage (m^3)	Emission Factor (kg CO_2-e/GJ	Energy Content (GJ/m^3)	Emissions (t CO_2-e)	Total
		Scope 1		Scope 1	
Average operational year	28,978,022	51.3	0.039	58,456	**58,456**
20 year life of Proposal	**579,560,440**	**51.3**	**0.039**	**1,169,129**	**1,169,129**

Blasting

Greenhouse gas emissions from blasting ammonium nitrate-fuel oil (ANFO) usage were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

$E_{CO2\text{-}e}$	=	Emissions of greenhouse gases from blasting using ANFO	(tCO_2-e/annum)
Q	=	Estimated blasting using ANFO	(tonnes/annum)[1]
EF	=	Emission factor (scope 2 or scope 3) for blasting using ANFO	(kgCO_2-e/kWh)[2]

[1] kWh/annum = kilowatt hours per annum
[2] kgCO_2-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

Greenhouse gas emission factors were sourced from the NGA Factors (DCCEE, 2012). The estimated annual and Proposal total GHG emissions from ANFO usage are presented in **Table 4**.

Table 4: Estimated CO_2-e (tonnes) for On-site ANFO Use

Phase	ANFO Usage (t)	Emission Factor (kg CO_2-e/t	Emissions (t CO_2-e)	Total
		Scope 1	Scope 1	
Average operational year	246	0.17	45	**45**
20 year life of Proposal	5,280	**0.17**	**898**	**898**

Electricity

Greenhouse gas emissions from electricity usage were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

$E_{CO2\text{-}e}$	=	Emissions of greenhouse gases from electricity usage	(tCO_2-e/annum)
Q	=	Estimated electricity usage	(kWh/annum)[1]
EF	=	Emission factor (scope 2 or scope 3) for electricity usage	($kgCO_2$-e/kWh)[2]

[1] kWh/annum = kilowatt hours per annum
[2] $kgCO_2$-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

Greenhouse gas emission factors were sourced from the NGA Factors (DCCEE, 2012). The estimated annual and Proposal total GHG emissions from electricity usage are presented in **Table 5**.

Table 5: Estimated CO_2-e (tonnes) for Electricity Use

Phase	Electricity Usage (GWh)	Emission Factor (kg CO_2-e/kWh	Emissions (t CO_2-e)	Total
		Scope 2	Scope 2	
Average operational year	137	0.88	120,560	**2,411,200**
20 year life of Proposal	**2,740**	**0.88**	**2,411,200**	**2,411,200**

Calcium carbonate

Greenhouse gas emissions from usage of calcium carbonate at the processing plant were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

where:

$E_{CO2\text{-}e}$	=	Emissions of greenhouse gases from electricity usage	(tCO_2-e/annum)
Q	=	Estimated calcium carbonate usage	(tonnes/annum)
EF	=	Emission factor for calcium carbonate usage	($kgCO_2$-e/tonne)

Greenhouse gas emission factors were sourced from the NGA Factors (DCCEE, 2012). The estimated annual and Proposal total GHG emissions from use of calcium carbonate are presented in **Table 6**.

Table 6: Estimated CO_2-e (tonnes) for calcium carbonate usage

Phase	**Calcium carbonate usage (tonnes)**	**Emission Factor (kg CO_2-e/kWh**	**Emissions (t CO_2-e)**	**Total**
		Scope 2	**Scope 2**	
Average operational year	195,000	0.396	77,220	**77,220**
20 year life of Proposal	**3,900,000**	**0.396**	**1,544,400**	**1,544,400**