Gwen Wilson
Broken Hill Operations Pty Ltd
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19 June 2017

Dear Gwen,

Re Rasp, silver lead and zinc mine – Modification No 4

Broken Hill Operations Pty Ltd (BHOP) have made application to the Department of Planning and Environment (DPE) to modify their existing tailings storage facility and add a concrete batching plant to their Rasp silver, lead and zinc (Rasp) mine in Broken Hill.

The Environmental Protection Authority (EPA) have reviewed the Environmental Assessment (EA) provided by the proponent and requested further information to support the EA.

This letter provides a response to EPA's submissions regarding air quality aspects associated with the proposed modification of the Rasp mine. Responses have been made with reference to the following documentation:

- *Appendix A: Tailings Lead Concentration Results*
- *Appendix B: Waste Rock Classification,* Pacific Environment Pty Ltd, 2017 (hereafter, "Waste Rock Classification study").
- *Appendix C: TSF Spray System Details – Rasp Mine Project Tailings Dam Spray System Version 1.40 – 13 June 2017,* Wet Earth Pty Ltd
- *Appendix D: Calibration certificates.* Ecotech, May 2016.
- *Appendix E: 21544C CBH Resources Rasp Mine TSF Lift and Concrete Batcher AQ Assessment Revision 2 -Appendix G: CABC Monitoring Report*, Pacific Environment Pty Ltd, 2017 (hereafter, "the AQ Assessment").
- *Appendix F: Emissions source characteristics,* Pacific Environment 2017
- *Appendix G: Decommissioning phase,* BHOP 2017*.*
- *Appendix H: Operational Controls for TSF2 Dust Suppression.*

This letter addresses each comment within the EPA submission (EPA reference DOC17/236124-21 dated 17 May 2017) sequentially below.

I trust that the following provides adequate clarification. Do not hesitate to contact the undersigned if you would like any additional information.

Yours sincerely

D.A. Roddis

Damon Roddis
National Practice Leader – Air Quality and Noise

1 Response to EPA Submissions

1.1 EPA Comment 1

Confirmation, including test data, to verify the percent lead concentration of tailings material and the Tailings Storage Facility No 2 (TSF2) walls (in situ and constructed) which have the potential to emit particulate matter/dust.

1.1.1 Response

BHOP have provided tabulated test data verifying the percent lead concentration of tailings material, as shown in Appendix A. The data has been derived from laboratory assays of each 12 hour shift composites, feed weightometer and concentrate weighbridge readings. The total amount of tailings deposited between April 2012 and December 2016 is 2,436,727 tonnes at 0.31% lead (Pb).

In terms of the spatial variability in Pb across the TSF, it is CBH's operational experience based on sampling of their Endeavor tailing that there is not a lot of segregation and grade differences in the lead from the south to the north of the TSF. Although the coarser grind at Rasp makes it more possible than at Endeavor but the losses are mainly found in the ultra-fines.

In March 2017, Pacific Environment completed a waste rock classification study (see Appendix B) referencing samples collected within the Kintore Pit. This material is considered representative of material that would be used for TSF2 wall construction. The analysis included the metals composition using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES).

Lead concentrations averaged 2,371.5 mg/kg (0.24%), and were taken from crushed samples (and therefore are considered conservative). The AQ Assessment adopted a waste rock composition of 0.5%, providing a conservatively high assumption of lead emissions from waste rock being used in the TSF wall construction.

1.2 EPA Comment 2

Engineering specification, assurance and guarantee that TSF2 management measures, such as watering, are achievable and able to service all parts of the TSF2 and its walls, including:

- *water availability and pressure,*
- *water application rate, timing, location and method.*

1.2.1 Response

This information is provided within a stand-alone technical document provided by Wet Earth Pty Ltd, reference *Rasp Mine Project Tailings Dam Spray System Version 1.00*, dated 2 June 2017, as reproduced within Appendix C.

1.3 EPA Comment 3

Verification of ambient monitoring data presented in the assessment including:

1. *Calibration and quality assurance applied to the data and to the monitoring instruments; and*
2. *Reanalysis, evaluation and confirmation of ambient PM_{10} and $PM_{2.5}$ values adopted in the assessment, noting –*

   adopted annual PM_{10} values are trending towards minimum reported values, when analysed by box and whisker plots (assessment figures E-10 and E-11). Adopted annual $PM_{2.5}$ values show far greater inter monitor variation than PM_{10}, indicating either a data error or an unidentified dominant $PM_{2.5}$ emission source(s) influencing TEOM2 values.

1.3.1 Response

1. Annual maintenance and calibration records for onsite air quality monitoring equipment have been conducted by Ecotech Pty Ltd, a NATA accredited laboratory. Calibration records are provided in Appendix D and have been provided for the following instruments:

   a. Three High Volume Air Samplers (HVAS) measuring Total Suspended Particulate (TSP) / particulate matter less than 10μm in aerodynamic diameter (PM_{10}) and lead (Pb) concentrations at three locations on site.

   b. Two Tapered Element Oscillating Microbalances (TEOMs) measuring PM_{10} at two locations on site.

2. The adopted annual mean concentrations presented in the AQ Assessment (Figures E-10 and E11) have been reviewed and were found to be in error, with the box plots showing the incorrect median and quartile data. The adopted annual was correct. Note that the error in the box and whisker plot had no influence on the results. The box and whisker plots of the 24-hour average PM_{10} concentrations measurements for TEOM1 and TEOM2 have been regenerated with a finer resolution and show an annual year (rather than financial year) results and are shown in Figure 1-1 and Figure 1-2, respectively. The original figures can be seen in Figure E-10 and E11 of Appendix E in the AQ Assessment. The adopted annual mean values in the AQ Assessment align with the updated plots presented in this letter.

   It is noted that BHOP incorrectly issued the same results for Both TEOM1 and TEOM 2 for the month of November and December. The updated monitoring results have now been provided by BHOP for November 2016 and December 2016. The reported annual mean PM_{10} values reflect the updated data sets (see Figure 1-1 and Figure 1-2). The updated annual average background concentrations are now 13.0μg/m^3 (no change) for receptors using the TEOM1 dataset and 13.9μg/m^3 (previously 13.1 μg/m^3) for receptors where the TEOM2 dataset was adopted.

   The variability in the annual $PM_{2.5}$ data adopted for the background (see Section 4.2 of the AQ Assessment) reflects a typographical error. The AQ Assessment incorrectly calculated the annual average $PM_{2.5}$ concentration at TEOM 2 to be 7.1 μg/m^3.

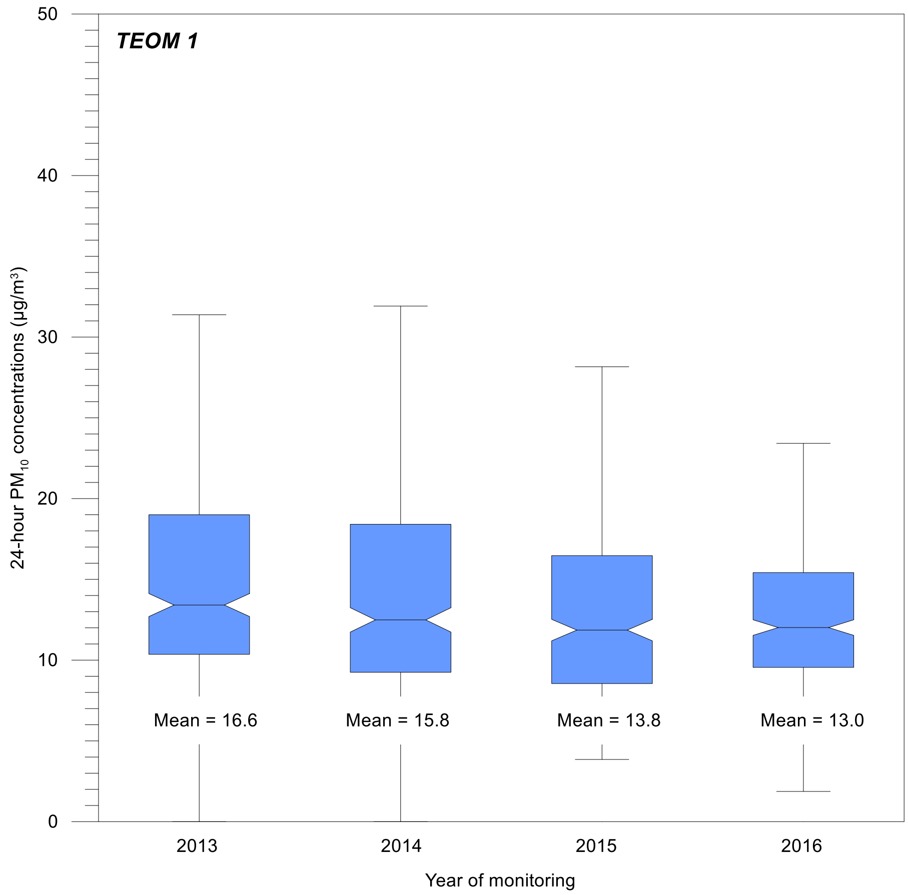
As the annual average PM_{10} concentrations were used to calculate the annual average $PM_{2.5}$ concentrations, the adopted background used for $PM_{2.5}$ has changed. The updated annual average background concentrations for $PM_{2.5}$ are now 5.3µg/m^3 (unchanged) for receptors using the TEOM1 dataset and 5.7µg/m^3 (previously 7.1µg/m^3) for receptors where the TEOM2 dataset.

In view of the above, the model predictions presented in Section 5.1 and 5.2 of the AQ Assessment require updating and are provided in Table 1-1 and Table 1-2. Where results have changed, the previous results are provided in brackets.

The updates mean the following changes to the results:

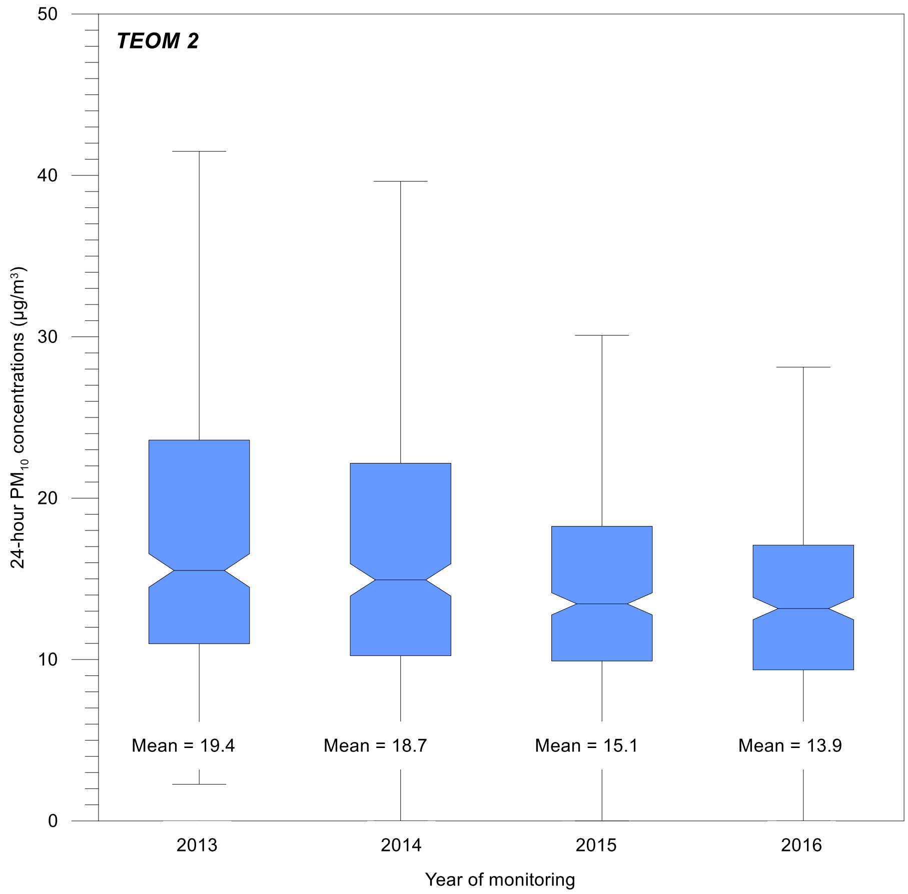
- PM_{10} results:
  - For the cumulative results when the TSF is operating under expected conditions the following receptors were predicted to have a 1 µg/m^3 increase annual average PM_{10} concentration, compared to those previously presented: R7 – R10, R14 – R17, R19, R20, R27 – R43, R47 – R49.
  - For the cumulative results when the TSF is operating under upset conditions the following receptors were predicted to have a 1 µg/m^3 increase annual average PM_{10} concentration, compared to those previously presented: R7 – R10, R14 – R17, R19, R20, R28 – R43, R47 – R49.
  - No change to the maximum 24-hour predictions.
- $PM_{2.5}$ results:
  - For the cumulative results when the TSF is operating both under expected and upset conditions, the following receptors were predicted to have a 1 µg/m^3 decrease in annual average PM_{10} concentration, compared to those previously presented: R7 – R10, R14 – R17, R19, R20, R27 – R43, R47 – R49.
  - No change to the maximum 24-hour predictions.

In summary, the updates do not result in any material change in the conclusions and recommendations with respect to either PM_{10} or $PM_{2.5}$ concentrations associated with the proposed modification.



The caps, or whiskers, at the end of each box indicate the extreme values (minimum and maximum, inter-quartile range times a factor, or a percentage of the data), the box is defined by the lower and upper quartiles, and the line in the center of the box is the median.

Figure 1-1: Box and whisker plots of 24-hour average PM_{10} measurements by calendar year at TEOM1



The caps, or whiskers, at the end of each box indicate the extreme values (minimum and maximum, inter-quartile range times a factor, or a percentage of the data), the box is defined by the lower and upper quartiles, and the line in the center of the box is the median.

Figure 1-2: Box and whisker plots of 24-hour average PM_{10} measurements by calendar year at TEOM2

Table 1-1: Updated predicted annual average and maximum 24-hour PM_{10} concentrations (µg/m^3)

Receptor ID	Annual average			Maximum 24-hour		
	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)[1]	Cumulative (Increment + TSF upset + background)[1]	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)	Cumulative (Increment + TSF upset + background)
NSW criterion	*n/a*	*25*	*25*	*n/a*	*50*	*50*
R1	0.03	13	13	1.4	36	36
R2	0.04	13	13	1.8	36	36
R3	0.05	13	13	1.9	36	36
R4	0.03	13	13	1.0	36	36
R5	0.02	13	13	0.8	36	36
R6	0.02	13	13	1.2	36	36
R7	0.01	14 (13)	14 (13)	0.5	46	46
R8	0.02	14 (13)	14 (13)	0.7	46	46
R9	0.02	14 (13)	14 (13)	1.2	46	46
R10	0.02	14 (13)	14 (13)	0.5	46	46
R11	0.01	13	13	0.6	36	36
R12	0.01	13	13	0.6	36	36
R13	0.01	13	13	0.6	36	36
R14	0.01	14 (13)	14 (13)	0.3	46	46
R15	0.00	14 (13)	14 (13)	0.3	46	46
R16	0.01	14 (13)	14 (13)	0.3	46	46
R17	0.01	14 (13)	14 (13)	0.4	46	46
R18	0.01	13	13	0.4	36	36
R19	0.00	14 (13)	14 (13)	0.2	46	46
R20	0.00	14 (13)	14 (13)	0.4	46	46
R21	0.03	13	13	1.8	36	36
R22	0.03	13	13	1.3	36	36
R23	0.02	13	13	1.0	36	36
R24	0.02	13	13	0.7	36	36
R25	0.02	13	13	0.8	36	36
R26	0.03	13	13	0.6	36	36
R27	0.14	14	14	3.1	46	52
R28	0.19	14	14	3.2	46	47
R29	0.06	14 (13)	14 (13)	1.4	46	46
R30	0.11	14 (13)	14 (13)	2.3	46	46

Receptor ID	Annual average			Maximum 24-hour		
	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)[1]	Cumulative (Increment + TSF upset + background) [1]	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)	Cumulative (Increment + TSF upset + background)
R31	0.03	14 (13)	14 (13)	1.7	46	46
R32	0.03	14 (13)	14 (13)	0.8	46	46
R33	0.04	14 (13)	14 (13)	1.9	46	46
R34	0.03	14 (13)	14 (13)	0.8	46	46
R35	0.02	14 (13)	14 (13)	1.0	46	46
R36	0.02	14 (13)	14 (13)	0.7	46	46
R37	0.02	14 (13)	14 (13)	0.6	46	46
R38	0.01	14 (13)	14 (13)	0.7	46	46
R39	0.01	14 (13)	14 (13)	0.7	46	46
R40	0.02	14 (13)	14 (13)	0.7	46	46
R41	0.02	14 (13)	14 (13)	0.7	46	46
R42	0.03	14 (13)	14 (13)	0.6	46	46
R43	0.06	14 (13)	14 (13)	3.2	46	46
R44	0.01	13	13	0.6	36	36
R45	0.01	13	13	0.6	36	36
R46	0.01	13	13	0.3	36	36
R47	0.01	14 (13)	14 (13)	0.5	46	46
R48	0.01	14 (13)	14 (13)	0.4	46	46
R49	0.00	14 (13)	14 (13)	0.1	46	46

Notes: 1. Where results have changed, the previous results are provided in brackets.

Table 1-2: Updated predicted annual average and maximum 24-hour $PM_{2.5}$ concentrations (µg/m³)

Receptor ID	Annual average			Maximum 24-hour		
	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)[1]	Cumulative (Increment + TSF upset + background)[1]	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)	Cumulative (Increment + TSF upset + background)
NSW criterion	*n/a*	*25*	*25*	*n/a*	*50*	*50*
R1	0.005	5	5	0.2	15	15
R2	0.006	5	5	0.2	15	15
R3	0.006	5	5	0.2	15	15
R4	0.004	5	5	0.1	15	15
R5	0.003	5	5	0.1	15	15
R6	0.003	5	5	0.3	15	15
R7	0.001	6 (7)	6 (7)	0.1	19	19
R8	0.003	6 (7)	6 (7)	0.1	19	19
R9	0.003	6 (7)	6 (7)	0.2	19	19
R10	0.003	6 (7)	6 (7)	0.1	19	19
R11	0.002	5	5	0.1	15	15
R12	0.002	5	5	0.1	15	15
R13	0.002	5	5	0.1	15	15
R14	0.002	6 (7)	6 (7)	0.1	19	19
R15	0.001	6 (7)	6 (7)	0.2	19	19
R16	0.002	6 (7)	6 (7)	0.1	19	19
R17	0.002	6 (7)	6 (7)	0.2	19	19
R18	0.001	5	5	0.1	15	15
R19	0.001	6 (7)	6 (7)	0.1	19	19
R20	0.001	6 (7)	6 (7)	0.1	19	19
R21	0.006	5	5	0.2	15	15
R22	0.006	5	5	0.2	15	15
R23	0.007	5	5	0.2	15	15
R24	0.008	5	5	0.2	15	15
R25	0.004	5	5	0.1	15	15
R26	0.009	5	5	0.2	15	15
R27	0.057	6 (7)	6 (7)	1.6	19	19
R28	0.082	6 (7)	6 (7)	1.5	19	19
R29	0.024	6 (7)	6 (7)	0.6	19	19
R30	0.048	6 (7)	6 (7)	1.1	19	19

Receptor ID	Annual average			Maximum 24-hour		
	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)[1]	Cumulative (Increment + TSF upset + background) [1]	Incremental (Mod 4 + CBP)	Cumulative (Increment + TSF normal + background)	Cumulative (Increment + TSF upset + background)
R31	0.012	6 (7)	6 (7)	0.9	19	19
R32	0.013	6 (7)	6 (7)	0.4	19	19
R33	0.018	6 (7)	6 (7)	0.8	19	19
R34	0.004	6 (7)	6 (7)	0.2	19	19
R35	0.004	6 (7)	6 (7)	0.2	19	19
R36	0.005	6 (7)	6 (7)	0.2	19	19
R37	0.006	6 (7)	6 (7)	0.2	19	19
R38	0.001	6 (7)	6 (7)	0.1	19	19
R39	0.001	6 (7)	6 (7)	0.1	19	19
R40	0.003	6 (7)	6 (7)	0.2	19	19
R41	0.004	6 (7)	6 (7)	0.2	19	19
R42	0.004	6 (7)	6 (7)	0.1	19	19
R43	0.028	6 (7)	6 (7)	1.6	19	19
R44	0.001	5	5	0.1	15	15
R45	0.002	5	5	0.1	15	15
R46	0.001	5	5	0.1	15	15
R47	0.003	6 (7)	6 (7)	0.1	19	19
R48	0.002	6 (7)	6 (7)	0.1	19	19
R49	0.001	6 (7)	6 (7)	0.0	19	19

Notes: 1. Where results have changed, the previous results are provided in brackets.

1.4 EPA Comment 4

A comprehensive description and results of the confined air bust chamber testing to demonstrate the relative control efficiency for emissions from wind erosion, with attention on TSF2 emissions.

1.4.1 Response

A comprehensive description and summary of results associated with the confined air burst chamber field investigations is provided within Appendix E. Appendix E provides an overview of the testing methodology for the Confined Air Burst Chamber (CABC) for measuring relative control efficiency and the USEPA Sieving Test for determination of threshold friction velocity (TFV) in addition to the field testing data.

The report also determines the lift-off threshold wind speed for the dry tailings, dry fines in drainage gullies for a range of particle size diameters. The results also include the test results for a range of control measures and the respective control efficiencies of the samples measured at Rasp Mine.

1.5 EPA Comment 5

Modelled emission source characteristics including but not limited to source location and source height (including height relative to receptors with attention given to final capping height of the TSF2). Where estimated and modelled emissions vary by hour, the basis for defining emission variability should also be clearly explained and justified.

1.5.1 Response

The emission source characteristics modelled are presented in Appendix F and include details of the coordinates and elevation for all discrete receptors and volume sources in addition to the stack parameters used for the point sources.

All volume sources were modelled with an initial sigma Y of 10.0m, initial sigma Z of 2.0m and release height of 2.0m.

Terrain heights located within the CML7 mining lease were derived from contour data provided by BHOP. For terrain elevations located outside of the CML7 mining lease, default AERMOD terrain (SRTM3) was adopted (i.e. is applicable to gridded and discrete receptors).

The terrain for the baseline (2016 operations) model was used from mid-2016 whilst the terrain for the proposed MOD4 was from projected terrain that accounts for the increase in embankment heights and slight increase in TSF height.

The air quality assessment addressed the particulate matter (PM) emissions that would be occurring during the construction of the MOD4. At this project point in time the TSF would not have reached the final height of the TSF.

A sensitivity analysis has subsequently been completed by modelling the emissions from the TSF with all heights set to 324mAHD. The maximum increase in 24-hour PM_{10} concentration at any sensitive receptor under normal operations was predicted to be 0.1µg/m^3, and thus not material to the assessment outcomes.

All activities relevant to MOD4 construction activities were modelled to occur between the hours of 7am and 6pm.

An hourly varying emission file was generated to simulate PM wind erosion from the TSF2, based on the threshold friction velocity (TFV) values determined from on-site measurements (refer Appendix E). The emissions were calculated in accordance with the AP-42 Chapter 13.2.5 Industrial Wind Erosion

(US EPA, 1995). A representation of this hourly emission file, in terms of g/s over the year of modelling, is presented in Figure 1-3..

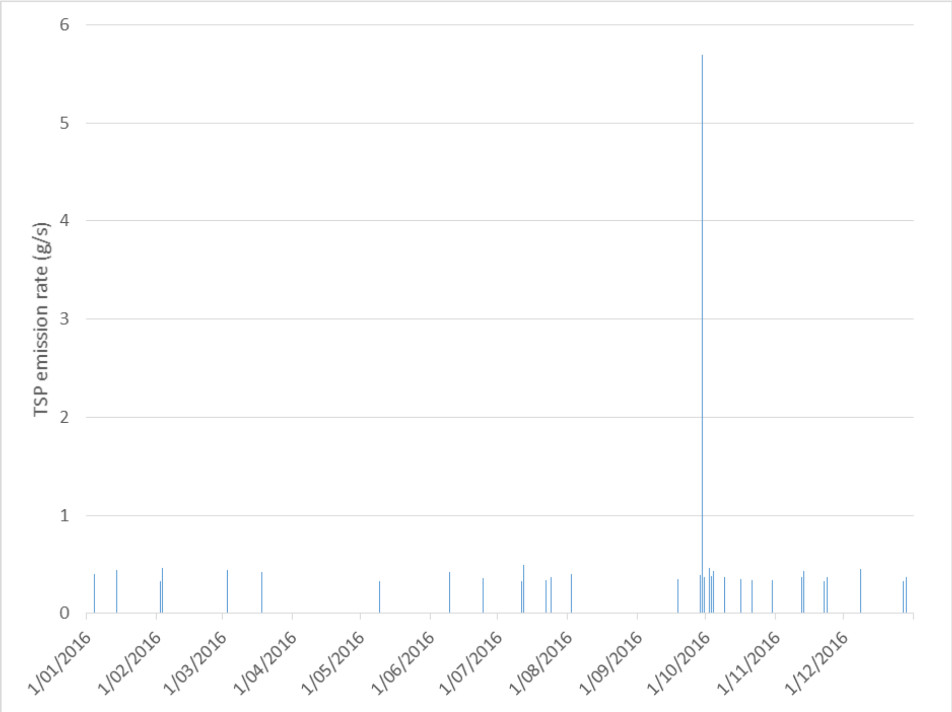


Figure 1-3: Hourly varying wind erosion emission file based on site-specific TFV in Appendix E

Figure 1-3 indicates that for the majority of the year the wind speed is sufficiently low such that there would be no emissions from the TSF. It also shows that there would be 152 hours of the year where the wind speed exceeds the TFV of 10.9m/s for dry fines (0.5mm particle diameter) and six hours of the year where the TFV of 14.3m/s would be exceeded such that lift off would occur for dry tailings (1mm particle diameter).

1.6 EPA Comment 6

Detailed discussion and calculation of any 'threshold friction velocity' adopted in the assessment.

1.6.1 Response

A detailed discussion of the site-specific investigations completed to derive a threshold friction velocity for the TSF2 is presented in Appendix E. Section 3 of Appendix E includes an overview of the field testing and calculation methodology. Section 4.2 of Appendix E shows the results of the calculation of the TFV. The results of the determination of the TFV have been replicated in below Table 1-3.

Table 1-3: Results of USEPA Sieve Testing from Appendix E

Sieve Test	Erosion Surface	Tyler Sieve Mode (Opening - mm)	Lift-off Threshold Wind Speed* (m/s)

#1	Dry tailings	1 mm	14.3
#2	Dry fines in drainage gullies	0.5 mm	10.9
#3	Wet tailings	> 4mm	N/A
#4	Dry tailings	1 mm	14.3

*Wind speed at 10 m above ground level.

Relevant to the AQ Assessment, the results in Table 1-3 were used in the calculation of wind erosion potential at TSF2. A TFV of 10.9m/s was adopted for the dry tailings area (approximately 90% of TSF2) and 14.3 for the dry fines area (approximately 10% of TSF2).

1.7 EPA Comment 7

Sensitivity analysis to evaluate the impact of an alternative 'threshold friction velocity', including 5.4 metres per second and any other suitable threshold referenced in the published literature.

1.7.1 Response

A sensitivity analysis of the TFV for calculated emissions from the TSF is provided below.

Emissions of wind-erodible material from TSF2 have been calculated for an alternative TFV of 5.4m/s. The results of this alternative compared with those adopted in the AQ Assessment are presented in Table 1-4.

Table 1-4: Summary of calculated emissions from the TSF under expected versus low-TFV conditions (kg/year)

Scenario	TSP	PM_{10}	$PM_{2.5}$	Pb (TSP)
Expected conditions (as modelled)				
Dry area	1,562	781	117	4.8
Dry Fines	2,716	1,358	204	8.4
Low TFV assumption				
Dry area	244,662	122,331	18,350	758.5
Dry Fines	27,185	13,592	2,039	84.3

Note: Note: *Annualised* emission estimates are reflective of the emission quantity applied in the model for the estimation of peak 24-hour impacts (i.e. assuming short-term peak operations occur on a continuous basis).

Unsurprisingly, the results for a TFV of 5.4m/s are significantly higher with those adopted in the assessment (see Appendix E).

To further evaluate this significant increase in calculated emissions under such a scenario, dispersion modelling was completed for PM_{10} adopting the low TFV value. The hourly varying emissions file is presented in Figure 1-4.

A time series of the incremental contribution of TSF wind erosion to the 24-hour PM_{10} concentration predictions at the most impacted sensitive receptor (R27) using a TFV as adopted in the AQ Assessment and when a TFV of 5.4m/s is used is shown in Figure 1-5.

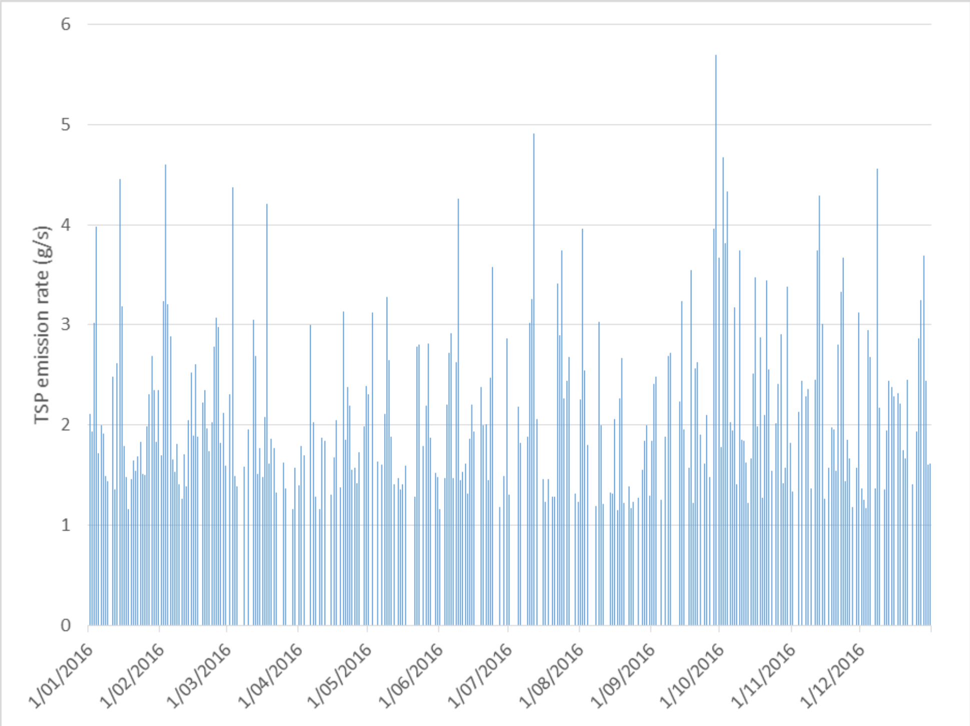


Figure 1-4: Hourly varying wind erosion emission file based on TFV of 5.4 m/s

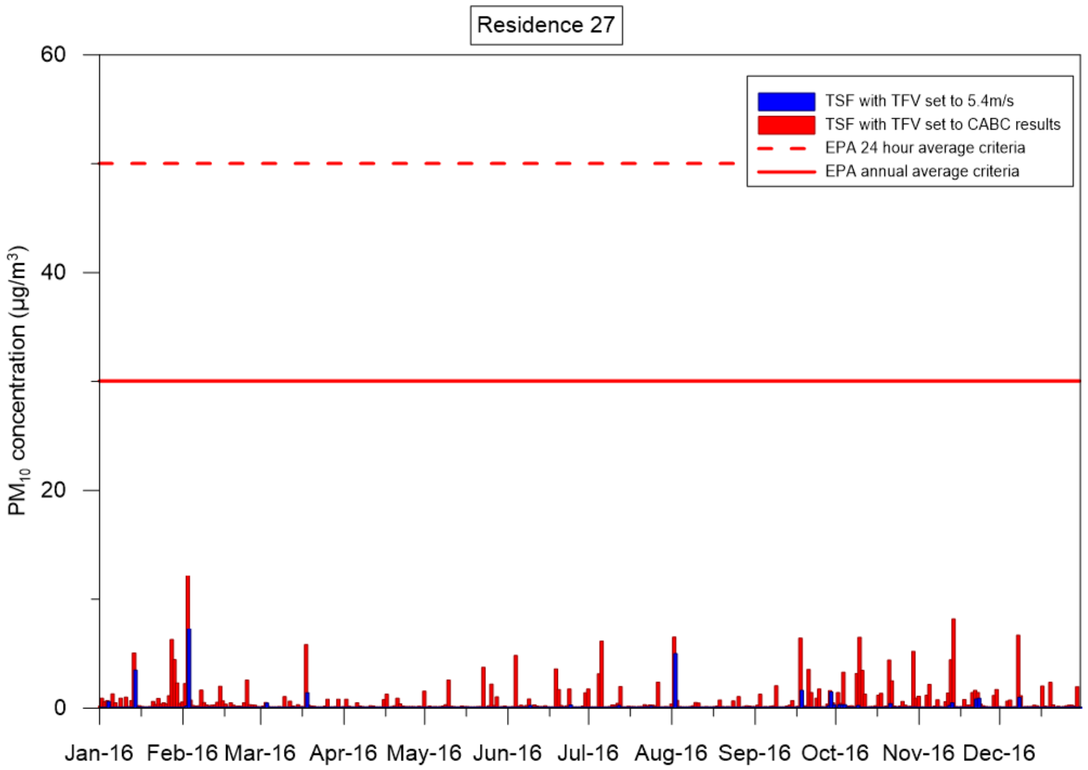


Figure 1-5: Time series of modelled contribution of TSF wind erosion to 24-hour average PM10 at R27 adopting TFV of 5.4 m/s

In terms of emission frequency, the results show that, unsurprisingly, TSF emissions would be predicted to occur more frequently when adopting the TFV of 5.4m/s. However, when considered in context of the PM_{10} 24-hour average criterion of 50µg/m^3, impacts from the TSF2 would be relatively low even under this highly conservative assumption.

While it is acknowledged that the modelled contribution of TSF wind erosion increases significantly under a TFV of 5.4m/s, this assumption is not considered valid.

This is since a value of 5.4m/s is based on a default value for dust lift off available in the literature. This value is generic, and does not correspond to the source material found at the surface of the TSF.

Rather, a site specific value for the TFV from TSF2 has been established through direct field measurement using the USEPA sieving method to derive lift-off threshold wind speeds for tailings under various conditions. Full details of this approach is provided in Appendix E.

1.8 EPA Comment 8

Evaluation of potential emissions, impacts and management measures for the decommissioning phase of the TSF2, including during initial drying prior to hard rock armouring and during armouring works.

1.8.1 Response

A comprehensive summary of the decommissioning phase of the TSF2 is provided in Appendix G. Within this, BHOP note that the primary objectives for closure of TSF2 are to manage the following:

- *Safety – providing a final surface, which does not expose the public to chemical and physical hazards, particularly from the generation of dust.*
- *Stability – ability for the landform to remain stable over an extended period beyond closure, e.g. withstand large earthquakes and flood events, as well as continuous erosion forces from air and water.*
- *Seepage and groundwater – managing infiltration such that transportation of contaminants either to groundwater and/or surface water bodies will not impact receptors adversely.*
- *Erosion and sediment load – resistance to wind and water energy which may degrade the final surface and result in transportation of sediments to the external environment.*
- *Aesthetics – ability to blend into the natural environment and support intended end land uses.*

The memorandum in Appendix G outlines that whilst the tailings are allowed to settle and consolidate the proponent will use a chemical dust suppressant to minimise dust entrainment.

As the surface of the TSF2 is progressively covered with waste rock, vehicles will only be permitted to travel on previously placed rock material. No vehicles will be permitted to travel directly on the tailings surface and disturb the dust control crust on the tailing surface. In addition a water truck will be used to suppress dust during material transfer activities, these activities will cease when wind speeds of 50 k/h are expected and water sprays may also be utilised over specific areas where material is being placed. The water spray system would not be removed until signed-off completion of the TSF rehabilitation stage.

Monitoring of particulate matter at the TSF boundaries will continue during this period.

As outlined in Appendix G , the proponent has prepared a conceptual design of the cover layer comprising of:

- *A 200 mm thick capillary break layer formed of screened waste rock placed over the tailings surface.*
- *A 300 mm thick cover formed of compacted run of mine waste rock. The mine waste rock would contain sufficient fines to create a well graded rockfill after compaction. The rockfill would be watered and compacted using heavy smooth drum compaction equipment. The cover would be robust and resistant to wind and water erosion. Studies would be conducted to determine if a further in-fill layer is required and the thickness of this additional layer (the current rehabilitation cover thickness allows for 1 m).*

Implementation of the conceptual design would require the following:

- 2 x 50t trucks running between Kintore Pit and the TSF

- Water truck
- Excavator operating in Kintore Pit
- Dozer, Cat D7 or equivalent, pushing out waste rock on TSF surface
- Padfoot roller operating on TSF surface

Pacific Environment has reviewed the information summarised above and provided in Appendix G. It is considered that the proposed decommissioning of the TSF2 is appropriate.

Further, it is anticipated that the operational safeguards presented in Section 1.9.1 will remain in place until decommissioning is complete. It is considered that these measures are comprehensive, and thus appropriate to control off-site particulate during the decommissioning phase.

1.9 EPA Comment 9

Further detail on a proposed management monitoring regime, including as a minimum, real time particle monitoring at representative locations on all sides of TSF2; telemetry notifications; response mechanisms; responsibilities; and quality assurance.

1.9.1 Response

The following builds upon the information documented in Section 6 of the AQ Report in relation to the proposed air quality management as it relates to the TSF.

To provide a clear direction as to the measurement of dust from the TSF2 and when the water sprays are to be activated we have incorporated an air quality management plan and trigger and response levels specific to TSF 2 operations. This documents is provided in Appendix H.

BHOP currently monitors PM_{10} concentrations and wind speed/direction continuously at two locations (north and south of current mining operations). Only the TEOM located to the north is located on site and relevant to potential TSF emissions.

Monitoring will continue at these locations, and will be supplemented with additional monitoring locations representative of conditions at the TSF. The location of the on-site TEOM and proposed additional monitors is shown in Figure 1-6.

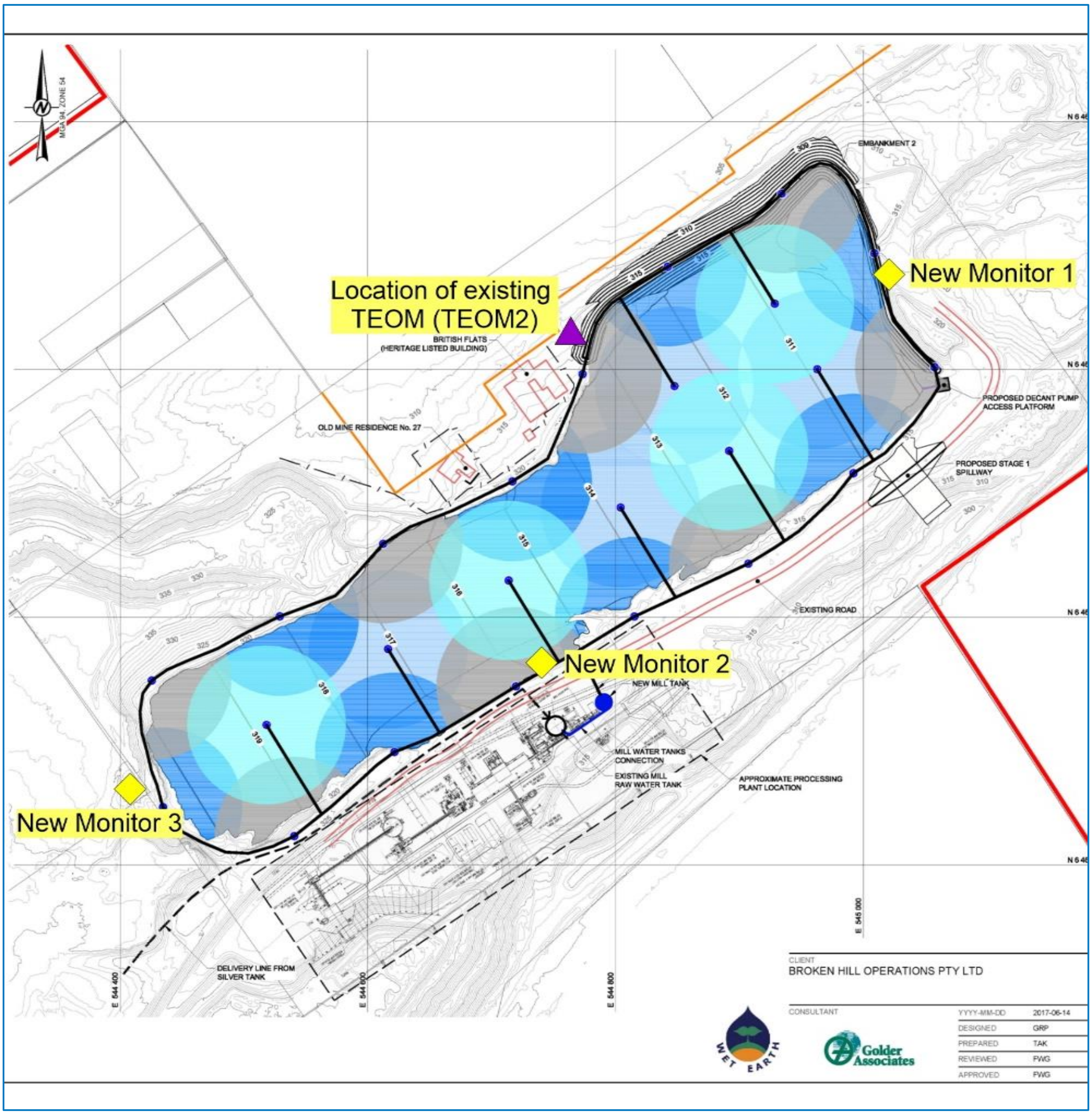


Figure 1-6: Location of the on-site TEOM and proposed additional monitors

Additional PM monitoring needs to be portable, ruggedised and operable without access to mains power. Pacific Environment has, at this stage, selected the TSI DRX $PM_{10}/PM_{2.5}$ monitor combined with Lufft sonic anemometer / weather station and solar power set-up as a suitable candidate technology to meet these criteria.

The TSI DRX unit has been field evaluated and continues to provide valuable dust management information at an equivalent application managed by Pacific Environment (gold mine TSF in Victoria).

This technology is shown in Figure 1-7. It is anticipated that for the current application, the instruments would be skid-mounted to allow for convenient relocation as the TSF progresses or when higher risk (i.e. dry fines) areas of the TSF may be identified.

Figure 1-7 Anticipated PM monitoring technology (TSI DRX unit)

By combining real-time observations with telemetry and readily available software, SMS or email alerts will be provided to relevant site personnel when critical PM concentrations or wind speeds occur.

In addition to the above, it is understood that the proposed TSF spray system (refer Appendix B) will use a PLC control system that is able to take both analogue and digital inputs from the dust management software.

The dust management software will be set up to include performance indicators, as well as specific rules, that will under certain conditions provide an output to the PLC to engage the spray system.

Short-term average (e.g. 1-hour average) PM_{10} performance indicators will be set at a concentration that allows proactive dust management (including automatic engagement of the water spray system) to be implemented in the event that PM concentrations are increasing, and may potentially approach the 24-hour PM_{10} impact assessment criterion in the near future.

Further, the site's proposed dust management software allows for meteorological forecasting up to four days into the future. Parameters of interest, from an air quality perspective, will include predictions of future wind speeds/directions, temperature, solar radiation and precipitation.

For example, the field investigations (Appendix E) indicate that a critical wind speed of 10.9 m/s (40km/hr; measured at 10m above ground level) may be used as an initial alert value to trigger further investigation and remedial action as this is the threshold friction velocity where dust entrainment may occur.

Winds that reach 14.3 m/s (50km/hr) should be used as the critical wind speed alarm value when immediate action is required (i.e. implementation of TSF water sprays or chemical dust suppressant). A review of the onsite meteorological data indicates that winds exceeding 11m/s may occur 1.3% of the time (or 112 hours per year) and exceeding 14.3m/s 0.02% of the time (or 2 hours per year).

Integration of the dust management system's forecasting tool with the spray system's PLC will allow the automatic engagement of water sprays in advance of adverse winds being forecast.

In addition, a real-time particulate matter concentration an alarm and alert system will also be implemented. Default values adopted at other extractive industry sites for the 1 hour average concentration are 80µg/m^3 as an alert / investigation level and 100µg/m^3 as an alarm requiring immediate rectification.

It is anticipated that these values (potentially with a rule set around the delta between upwind and downwind PM) would be integrated within the site's dust management system software to again engage the spray system to the TSF automatically.

Alert/alarm values may be reviewed iteratively to ensure that they are sufficiently protective without generating excessive false alarms.

The monitoring network would be reviewed and augmented (if warranted) to provide additional data relevant to the future operation of the TSF.

It is proposed that the existing PM monitoring will be augmented using a three additional mobile PM / wind speed monitoring units that can be placed close to the TSF surface and progressively moved as the TSF is filled. One such a location is the ramp that is annotated in Figure 3 1 of the AQ Report, however it is acknowledged that this ramp will be removed during the construction of EMB3, at which point it will be relocated. The remaining two monitor locations are proposed to be located at the eastern and western boundaries of the TSF 2.

As noted above, an additional component of BHOP's dust management comprises the use of predictive / forecast meteorology and real time management using dedicated dust management software.

This system is used to predict meteorological conditions that indicate when an elevated risk of PM emissions may occur (e.g. based on wind speed, direction, rainfall and atmospheric stability).

Figure 1-8 Example screen grabs showing graphical user interface from proposed Dust Management Software

The predictive meteorological forecasting aspect of the dust management system will provide simple indicators of the following day's dust risk, based on meteorological conditions that are known to have adverse impacts, and, in addition to enabling automatic engagement of water sprays, will allow mine personnel to put measures into place in advance.

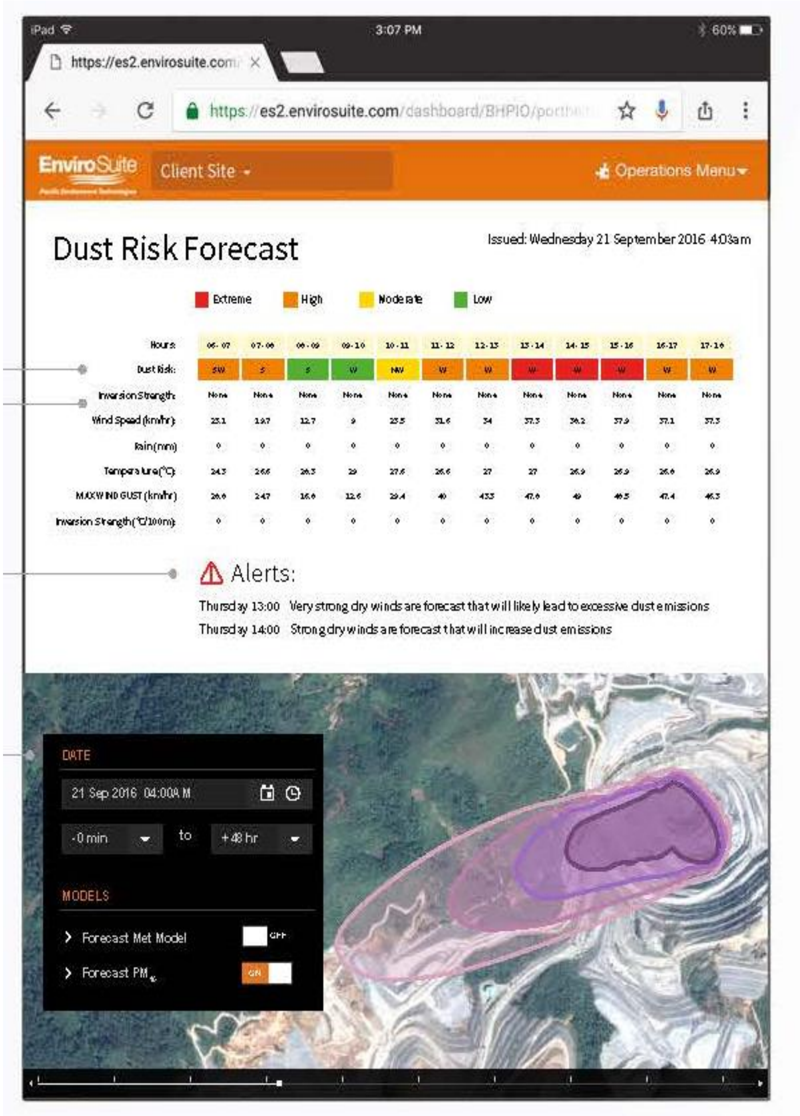


Figure 1-9 Example of site-specific risk forecasting and advisory within the Dust Management Software

Such preparatory measures will include:

- scheduling additional use of the TSF spray system / chemical dust suppressant application;
- planning for modifying or relocating certain activities; and
- scheduling maintenance on equipment.

Appendix A
Tailings Lead Concentration

Tailings Lead Concentration

Table 1-5 Monthly Lead Concentrations for Tailings

Year	Month	Tonnes	Pb (%)
2012	April/ May	10805.72	1.09832
2012	June	39998.65	0.397109
2012	July	41367.88	0.297189
2012	August	52534.61	0.303922
2012	September	42587.57	0.463332
2012	October	45973.12	0.406843
2012	November	44633.31	0.218113
2012	December	41810.25	0.209143
2013	January	52132.16	0.252097
2013	February	47149.15	0.20105
2013	March	50197.15	0.249975
2013	April	50590.61	0.267528
2013	May	46881.32	0.287752
2013	June	51155.06	0.22961
2013	July	56147.27	0.301498
2013	August	54256.12	0.278594
2013	September	39672.56	0.246322
2013	October	42548.48	0.457453
2013	November	40621.45	0.297054
2013	December	43481.85	1.118313
2014	January	42575.87	0.183357
2014	February	35692.29	0.203183
2014	March	39985.95	0.412053
2014	April	37882.64	0.318373
2014	May	40539.67	0.262145
2014	June	40278.43	0.220096
2014	July	40098.5	0.249143
2014	August	44892.48	0.201496
2014	September	44392.41	0.295853
2014	October	40778.12	0.266049
2014	November	39792.16	0.272073
2014	December	39840.04	0.333137
2015	January	38923.46	0.270905
2015	February	37932.62	0.28

2015	March	38285.93	0.243219
2015	April	37393.83	0.30494
2015	May	38677.95	0.185298
2015	June	43365.49	0.522086
2015	July	45758.71	0.345179
2015	August	44470.82	0.251845
2015	September	42089.75	0.164785
2015	October	44345.28	0.262739
2015	November	44177.36	0.240538
2015	December	44176.57	0.299408
2016	January	44157.49	0.29258
2016	February	41571.3	0.292292
2016	March	47123.59	0.366871
2016	April	45686.89	0.23
2016	May	48825.93	0.282708
2016	June	49858.57	0.401417
2016	July	48490.51	0.322385
2016	August	45744.05	0.224185
2016	September	39219.99	0.277205
2016	October	54415.33	0.296987
2016	November	45093.5	0.280761
2016	December	45649.59	0.401365

Appendix B
Waste Rock Classification Report

Rasp Mine

Waste Rock Classification

Document Control Number: WSA-QD-001-21544

Date: 20 March 2017

Pacific Environment Limited

Technologies Consulting Monitoring

www.pacific-environment.com

Project Name:	Waste Rock Classification
Document Control Number:	WSA-QD-001-21544
Prepared For:	Broken Hill Operations Pty Ltd
Approved For Release By:	Brian Fainton
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Table 1-1. *Document Control*

Version	Date	Comment	Prepared by	Reviewed by
A	13.10.2016	DRAFT	Ross Lawrence	Brian Fainton
B	14.10.2016	DRAFT	Ross Lawrence	Brian Fainton
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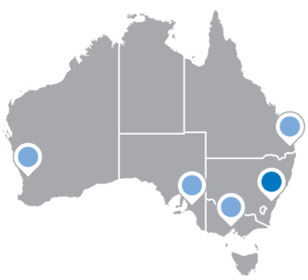

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1. Executive Summary

Pacific Environment undertook an assessment of waste rock from a stockpile present within the Kintore Pit of the Rasp Mine located at Broken Hill, NSW. The assessment was required to support an application (‘MOD 4’) to use the waste rock for the construction of embankments at the Blackwood Pit Tailings Storage Facility (‘TSF2’) and for construction of a noise abatement bund around the perimeter of the concrete batching plant to the north, east and west.

More generally, BHOP intend to use the waste rock for other dust suppression applications as part of its rehabilitation process for the mine site. This will include cover for existing areas that may otherwise have a potential to generate dust containing elevated lead concentrations. The rock is known to contain potentially elevated lead concentrations due to the ore bodies being mined.

To minimise any potential health affects for the local community the original EA for the Rasp Mine (BHOP, July 2010) stipulated that any waste rock material used for rehabilitation, or other site surface purposes, will be ‘inert’. What constitutes ‘inert’ material has not been defined in the EA. No directly applicable criteria are available for assessing the potential for hazardous dusts generated from the weathering of waste rock at the site, potentially resulting in exposure scenarios for inhalation/ingestion by residents outside the site, or for site users post-rehabilitation.

The study utilised a ‘multiple lines of evidence approach’, in accordance with guidance provided in the NEPM 2013. This is used for evaluating and integrating information from different sources of data and uses best professional judgement to assess the consistency and plausibility of the conclusions which can be drawn.

This approach studied the following parameters:

- rock type (geological description);
- moisture content;
- particle size distribution (PSD); and
- metals content.

In addition to these studies, additional consideration was given to the prior Human Health Risk Assessment work undertaken by Toxikos (2010, 2015), background soil/dust data, air quality modelling and recent Confined Air Burst Chamber (CABC) testing undertaken by Pacific Environment on-site for the purposes of quantifying dust control.

Results and Conclusions

The results of the waste rock assessment, and in consideration of associated studies, identified that;

- The rock type varies, however all rock types identified are competent and mostly hard, with good resistance to weathering;
- The rock comprises only approximately 1% fines capable of producing dust;

- This was qualified by Confined Air Burst Chamber tests, which identified a 99.7% reduction in dust generation from the waste rock, compared to disturbed dry tailings.
- Lead concentrations averaged 2,371.5 mg/kg (0.24%), and were taken from crushed samples (and therefore conservative). This is approximately 4 x the NEPM HIL-C criterion (600 mg/kg), but significantly below surface dust averages (15,640 mg/kg, or 1.56%). Whilst the NEPM criteria are not directly applicable, they do represent a level below which soils would not be considered a risk to human health.
- Bioaccessibility is very low (7.3% on average). This is much lower (6.8 x) than the 50% (bioavailability) assumed for the calculation of HIL's. This would suggest that results, if adjusted for bioaccessibility, would meet HIL-C criteria;
- Air quality modelling conducted by PE (2017), assumed a waste rock concentration of 0.5% (5,000 mg/kg). Results demonstrate compliance with all the NSW EPA impact assessment criteria for all air quality parameters assessed.

In conclusion, the results support the use of the waste rock for dust suppression for the TSF and 'free areas', and are considered unlikely to cause an unacceptable risk to human health based upon the site's final land use as a proposed tourist/recreational site.

Air quality modelling has assumed lead concentrations above those identified in the waste rock on site (0.5% compared to 0.24%), and therefore the waste rock is likely to meet NSW EPA impact assessment criteria, and is unlikely to impact further upon surface soil lead concentrations within local communities. The very low dusting potential of the rock supports this conclusion.

In consideration of all other lines of evidence, the 0.5% lead concentration adopted by the air quality model is considered to be a suitable criterion for waste rock placement on-site.

It is therefore considered that the waste rock meets the criteria of being 'inert' material, based upon the multiple lines of evidence approach.

Recommendations

The waste rock, when placed, is considered to be suitable as a means of reducing, to an acceptable level, the potential for dust generation from the TSF and 'free areas' of the site. To reduce potential risks during placement, we recommend that dust suppression spraying is carried out during capping material (waste rock) placement. A final spray is recommended to ensure that finer particles are washed between the larger rocks. This will greatly reduce the future potential for the rock to create dust.

This assessment has been partially based upon a limited number of waste rock samples, which were analysed for lead composition. For the conclusions of this assessment to maintain validity, it is recommended that field screening of the waste rock is undertaken during placement to confirm that median lead concentrations do not exceed 0.5%. PE recommends that this is undertaken by use of a calibrated x-ray fluorescence (XRF) field meter. It is noted that:

- laboratory results were considered to be conservative due to the crushing and leaching processes used as part of the analysis methodology;

- XRF results are therefore unlikely to be comparable to laboratory results (they may be lower), however they would be considered to be representative for the reasons above; and
- use of an XRF provides a practical and timely characterisation of field material. Many more samples may be screened in comparison to laboratory analysis.

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1. Introduction

The Land and Water group of Pacific Environment was commissioned by Broken Hill Operations Pty Ltd (BHOP) to carry out classification of the waste rock stockpile present within the Kintore Pit of the Rasp Mine located at Broken Hill, NSW. The site has mined for lead, zinc and silver for approximately 130 years. This study is in support of an application for the modification of the site ('MOD 4'), to include a purpose built concrete batching plant and modifications to the Blackwood Pit Tailings Storage Facility ('TSF2').

A noise abatement bund will be constructed around the perimeter of the concrete batching plant to the north, east and west, utilising the waste rock. The TSF2 modifications will include installation of embankments and a retaining wall along low points in the perimeter utilising the waste rock. More generally, BHOP intend to use the waste rock for other dust suppression applications as part of its rehabilitation process for the mine site. This will include cover for existing areas that may otherwise have a potential to generate dust containing elevated lead concentrations. Due to the historical growth of the City of Broken Hill, many residential structures are located within close proximity to the mine workings. The protection of human health is of the greatest importance.

1.1 Project Description

The project involves the classification of the waste rock, which is intended to be utilised for placement within the site. Currently a large waste rock stockpile, believed to exceed 700,000 tonnes, is contained within Kintore Pit. If suitable, the waste rock will be used for general rehabilitation within the site. Proposed uses include:

- Supporting the batter sides of the Tailings Storage Facility (TSF) to allow a vertical extension of the TSF, and;
- Noise abatement bunding.
- Placement on the 'free areas' (non-active areas of the mine site) of the site to mitigate against wind erosion of any loose material.

Although there are many more years of extractive operation remaining under the current Project Approval (PA07_0018), the final use of the site, as outlined in the original Environment Assessment Report (EA), is to return the facility to a condition suitable for continuing tourist operations, with some historical buildings and mine workings preserved for tourism activities post closure of the mine. Tourist operations were conducted on-site prior to BHOP's acquisition of the lease in 2001, including a walking tour and underground tour. Current tourism activities on site include interpretive signage and a miner's memorial and café.

With the final use in mind and the proximity of the residential population to the mine site, the assessment of the waste rock material must consider potential human health effects.

To minimise any potential health affects for the local community the original EA for the Rasp Mine (BHOP, July 2010) stipulated that any waste rock material used for rehabilitation, or other site surface purposes, must be 'inert'. What constitutes 'inert' material has not been defined in the EA. This study will recommend criteria for this term as part of this assessment considering that the material should not cause, or have the potential to cause air pollutant concentrations (metals in dust) that would exceed relevant ambient air quality limits.

A definition of 'solid inert waste' found in the Victorian EPA Publication 448, Classification of Wastes, states: "hard waste which has negligible activity or effect on the environment". No specific directly applicable criteria are available for dust generation from waste rock. Other available criteria are discussed in Sections 3.2.3, 3.2.4 and 3.2.5 .

1.2 Objectives

The objectives of this study are:

1. To characterise the physical and chemical attributes of the waste rock, with respect to its potential to generate lead bearing dusts post-placement;
2. To determine a suitable criteria for the use of the waste rock so as to minimise any health effects on the local community, in particular the potential impact of lead exposure to children, and;
3. To assess if the waste rock meets the identified suitability criteria for use as rehabilitation material in open areas of the Rasp Mine site. This will include;
    a. Comparison against applicable criteria (if any), and
    b. Defining the term 'inert' and evaluation of the waste rock against these definitions

1.3 Reference documents

In order to complete a desktop assessment of the waste rock material, information from the following documents has been incorporated into this report:

- Rasp Mine Environmental Assessment Report (EAR), Chapter 5 – Existing Environment;
- Rasp Mine EAR, Chapter 8 – Air Quality and Greenhouse Gases;
- Rasp Mine EAR, Chapter 17 – Rehabilitation and Final Landform;
- Rasp Mine EAR – Annexure F – Tailings Scoping Study and Preliminary Design;
- Rasp Mine EAR – Annexure I (Part B) – Chemical Dust Suppression Agent HRA;
- NSW Government, Department of Planning, Rasp Mine Project (07_0018) Director Generals Requirements (dated 29 March 2009);
- CBH Resources Limited, Broken Hill Operations Pty Ltd, Rasp Mining Project: *Project Application* (dated February 2007);
- Vic EPA 448.3 Waste Classification, Publication 448.3* May 2007 available from http://www.esdat.com.au/Environmental%20Standards/Australia/448.3%20Waste%20Classification.pdf;
- Lyle DM, Phillips AR, Balding WA, Burke H, Stokes D, Corbett S, Hall J. (2006) Dealing with lead in Broken Hill – trends in blood lead levels in young children 1991 – 2003. Science of the Total Environment 2006, 359:111-119.
- National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No.1) – Volume 2: Schedule B1. National Environment Protection Council (NEPC) (1999).
- National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No.1) – Volume 10: Schedule B7 – Appendix A1, The Derivation of HILs for Metals and Inorganics. National Environment Protection Council (NEPC) (1999).

- Toxikos Pty Ltd (2010), *Health Risk Assessment for Rasp Mine Proposal, Broken Hill*, Toxikos document TR200510-RF (Volume 1, V2), June 2010.
- Pacific Environment Ltd, *Re: Air Quality Assessment for the Rasp Mine Modification 4*, March 2017
- Pacific Environment Ltd, '*Re: Rasp Mine Wind Erosion Field Testing*', March 2017
- AP 42, Fifth Edition, Volume I Chapter 13: Miscellaneous Sources, Prepared for U. S. Environmental Protection Agency Office of Air Quality Planning and Standards Emission Measurement Center Research Triangle Park, NC 27711, published January 1995, last updated November 2006.
- Boreland, F. and Lyle, D. (2009a) Using performance indicators to monitor attendance at the Broken Hill blood screening clinic. Environmental Research. 109 (3): 267-272.

2. Site Description

Mining operations commenced on the site in 1885. Historically both open pit and underground mining methods have been used at the site. Today mining is conducted underground to extract zinc, lead and silver ore. The site consists of a series of open cut pits along the Line of Lode, which is in an approximate north-east to south-west alignment. The remaining hill is made up of tailings storage and ore waste rock emplacement, and there is little evidence of the original ore outcropping. There is little buffer distance between the site and the town, with residential encroachment to the north-west and south-east of the mine.

Underground mining access is via a portal 70m from surface located in Kintore Pit. A processing plant takes the ore and through a flotation and filtering process produces two separate concentrates zinc and lead with silver reporting to the lead concentrate. A rail load out area is located to the north east of the site for rail dispatch of concentrates. Tailings are currently stored in an historic open pit, Blackwood Pit ('TSF2') and stormwater retention and evaporation basins are located across the site. Internal roads (sealed or compacted surfaces) are present between the various buildings and facilities within the site. Historic buildings and structures are located across the site together with old stockpiles of mine overburden, waste rock from both open pit and underground mining operations and old tailings. BHOP purchased the site from Normandy Mining Investments in 2001, and has therefore inherited the condition of the site from the previous operators of the site.

2.1 Site Location/Setting

Broken Hill is located in far west New South Wales; the local environment is classed as semi-arid with a low annual rainfall in the range of 200 – 300mm and high evaporation rates (2,614mm/yr). The Rasp Mine was founded after the discovery of lead bearing galena on the surface, which had been exposed by weathering of a ridge of the main ore body. Although exposed at the point of discovery, the ore body then dips to the north and south.

With the development of the mine, the area went from rural grazing land with few permanent occupants to mining and residential, with workers' accommodation established in close proximity to the mine. As was common in the late 1800's, private transport was limited and people lived close to their places of work. The mine has operated over an unusually extended time due to the quantity and quality of the ore, with the town gradually developing around the mine.

2.2 Site Layout

The site is approximately rectangular and lies in a north-east to south-west orientation as can be seen in Figure 2-1 below. The ore body was discovered in an outcrop in the approximate centre of the site, but dips both to the north-east and south-west. Open cut pits were originally established for extraction of the ore, followed by both the continuation of open cut operations and underground operations occurring concurrently by various mining companies. The Kintore Pit was a former open-cut pit located in the south-western end of the site (Figure 2-1), and now provides access to the underground operations.

Historical buildings and structures, some of which date from the 1890s, have been retained at various locations across the site. A large number of these are listed as heritage items on the BHCC Local Environment Plan 2013 (LEP). In 2015 the City of Broken Hill was included on the National Heritage List primarily for its contributions to mining and ore processing developments.

During current underground mine operations, waste rock material has been stockpiled in the Kintore Pit at the southern end; the waste rock stockpile is estimated to comprise more than 700,000 tonnes of material.

Tailings are stored in an historic open-cut pit (Blackwood Pit) (TSF2), which is located towards the north-east end of the site as shown in Figure 1 below.

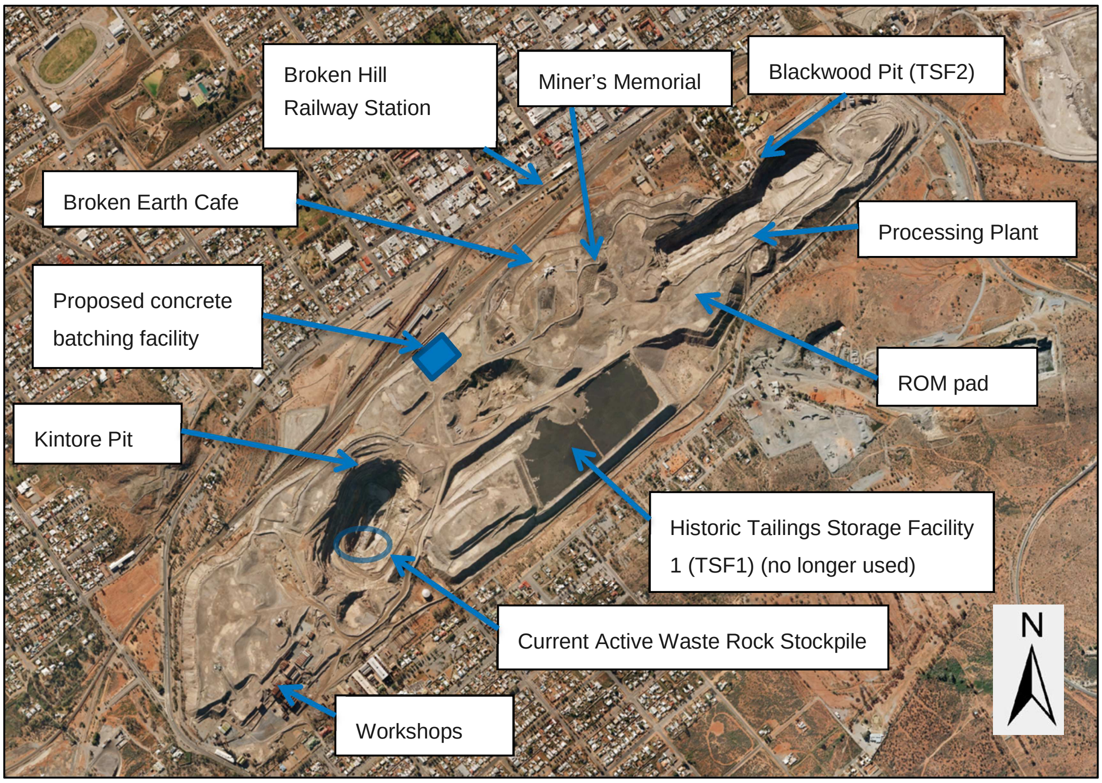


Figure 2-1: Aerial view of the Rasp Mine site – Mine Features

2.3 Current and Proposed Land Use

The current use of the site is for mining activities, the current development consent (PA07_0018) allows for the mining to continue until 2026. Further extensions may be sought after that date providing it is economic to continue production.

The end use of the site, as presented in the site's EA, is for tourism. Guided tours of the old processing plant and heritage buildings were conducted by the then Line of Lode Association and another tourism operator conducted underground tours via the Delprat Shaft, prior to the current mining operation. Several historical buildings and mining related structures have been preserved within the site and the potential for tourism has been noted as a potential post closure use option.

2.4 Stockpile Material Origin

The current active waste rock stockpile in the Kintore Pit is composed of material obtained from the creation of the Rasp Decline with portal access at the base of the Pit, which commenced development in 2007. It includes some fines, and may contain limited volumes of low grade ore from areas adjacent to the ore body   The vast majority of the stockpile is either very low grade ore, or material deficient in the minerals extracted at the Rasp Mine. All of the waste rock was derived from within the site and is therefore comprised of material natural to this region.

The waste rock stockpile is placed on the southern end of the Kintore Pit and has a depth of approximately forty metres. The most recent waste rock material has originated from the development of the zinc lode decline, as well as material from stope development adjacent to the ore body. Due to the nature of the construction of the stockpile, some recent material will have flowed down the outside face of the stockpile, although the majority of the recently extracted waste rock material will have remained at the top of the stockpile, where a flat area is maintained.

3. Methodology

To use the waste rock material for rehabilitation and other surface activities the waste rock is required to meet the following requirements:

1. Be ‘inert’ as stipulated in the original EAR. What constitutes ‘inert’ material has not been defined in the EAR.
2. The material should not cause, or have the potential to cause air pollutant concentrations (metals in dust) that would exceed relevant ambient air quality limits; and
3. Any dusts created by the waste rock material should not result in metals in soils concentrations off-site that exceed relevant criteria, or present unacceptable risks to human health based upon the final land use.

This report will provide a characterisation of the physical and chemical attributes of the waste rock in comparison with the above requirements and provide a recommendation on the suitability for use of this material.

Our evaluation of this issue utilises a multiple lines of evidence approach. The multiple-lines-of-evidence approach is the process for evaluating and integrating information from different sources of data and uses best professional judgement to assess the consistency and plausibility of the conclusions which can be drawn (NEPM 2013 definition).

The following parameters were deemed critical parameters for use in assessing the waste rock material:

- rock type (geological description);
- moisture content;
- particle size distribution (PSD); and
- metals content.

In order to obtain data on the waste rock material, several representative samples were collected from the upper levels of the Kintore Pit stockpile by Rasp Mine staff and forwarded to testing facilities NATA accredited for the appropriate range of analysis. These were ALS (moisture content and metals content) and GHD (PSD).

An initial sample was taken by BHOP staff and submitted for analysis. Based upon the treatment and analysis of this sample, a revised methodology was as developed to obtain more relevant characterisation data for the upper strata of the waste rock stockpile. Specifically, this included moisture content analysis prior to PSD analysis (which requires a drying stage), and PSD prior to crushing to identify the relevant proportions of fine material. Further discussion of these methods is provided in sections 3.2.1 and 3.2.2.

3.1 Identification of potential exposure pathways

The NEPM determines risk to human health via a 'source-pathway-receptor' concept, and that a complete linkage must be present for risks to be realised. For the Rasp Mine the current source is the open areas of the site containing fine, loose material, which is naturally impacted by heavy metals. Of these metals, lead is the primary concern. Studies have proven that there is a positive link between the lead levels in the environment and those in the blood of children living in areas with high environmental concentrations of lead present.

The potential pathway for exposure is wind driven dust generated from these open areas of the site and deposited among the residential and recreational spaces of the town and mine site. The potential human health receptors are the Broken Hill residents, and in the case of the final land use, tourists and site users.

The pathways are therefore, potentially, dust (inhalation and ingestion) and direct contact/ingestion on site at final land use. A Human Health Risk Assessment (HHRA) has already been carried out for the site (Toxikos, 2010, and 2015) where the dust pathway was assessed under several scenarios, including mitigation by 80% using chemical dust suppressant. The capping of exposed areas of the site by coarse waste rock with extremely low fines content is also expected to mitigate against the generation of wind driven dust.

Where a pathway can be blocked or restricted, the risk to the receptors is therefore removed or reduced. Providing that the waste rock is deemed suitable for use in mitigating wind driven dust at the mine site, then the risk from this pathway may be reduced to an acceptable level. The potential for dust generation from the waste rock after placement is therefore the primary concern regarding the use of this material.

3.2 Characterisation of Waste Rock

A total of six waste rock samples were submitted for laboratory analysis;

- one initial sample for characterisation; and
- a further five subsequent samples based upon a revised analysis suite

Samples were submitted for moisture content, particle size distribution (PSD) and metals content. Samples were analysed by ALS and GHD, who are NATA accredited for the analyses specified.

The transect along which samples were taken is shown in **Figure 1, Appendix A**. Laboratory results are provided in **Appendix B**, and a photographic log is presented as **Appendix C**.

locations are

3.2.1 Initial sample

The results of a single waste rock sample ('Waste Rock Tipple') obtained by BHOP site staff were initially provided for review. The sample was composited from material collected from the surface layer of the waste rock stockpile and analysed by ALS in Sydney. The weight of the sample was almost 10kg and it was crushed by the laboratory prior to analysis. The analytical suite included total metals and water leaching tests to replicate conditions when exposed to weather on the site. The full laboratory report may be viewed in **Appendix B**. A summary table is provided below.

The sample results were reviewed by Pacific Environment and the following information/limitations were noted:

- The exact weight of material from each individual collection point that comprised the composite sample was not noted;

- The sample was crushed prior to leaching, which exposes a far greater surface area to leaching than would otherwise be available when the rock is placed at the mine site; and
- Photographs of the upper surface of the waste rock stockpile indicated that some fines are present. It was not noted if fines were included in the sample material.

Figure 3-1: Material form the Waste Rock Stockpile

In order to obtain more representative data, a process was devised to obtain more relevant characterisation data for the upper strata of the waste rock stockpile. Specifically, this included PSD analysis prior to crushing to identify the relevant proportions of fine material.

3.2.2 Additional samples

Another five (5) discrete samples were collected by BHOP site staff and forwarded to NATA accredited laboratories (ALS and GHD) for analysis for a revised suite of analytical parameters (moisture content and PSD (prior to crushing) and metals content (post-crushing). The transect of these samples is shown in **Figure 1** in **Appendix A**.

Moisture content was determined by ALS prior to the waste rock being forwarded to a geological testing facility (GHD) for particle size distribution (PSD) in its natural state. Following the sizing process, the waste rock material was returned to the chemical analytical facility for the determination of concentrations of potential contaminants of concern (heavy metals).

The following information is relevant to the sampling and analysis process:

- The waste rock samples were washed (as standard) as part of the PSD analysis,
- The waste rock samples were crushed by the laboratory for the extraction of the metals and,

- The waste rock samples were obtained from the near surface of the Kintore Pit stockpile.

The types of rock present in the Kintore Pit waste rock stockpile are described and illustrated in Section 4.1**Error! Reference source not found.**. There is significant variation between these rock types and some ore grade material may be present where it was uneconomic to separate this ore for processing. The results of the laboratory analysis are therefore expected to vary

3.2.3 Applicable Criteria

No directly applicable criteria are available to assess the potential for hazardous dusts generated from the weathering of waste rock at the site, potentially resulting in exposure scenarios for inhalation/ingestion by residents outside the site, or for site users post-rehabilitation. An assessment of the 'dusting potential' of the rock, and therefore potential risks posed via this pathway can only be quantified by site testing that is beyond the scope of this assessment.

3.2.4 Other criteria and guidance

The primary national guidance for criteria relating to human health risks from metals is from the National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) Health Based Investigation Levels (HILS). These include criteria for total concentrations of heavy metals in soil media based upon exposure estimates and toxicity reference values.

These HIL's are to be used in the first stage ('Tier 1' or 'screening') of an assessment of potential risks to human health and are intentionally conservative. They are levels at which more investigation is required to assess human health risks, and have been derived from the NHRMC Blood Lead Goal for Australia[1].

The NEPM guideline criteria are not directly applicable to the use of waste rock for rehabilitation works. This is primarily because soils are more readily available (for ingestion) than rock (generally having a smaller particle size), and are more accessible to children (the most sensitive receptors) as a part of gardens, playgrounds or other urban spaces. However, the NEPM criteria do provide a basic level below which no adverse human health risks are expected. For this reason, they have been adopted as a basic trigger level for further investigation.

The NEPM criteria listed in Table 2 below are for the following land use categories;

- Residential (HIL A) **-** for low density residential use with access to the soil, assumes that less than 10% of food intake will be grown in the soil;
- Recreational (HIL C) - open public space (parks, playgrounds, playing fields, secondary schools and footpaths); and
- Commercial/Industrial (HIL D) – includes premises such as shops, offices, factories and industrial sites.

The most relevant criteria for the site's intended post mining use are **HIL C** (Recreational).

It must be noted that Broken Hill has a naturally occurring exposed ore body with a high lead content which has been exposed to weathering for centuries, if not longer. This natural process could be expected to have elevated the background concentrations of lead in the residential areas of the city without the advent of the mining operations.

[1] National Health and Medical Research Council, *Evidence on the Effects of Lead on Human Health* (2015)

Table 3-1 - *NEPM Guideline Criteria*

Analyte	NEPM HIL A Guidelines (Residential) (mg/kg)	NEPM HIL C Guidelines (Recreational) (mg/kg)	NEPM HIL D Guidelines (Commercial/industrial) (mg/kg)
Arsenic	100	300	3,0000
Barium	ND	ND	ND
Beryllium	60	90	500
Boron	4,500	20,000	300,000
Cadmium	20	90	900
Chromium (VI)	100	300	3,600
Cobalt	100	300	4,000
Copper	6,000	17,000	240,000
Lead	**300**	**600**	**1,500**
Manganese	3,800	19,000	60,000
Nickel	400	1,200	6,000
Selenium	200	700	10,000
Vanadium	ND	ND	ND
Zinc	7,400	30,000	400,000
Mercury (methyl)	10	13	180

ND: Not Defined ** Total Mercury* *^ Arsenic (V) – lowest criterion*

The NEPM also contains criteria for metals in surface waters, however; these levels relate to drinking water and fresh (recreational) waters. These water criteria do not directly apply to rainwater detained within the mine site via storm water retention basins and therefore the rainwater/runoff retained within the site has not been included in these discussions. The retained mine site water is understood not to be in continuity with surface water or groundwater resources.

3.2.5 Background data

3.2.5.1 Broken Hill – Town Soils

While ‘baseline’ or background lead levels in the town’s soil have not been assessed as part of this report, it should be noted that several reports into the natural and anthropogenic deposition of dust within Broken Hill have been carried out for health assessment purposes. Soil lead and indoor dust levels measured in 1992 were reported by Lyle et al. (2006), for five zones covering the residential area of Broken Hill. The reported concentrations of lead in soil ranged from 262mg/kg (less than the NEPM HIL A residential criteria of 300mg/kg) to 1,967mg/kg (greater than the NEPM HIL D commercial /industrial criteria of 1,500mg/kg).

Since the soil lead analysis was undertaken more than a century after the commencement of mining operations at Broken Hill, it is most likely a product of a combination of both anthropogenic and natural processes relating to the ore body. It should also be noted that some soil remediation of highly impacted areas was carried out in Broken Hill in the late 1990’s.

A Human Health Risk Assessment carried out by Toxikos (2010) used later soil concentrations and the Lyle et al. data and found that the five previous zones had most likely merged into three zones with the following assumed soil lead concentrations:

- Zone 1 – 2,000mg/kg
- Zones 2 & 3 – 1,000mg/kg
- Zones 4 & 5 – 500mg/kg

The zones are depicted in Figure 2 below.

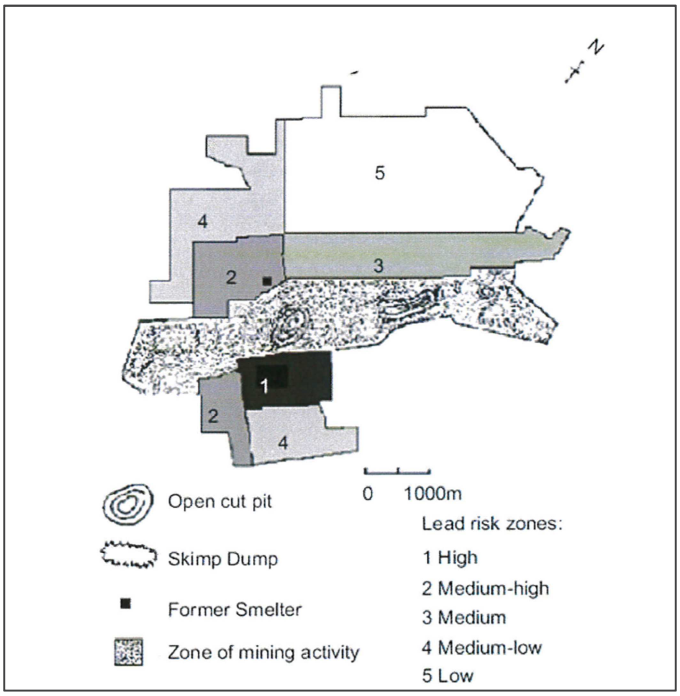


Figure 3-2: Lead Risk Zones (Figure from Boreland et al. (2009a))

3.2.5.2 Rasp Mine Soils

Further to the Broken Hill town soil lead concentrations adopted as part of the Human Health Risk Assessment (HHRA) (Toxikos, 2010), this assessment also considered lead concentrations in surface dust (composite) samples taken from five site locations representing operational and non-operational ('free') areas. The results are provided in Table 3-2, below

Table 3-2 - *Lead concentrations in surface dusts – Rasp Mine*

Sampling Point	Lead Concentration (mg/g)	Lead Concentration (mg/kg)	Lead Concentration (%)
1	31	31,000	3.1
2	8.8	8,800	0.88
3	7.1	7,100	0.71
4	11.8	11,800	1.18
5	18.7	18,700	1.87

ND: Not Defined ** Total Mercury* *^ Arsenic (V) – lowest criterion*

3.2.5.3 Bioavailability and Bioaccessibility

In addition to lead concentrations in dust, the HHRA also considered bioavailability. Bioavailability is a function of;

- bioaccessibility – the amount of contaminant released from the media (e.g. soil/dust) during digestion within the body that is available to be absorbed; and
- absorption – the part of the bioaccessible fraction that is actually absorbed into systemic circulation within the body

The HHRA used the physiologically based extraction test (PBET) for determining the bioaccessibility of metals from surface dusts at the mine site. This involved simulating the leaching of a solid matrix in the human stomach and small intestine under feed and fasting conditions. This test was conducted by enTox at Queensland University (2009) on the same samples as those submitted for lead concentration (refer Table 3-2)

Results were as follows:

Table 3-3 – *Bioaccessibility of lead in surface dusts – Rasp Mine*

Sampling Point	Lead Concentration (mg/g)	Lead Concentration (mg/kg)	Lead Concentration (%)	Bioaccessibility (Bac) (%)
1	31	31,000	3.1	**14.6**
2	8.8	8,800	0.88	**3.6**
3	7.1	7,100	0.71	**8.5**
4	11.8	11,800	1.18	**6.1**
5	18.7	18,700	1.87	**3.7**
			Average bioaccessibility	**7.3**

For comparison, NEPM HILs have been derived based upon assumed bioavailability for lead (from soil/dust, food and water) of **50%**[2]. This was considered to be 'sufficiently conservative', based upon the wide range of values and factors that have the potential to affect absorption.

[2] NEPM Schedule B7 – Appendix A1, The Derivation of HILs for Metals and Organics

4. Results

4.1 Physical and geotechnical characteristics

BHOP provided PE with geological descriptions of the potential waste rock types, based upon geological studies of the ore body and surrounds, and overburden material. These are as follows:

The bulk of the waste rock is composed of **Garnet Pelite (GPE)** and **Psammopelite (PM)** then Garnet Spotted Psammopelite (SPM). Only very minor quantities of DOL and GQ will be present. All of these rock types are described as hard and competent units with the exception of GPE1 and GPE2, which is noted as a softer rock type that has been more susceptible to accommodating shearing. Conversely, DOL1 and DOL2 is rated as extremely hard rock with very high UCS.

An explanation of these geological rock description terms is contained below.

GPE1 and GPE2: Garnet pelite. Strongly foliated to slightly sheared granulite facies metamorphic pelite. Composition dominated by large garnet porphyroblasts within a strongly foliated biotite and sillimanite matrix with regular quartz and feldspar leucocratic melt veins. Softer rock type that has been more susceptible to accommodating shearing with the lithological sequence and as a result may have more chloritic retrograde alteration associated within.

Figure 4-1: Image of Garnet Pelite (GPE) Sample

PM1 and PM2: Psammopelite. Rock type characterised by a moderately banded, interbedded sequence of pelite and psammite layers on an approximate 10cm scale. Quartz garnet biotite sillimanite pelite interbedded with Quartz garnet psammite. Some psammite layers have been subjected to minor hydrothermal garnet dominant alteration. Generally a strong and competent rock unit.

Figure 4-2: Image of Psammopelite Sample

SPM1 and SPM2: Garnet spotted psammopelite. Moderately foliated siliceous rock characterised by 0.5-1cm garnet porphyroblast aggregations. Quartz garnet gneiss. Gneissic banding dominated by quartz melt veins with lesser feldspar leucocratic melt veins. This rock type is strong and competent and has been observed to produce extremely good ground conditions in the underground mine with few defects in the rock mass.

Figure 4-3: Image of Garnet Spotted Psammopelite Sample

DOL1 and DOL2: Massive I type igneous intrusion with minor assimilation of S type country rock. Dolerites form minor cross cutting dyke structures occasionally encountered in mine development. Extremely hard rock with very high Uniaxial Compressive Strength (UCS).

Figure 4-4: Image of Dolerite Sample

GQ1 and GQ2: Garnet quartzite. Hard quartzite rock with massive texture subjected to granulite facies pressure temperature conditions with hydrothermal garnet dominated alteration. Composition dominated by quartz with minor garnet, lesser biotite and irregular minor chlorite alteration. This rock type is rated as a strong competent rock unit.

Figure 4-5: Image of Garnet Quartzite Sample

4.2 PSD and Moisture Content

The waste rock composition was analysed for moisture content and PSD by ALS and GHD laboratories respectively. Results are presented in Table 4.1 below.

Table 4-1: Size and Moisture Characterisation

Sample ID	Moisture Content	Sieve sizes - Percentage Passing				
		75mm	53mm	19mm	2.36mm	75µm (silt and clay)
1	3.1%	100%	52%	23%	8%	**2%**
2	1.6%	68%	49%	14%	3%	**1%**
3	3.1%	85%	47%	15%	5%	**1%**
4	3.4%	70%	47%	16%	5%	**1%**
5	3.4%	71%	49%	11%	3%	**1%**

Results in **bold** represent particle sizes that are potentially 'dust producing'

The moisture content of all samples is very low. Moisture content has a significant effect on rock strength, lower moisture contents are typically linked to increased rock strength.

The waste rock samples (1-5) that were sent for PSD analysis at the GHD laboratory showed a consistent trend with a low proportion of small particle sizes. Laboratory reports showed that 4 of the 5 samples had 1% of the sample passing a 75µm sieve; while the last sample had 2% passing the 75µm sieve. Significant volumes of dust are unlikely to be generated from particle sizes greater than 75µm.

Furthermore, the greatest percentage of any sample passing a 2.36mm sieve was only 8%. 2.36mm is considered to be the geotechnical cut-off point for fine grained soils, i.e. particles with a diameter less than 2.36mm are classed as fine grained. Silt is classed as particles of less than 75µm, but greater than 2µm; particles of less than 2µm are classed as clay.

Therefore, the average silt content of the five samples is 1.2%, which may include some proportion of clay particles.

Importantly, it is also noted that the proportion of small or fine grained material in the waste rock pile is likely strongly influenced by the method of mining (blasting) rather than being reflective of the rock's natural degradation and erosion (which will be slow).

4.3 Metals Content

It is known that the waste rock comprises a number of different rock types, in varying quantities (refer section 4.1. Crushing of the samples prior to metals analysis was undertaken in order to homogenise the sample and eliminate or reduce the possibility that sampling of the finer material, that may constitute a particular rock type, may bias analytical results.

The analytical results have been summarised in Table 4-2 below. The full laboratory reports may be viewed in **Appendix B**.

Table 4-2: *Summary of Laboratory Analysis Results, Moisture and Heavy Metals*

Analyte	Units	Sample ID					
		Waste Rock Tipple	1	2	3	4	5
Sample Date	--	25.08.16	15.09.16	15.09.16	15.09.16	15.09.16	15.09.16
Moisture Content	%	1.3	3.1	1.6	3.1	3.4	3.4
Arsenic	mg/kg	13	9	241	34	26	75
Barium	mg/kg	40	30	30	30	30	20
Beryllium	mg/kg	<1	<1	<1	<1	<1	<1
Boron	mg/kg	<50	<50	<50	<50	<50	<50
Cadmium	mg/kg	6	<1	5	57	4	17
Chromium	mg/kg	17	22	13	10	20	17
Cobalt	mg/kg	8	9	16	14	10	11
Copper	mg/kg	93	15	55	240	45	141
Lead	mg/kg	543	57	**905**	**9010**	**684**	**3030**
Manganese	mg/kg	78	91	258	405	174	188
Nickel	mg/kg	12	18	18	12	19	18
Selenium	mg/kg	<5	<5	<5	<5	<5	<5
Vanadium	mg/kg	15	22	18	14	28	22
Zinc	mg/kg	1780	222	1420	21500	973	4060
Mercury	mg/kg	<0.1	<0.1	<0.1	0.1	<0.1	<0.1

The concentrations of all metals analysed other than lead are within the NEPM HIL-C (recreational) and HIL-D (industrial/commercial) guideline criteria. Exceedances of the HIL-C criterion are highlighted in bold in Table 4-2.

Four of the six samples exceed the NEPM HIL-C (recreational) criteria for lead in soil, and two of the samples (samples 3 and 5) exceed HIL-D (industrial/commercial) criteria. The mean lead concentration of all six samples in Table 4-2 was calculated as being 2,371.5 mg/kg. This mean also exceeds the NEPM HIL-C guideline value of 600 mg/kg and the HIL-D guideline value of 1,500 mg/kg.

4.4 Dust generation potential

Typically, we would use the US emission factor documentation (AP-42) to derive site-specific emissions from wind erosion, specifically chapter 13.2.5 – Industrial Wind Erosion. The General statement from this document is copied below -

"*Dust emissions may be generated by wind erosion of open aggregate storage piles and exposed areas within an industrial facility. These sources typically are characterized by nonhomogeneous surfaces impregnated with non-erodible elements (particles larger than approximately 1 centimetre [cm] in diameter). Field testing of coal piles and other exposed materials using a portable wind tunnel has shown that (a) threshold wind speeds exceed 5 meters per second (m/s) (11 miles per hour [mph]) at 15 cm above the surface or 10 m/s (22 mph) at 7 m above the surface, and (b) particulate* *emission rates tend to decay rapidly (half-life of a few minutes) during an erosion event. In other words, these aggregate material surfaces are characterized by finite availability of erodible material (mass/area) referred to as the erosion potential. Any natural crusting of the surface binds the erodible material, thereby reducing the erosion potential*"

From the review of the geological test data (PSD) of the waste rock stockpile material discussed in Section 4.2 above, it is likely that this material will have a very low potential for dust generation. This is partially due to the low percentage of particles sized below 0.75µm as well as the rock type.

The hardness of the rock types and low rainfall conditions at the site indicate that weathering of the rock types present will be particularly slow, requiring geological time frames to decompose significantly.

4.4.1 Confined air burst chamber (CABC) testing

Additional field testing was undertaken by Pacific Environment staff in December 2016 to determine the wind erosion/dust generating potential of the waste rock (as well as other areas of the site). The field tests undertaken were 'Confined Air Burst Chamber (CABC)' tests. This is a semi-quantitative method developed in the US to measure relative wind erosion potential, comprising:

- Pressurised air jet released onto the test surface within the chamber
- Peak particulate matter (PM) concentrations within the chamber recorded as a measure of surface erodibility
- Test conducted on uncontrolled surface and repeated on other (controlled) surfaces allowing estimation of relative control efficiency (% control)

A total of 52 CABC tests were conducted on:

- Dry tailings (Crusted and Disturbed).
- Wet tailings
- **Waste rock trial areas**
- Uncontrolled free areas (Crusted and Disturbed)
- Dust suppressant application area (applied June 2016)
- Fresh dust suppressant application

Table 4-3 – *CABC Results*

Material Type	% control
Base Case – Dry Tailings - Disturbed	**0.0%**
Dry Tailings – Crusted	**99.7%**
Wet Tailings	**100%**
Waste Rock Trial	**99.7%**
Base Case – Dry Tailings - Disturbed	**0.0%**
Uncontrolled Free Areas – Crusted	**96.6%**
Uncontrolled Free Areas – 5 mo old RST Total Ground Control	**98.9%**
Base Case – Dry Tailings - Disturbed	**0.0%**
Unsealed Areas - Crusted	**90%**
Unsealed Areas – Fresh RST Total Ground Control	**99.2%**

The results of the CABC tests on the waste rock showed a 99.7% level of control, when compared to the control site (disturbed, dry tailings).

The full report on this work is presented as a letter report to BHOP, *Air Quality Assessment for the Rasp Mine Modification 4***,** Pacific Environment Limited, March 2017 and can be viewed at Appendix I of the *Rasp Mine Environment Assessment Modification 4 Concrete Batching Plant Blackwood Pit TSF2 Extension*, BHOP, March 2017.

5. Discussion

The multiple lines of evidence used to assess the “inert’ properties of the Kintore Pit waste rock stockpile were:

- rock type
- moisture content;
- particle size distribution (PSD), and
- metals concentration.

In addition to these studies, additional consideration was given to the prior Human Health Risk Assessment work undertaken by Toxikos (2010, 2015), background soil/dust data and recent Confined Air Burst Chamber (CABC) testing undertaken on site for the purposes of quantifying dust control.

Rock type – Studies and observations undertaken by BHOP have identified that the bulk of the waste rock is composed of Garnet Pelite and Psammopelite then Garnet Spotted Psammopelite. Only very minor quantities of Dolerite and Garnet Quartzile will be present. Psammopelite is generally a strong and competent rock unit. Garnet pelite is less strong, but is nonetheless a competent, metamorphic rock type.

Moisture content - The moisture content of the samples is quite low, with the upper level being 3.4% and the lower level being 1.3%. These figures fit with the known rainfall and evaporation conditions at the site, even in the wettest months; evaporation exceeds rainfall by greater than a factor of ten. Low moisture content is typical of harder rock types.

Particle Size Distribution - The silt content of the waste rock make-up in its unprocessed state is considered low, being an average of 1.2% of material <0.75µm in the samples subjected to PSD. The potential for dust generation is therefore ranked as low. If the waste rock is subjected to rainfall, this will wash the fines deep into the lower strata, where it will not be subject to wind scour, therefore reducing the potential for dust generation even further.

Metals concentration - No directly applicable criteria are available for are available for dust generation from waste rock. The metals concentrations in the waste rock were found to be below NEPM HIL-C (recreational) soil trigger values for the protection of human health for all metals with the exception of lead. Lead concentrations in the samples ranged from 57 mg/kg to 9,010 mg/kg. Four of the six samples exceed the NEPM HIL-C criteria for lead in soil (600 mg/kg), and two of the samples (samples 3 and 5) exceed HIL-D (industrial/commercial) criteria for lead in soil (1,500 mg/kg)

The mean lead concentration of all six (waste rock) samples was **2,371.5 mg/kg (0.23 %)**.

It should be noted that:

- The waste rock, as physically characterised, presents a reduced risk to potential sensitive receptors on-site when compared to soils with similar concentrations of metals. This is based upon its strength/competency and particle size;

- The analysis process involves crushing the samples prior to extracting the metals. The crushing process exposes a greater surface area to the laboratory’s extraction fluid, releasing metals that may otherwise have remained within the rock over geological time periods. It is therefore considered to be a highly conservative analysis.

Comparison of waste rock lead content to other available criteria/data

The mean lead concentration of the waste rock samples (2,371.5 mg/kg or 0.23 %) can be compared to surface dust concentrations

Table 5-1 – *Comparison of lead concentration and bioaccessibility data*

Sample ID	Median Lead Concentration (mg/kg)	Median Lead Concentration (%)	Median Bioaccessibility (Bac) (%)
Surface dust samples (Toxikos, 2010)	15,640	1.56	**7.3**
Waste Rock (PE, 2017)	2,371.5	0.24	**7.3^**
Broken Hill Town soils (Lyle, et al, 2006)	500 – 2,000	0.05 – 0.2	UK*
HIL-C Criteria (recreational)	600	0.06	**50**
HIL-D Criteria (industrial/commercial)	1,500	0.15	**50**

**unknown*

^assumed, based upon Toxikos prior studies on-site

The comparison identifies that:

- Waste rock has a significantly lower median concentration of lead compared to existing site surfaces (both processing and 'free areas');
- Waste rock has a marginally higher concentration of lead than soils in the Broken Hill Town;
- Waste rock exceeds HIL-C criteria and HIL-D criteria for soils, however;
    a. These criteria are based upon soils concentrations and are not directly applicable. This is because soils are more readily available (for ingestion) than rock (generally having a smaller particle size), and are more accessible to children (the most sensitive receptors) as a part of gardens, playgrounds or other urban spaces.
    b. HILs assume a bioaccessibility of 50%. Site dusts have been shown to have a median bioaccesibility of 7.3%.

Confined Air Burst Chamber (CABC) Tests

CABC tests identified that waste rock provided a 99.7% level of control (reduction, compared to the base case) when compared to dust emissions from existing dry tailings.

Comparison to modelling data

Pacific Environment has assessed particulate matter and lead impacts associated with MOD 4 activities as part of an air quality modelling exercise. The model used assumed concentrations of 0.5% lead in waste rock. This is higher than the median of 0.24% identified from limited field sampling. The results demonstrate compliance with all the NSW EPA impact assessment criteria for all air quality parameters assessed.

6. Conclusions

PE have considered numerous physical and chemical attributes of the waste rock in assessing it's potential to impact the identified receptors (on-site visitors/tourists and off-site residents (children)).

The results of the waste rock assessment, and in consideration of associated studies, identified that;

- The rock type varies, however all rock types identified are competent and mostly hard, with good resistance to weathering;
- The rock comprises only approximately 1% fines capable of producing dust;
- This was qualified by Confined Air Burst Chamber tests, which identified a 99.7% reduction in dust generation compared to disturbed dry tailings.
- Lead concentrations averaged 2,371.5 mg/kg (0.24%). This is above NEPM HIL-C and HIL-D criteria (600 mg/kg and 1,500 mg/kg respectively), but significantly below surface dust averages (15,640 mg/kg, or 1.56%).
- Bioaccessibility is very low (7.3% on average). This is much lower (6.8 x) than the 50% (bioavailability) assumed for the calculation of HIL's. This would suggest that results, if adjusted for bioaccessibility, would meet HIL-C criteria;
- Air quality modelling conducted by PE (2017), assumed a waste rock concentration of 0.5% (5,000 mg/kg). Results demonstrate compliance with all the NSW EPA impact assessment criteria for all air quality parameters assessed.

In conclusion, the results support the use of the waste rock for dust suppression for the TSF and 'free areas', and are considered unlikely to cause an unacceptable risk to human health based upon the site's final land use as a proposed tourist/recreational site.

Air quality modelling has assumed lead concentrations above those identified in the waste rock on site (0.5% compared to 0.24%), and therefore the waste rock is likely to meet NSW EPA impact assessment criteria, and is unlikely to impact further upon surface soil lead concentrations within local communities. The very low dusting potential of the rock supports this conclusion.

In consideration of all other lines of evidence, the 0.5% lead concentration adopted by the air quality model is considered to be a suitable criterion for waste rock placement on-site.

It is therefore considered that the waste rock meets the criteria of being 'inert' material, based upon the multiple lines of evidence approach.

7. Recommendations

The waste rock, when placed, is considered to be suitable as a means of reducing, to an acceptable level, the potential for dust generation from the TSF and ‘free areas’ of the site. To reduce potential risks during placement, we recommend that dust suppression spraying is carried out during capping material (waste rock) placement. A final spray is recommended to ensure that finer particles are washed between the larger rocks. This will greatly reduce the future potential for the rock to create dust.

This assessment has been partially based upon a limited number of waste rock samples, which were analysed for lead composition. For the conclusions of this assessment to maintain validity, it is recommended that field screening of the waste rock is undertaken during placement to confirm that median concentrations do not exceed 0.5%. PE recommends that this is undertaken by use of a calibrated x-ray fluorescence (XRF) field meter. It is noted that:

- laboratory results were considered to be conservative due to the crushing and leaching processes used as part of the analysis methodology;
- XRF results are therefore unlikely to be comparable to laboratory results (they may be lower), however they would be considered to be representative for the reasons above; and
- use of an XRF provides a practical and timely characterisation of field material. Many more samples may be screened in comparison to laboratory analysis.

8. Limitations

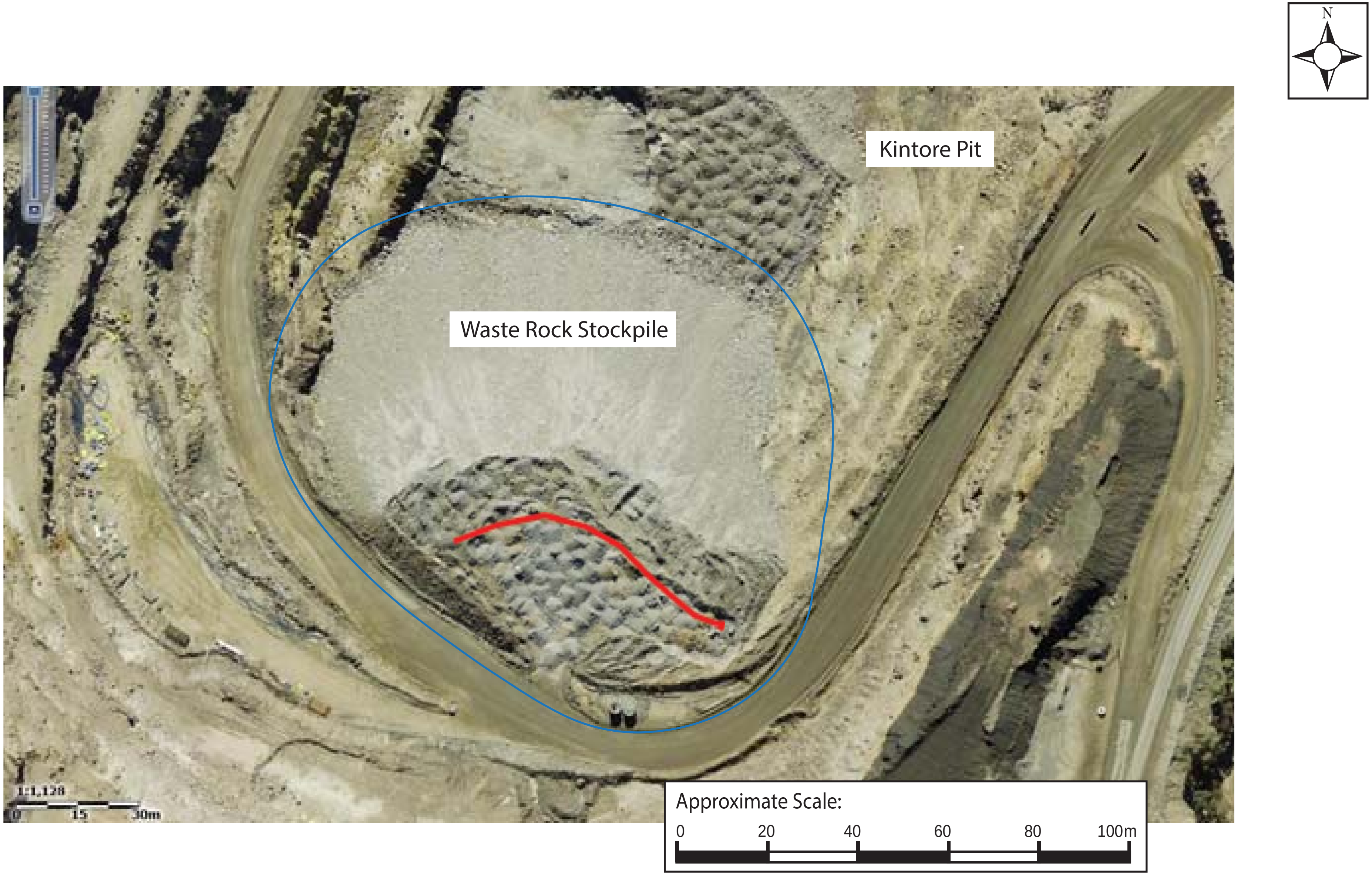
This report has been prepared, in part, from materials provided by third parties and from the analysis of samples collected by third parties. These third parties were not under the direct supervision of Pacific Environment at the time these activities were carried out. Pacific Environment cannot guarantee the data and other information gained from these sources is entirely accurate although we have not been given reason to think that it is not accurate. The validity and comprehensiveness of supplied information has not been independently verified and, for the purposes of this report, it is assumed that the information provided to Pacific Environment is both complete and accurate.

Errors made where Pacific Environment was reliant on third party data or other information obtained from sources outside the control of Pacific Environment will not constitute a failure of Pacific Environment in their duty to their client.

9. Signatories

Drafted by:	Approved By:
	
Ross Lawrence B. Env Tech, CEnvP Senior Consultant Pacific Environment Limited	Brian Fainton BSc (Hons), MSc Principal & Team Lead, Contaminated Land Pacific Environment Limited

Appendix A - Figures



LEGEND

FIGURE 001

Approximate outline of waste rock stockpile

Sampling transect

Sampling Transect - Kintore Pit Stockpile

Rasp Mine
Broken Hill Operations Pty Ltd
Broken Hill, New South Wales

JOB ID: 21544B | DRAWN BY: RL | APPROVED BY: BF | March 2017

Pacific Environment Limited
Level 19, 240 Queen Street
Brisbane CBD, QLD, 4000
Ph: 07 300 46 400
www.pacific-environment.com

Appendix B - Laboratory Reports

CHAIN OF CUSTODY

ALS Laboratory: please tick →

- ☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
- ☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
- ☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
- ☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
- ☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
- ☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
- ☐NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com
- ☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
- ☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
- ☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
- ☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
- ☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

Broken Hill Operations (ALS shortcode: BROHIL)

PO BOX 5073, BROKEN HILL NSW 2880

CT: RASP MINE

NUMBER: PO 37241

CT MANAGER: Leonard Sharp — CONTACT PH: (08) 8088 9111

ER: L.Sharp — SAMPLER MOBILE: 0414 347 125

ailed to ALS? (YES / NO) — EDD FORMAT (or default):

eports to (will default to PM if no other addresses are listed): leonardsharp@cbhresources.com.au

voice to (will default to PM if no other addresses are listed): travisbow@cbhresources.com.au

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)

☑ Standard TAT (List due date):

☐ Non Standard or urgent TAT (List due date):

ALS QUOTE NO.: SY/127/13

GROUNDWATER SAMPLES

COC SEQUENCE NUMBER (Circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact? Yes No N/A

Free ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: 15.7 °C

Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Len Sharp	Jessie		
DATE/TIME: 25/08/16 2.00pm	DATE/TIME: 26/8/16 12:35	DATE/TIME:	DATE/TIME:

NTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)

CONTAINER INFORMATION

ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).

SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	Deionised water leach	W-30	S-3	Jaw crush/pulverise (sample already jaw crushed as per Len)	Size fractioning	~~[illegible]~~	Hydrometer + sieve in order to get silt, sand + clay	As discussed with Len. D.W. 29/8/16	Additional Information: Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
Waste Rock Tipple	25/08/2016	soil	snaplock bag	1	X	X	X	X					possible high Pb and Zn
Mill Material	25/08/2016	soil	snaplock bag	1	X	X	X						possible high Pb and Zn
Mill Material 2	25/08/2016	soil	snaplock bag	1					X				possible high Pb and Zn
Spillway	25/08/2016	soil	snaplock bag	1	X	X	X						possible high Pb and Zn
			TOTAL	4									

Subcon / Forward Lab / Split WO

Lab / Analysis: Newcast

Organised By / Date:

Relinquished By / Date: ASD

Connote / Courier:

WO No:

Attach By PO Internal Sheet:

Environmental Division
Sydney
Work Order Reference
ES1618999

Telephone : + 61-2-8784 8555

ntainer Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
ial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
cetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1618999**	Page	: 1 of 5
Client	: **BROKEN HILL OPERATIONS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR LEONARD SHARP	Contact	:
Address	: PO BOX 5073 BROKEN HILL NSW 2880	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 8088 9104	Telephone	: +61-2-8784 8555
Project	: RASP MINE	Date Samples Received	: 26-Aug-2016 12:35
Order number	: 37241	Date Analysis Commenced	: 30-Aug-2016
C-O-C number	: ----	Issue Date	: 02-Sep-2016 11:13
Sampler	: LEONARD SHARP		
Site	: ----		
Quote number	: ----		
No. of samples received	: 4		
No. of samples analysed	: 4		

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics, Mayfield West, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
RICHARD TEA	Lab technician	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)			Client sample ID	WASTE ROCK TIPPLE	MILL MATERIAL	SPILLWAY	----	----
			Client sampling date / time	[25-Aug-2016]	[25-Aug-2016]	[25-Aug-2016]	----	----
Compound	CAS Number	LOR	Unit	ES1618999-001	ES1618999-002	ES1618999-004	--------	--------
				Result	Result	Result	----	----
EG020W: Water Leachable Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**3.76**	**1.76**	**0.02**	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.005**	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0002**	**0.0149**	**0.197**	----	----
Chromium	7440-47-3	0.001	mg/L	**0.004**	**0.002**	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.008**	**0.016**	**0.002**	----	----
Lead	7439-92-1	0.001	mg/L	**0.054**	**0.491**	**3.56**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	**0.011**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	**0.121**	**0.950**	**6.20**	----	----
Iron	7439-89-6	0.05	mg/L	**1.74**	**0.93**	<0.05	----	----
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WASTE ROCK TIPPLE	MILL MATERIAL	MILL MATERIAL 2	SPILLWAY	----
			Client sampling date / time	[25-Aug-2016]	[25-Aug-2016]	[25-Aug-2016]	[25-Aug-2016]	----
Compound	CAS Number	LOR	Unit	ES1618999-001	ES1618999-002	ES1618999-003	ES1618999-004	--------
				Result	Result	Result	Result	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	1.3	5.5	----	6.5	----
EA150: Particle Sizing								
+75µm	----	1	%	----	----	81	----	----
+150µm	----	1	%	----	----	76	----	----
+300µm	----	1	%	----	----	71	----	----
+425µm	----	1	%	----	----	68	----	----
+600µm	----	1	%	----	----	65	----	----
+1180µm	----	1	%	----	----	59	----	----
+2.36mm	----	1	%	----	----	50	----	----
+4.75mm	----	1	%	----	----	42	----	----
+9.5mm	----	1	%	----	----	32	----	----
+19.0mm	----	1	%	----	----	28	----	----
+37.5mm	----	1	%	----	----	14	----	----
+75.0mm	----	1	%	----	----	<1	----	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	----	6	----	----
Silt (2-60 µm)	----	1	%	----	----	12	----	----
Sand (0.06-2.00 mm)	----	1	%	----	----	29	----	----
Gravel (>2mm)	----	1	%	----	----	41	----	----
Cobbles (>6cm)	----	1	%	----	----	12	----	----
EA152: Soil Particle Density								
ø Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	2.77	----	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	13	86	----	97	----
Barium	7440-39-3	10	mg/kg	40	30	----	60	----
Beryllium	7440-41-7	1	mg/kg	<1	<1	----	<1	----
Boron	7440-42-8	50	mg/kg	<50	<50	----	<50	----
Cadmium	7440-43-9	1	mg/kg	6	43	----	13	----
Chromium	7440-47-3	2	mg/kg	17	12	----	15	----
Cobalt	7440-48-4	2	mg/kg	8	10	----	12	----
Copper	7440-50-8	5	mg/kg	93	108	----	216	----
Lead	7439-92-1	5	mg/kg	543	3190	----	15800	----
Manganese	7439-96-5	5	mg/kg	78	2160	----	5500	----
Nickel	7440-02-0	2	mg/kg	12	13	----	16	----

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

			Client sample ID	WASTE ROCK TIPPLE	MILL MATERIAL	MILL MATERIAL 2	SPILLWAY	----
			Client sampling date / time	[25-Aug-2016]	[25-Aug-2016]	[25-Aug-2016]	[25-Aug-2016]	----
Compound	CAS Number	LOR	Unit	ES1618999-001	ES1618999-002	ES1618999-003	ES1618999-004	--------
				Result	Result	Result	Result	----
EG005T: Total Metals by ICP-AES - Continued								
Selenium	7782-49-2	5	mg/kg	<5	<5	----	<5	----
Vanadium	7440-62-2	5	mg/kg	**15**	**15**	----	**18**	----
Zinc	7440-66-6	5	mg/kg	**1780**	**2600**	----	**3130**	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	**0.3**	----
EN60: Bottle Leaching Procedure								
Final pH	----	0.1	pH Unit	**8.0**	**7.5**	----	**5.8**	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1618999**	Page	: 1 of 5
Client	: **BROKEN HILL OPERATIONS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR LEONARD SHARP	Contact	:
Address	: PO BOX 5073 BROKEN HILL NSW 2880	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 8088 9104	Telephone	: +61-2-8784 8555
Project	: RASP MINE	Date Samples Received	: 26-Aug-2016
Order number	: 37241	Date Analysis Commenced	: 30-Aug-2016
C-O-C number	: ----	Issue Date	: 02-Sep-2016
Sampler	: LEONARD SHARP		
Site	: ----		
Quote number	: ----		
No. of samples received	: 4		
No. of samples analysed	: 4		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics, Mayfield West, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
RICHARD TEA	Lab technician	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA055: Moisture Content (QC Lot: 567254)									
ES1618999-002	MILL MATERIAL	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	5.5	5.7	3.71	No Limit
ES1619032-016	Anonymous	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	70.7	70.3	0.576	0% - 20%
EG005T: Total Metals by ICP-AES (QC Lot: 567185)									
ES1618941-002	Anonymous	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	<10	<10	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	3	3	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	5	5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	6	6	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	19	18	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	14	20	35.1	No Limit
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	5	7	24.4	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	15	14	6.87	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
ES1619096-002	Anonymous	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	<10	<10	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Cobalt	7440-48-4	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	<2	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.00	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG005T: Total Metals by ICP-AES (QC Lot: 567185) - continued									
ES1619096-002	Anonymous	EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	7	8	13.1	No Limit
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 567186)									
ES1618941-002	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	0.2	0.2	0.00	No Limit
ES1619096-002	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020W: Water Leachable Metals by ICP-MS (QC Lot: 569454)									
ES1618999-001	WASTE ROCK TIPPLE	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0002	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.004	0.003	0.00	No Limit
		EG020A-W: Copper	7440-50-8	0.001	mg/L	0.008	0.008	0.00	No Limit
		EG020A-W: Lead	7439-92-1	0.001	mg/L	0.054	0.055	0.00	0% - 20%
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	0.121	0.123	2.08	0% - 20%
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	3.76	3.51	6.97	0% - 20%
		EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	1.74	1.84	5.70	0% - 20%
ES1619038-019	Anonymous	EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-W: Arsenic	7440-38-2	0.001	mg/L	0.002	0.003	0.00	No Limit
		EG020A-W: Chromium	7440-47-3	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-W: Copper	7440-50-8	0.001	mg/L	0.074	0.076	3.04	0% - 20%
		EG020A-W: Lead	7439-92-1	0.001	mg/L	2.19	2.17	1.09	0% - 20%
		EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-W: Zinc	7440-66-6	0.005	mg/L	0.037	0.037	0.00	No Limit
		EG020A-W: Aluminium	7429-90-5	0.01	mg/L	1.84	1.92	4.20	0% - 20%
		EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-W: Iron	7439-89-6	0.05	mg/L	1.94	1.86	4.24	0% - 20%
EG035W: Water Leachable Mercury by FIMS (QC Lot: 569492)									
ES1618999-001	WASTE ROCK TIPPLE	EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 567185)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	100	86	126
EG005T: Barium	7440-39-3	10	mg/kg	<10	143 mg/kg	97.9	85	115
EG005T: Beryllium	7440-41-7	1	mg/kg	<1	5.63 mg/kg	111	90	112628
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	99.2	83	113
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	88.9	76	128
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	16 mg/kg	102	88	120
EG005T: Copper	7440-50-8	5	mg/kg	<5	32 mg/kg	108	86	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	40 mg/kg	96.4	80	114
EG005T: Manganese	7439-96-5	5	mg/kg	<5	130 mg/kg	97.4	85	117
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55 mg/kg	99.7	87	123
EG005T: Selenium	7782-49-2	5	mg/kg	<5	5.37 mg/kg	103	75	131
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	29.6 mg/kg	106	92	122
EG005T: Zinc	7440-66-6	5	mg/kg	<5	60.8 mg/kg	108	80	122
EG035T: Total Recoverable Mercury by FIMS (QCLot: 567186)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.57 mg/kg	87.2	70	105

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG020W: Water Leachable Metals by ICP-MS (QCLot: 569454)								
EG020A-W: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	101	81	121
EG020A-W: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	104	79	119
EG020A-W: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	102	84	108
EG020A-W: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	97.6	84	114
EG020A-W: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	104	81	117
EG020A-W: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	83	115
EG020A-W: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	98.2	80	116
EG020A-W: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	96.6	74	122
EG020A-W: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	96.7	80	114
EG020A-W: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	97.8	83	117
EG035W: Water Leachable Mercury by FIMS (QCLot: 569492)								
EG035W: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	87.5	82	106

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 567185)							
ES1618876-012	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	98.2	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	99.0	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	90.4	70	130
		EG005T: Copper	7440-50-8	250 mg/kg	100	70	130
		EG005T: Lead	7439-92-1	250 mg/kg	94.9	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	98.0	70	130
		EG005T: Zinc	7440-66-6	250 mg/kg	99.6	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 567186)							
ES1618941-002	Anonymous	EG035T: Mercury	7439-97-6	5 mg/kg	89.9	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020W: Water Leachable Metals by ICP-MS (QCLot: 569454)							
ES1618999-001	WASTE ROCK TIPPLE	EG020A-W: Arsenic	7440-38-2	1 mg/L	97.6	70	130
		EG020A-W: Cadmium	7440-43-9	0.25 mg/L	97.3	70	130
		EG020A-W: Chromium	7440-47-3	1 mg/L	98.2	70	130
		EG020A-W: Copper	7440-50-8	1 mg/L	94.1	70	130
		EG020A-W: Lead	7439-92-1	1 mg/L	94.4	70	130
		EG020A-W: Nickel	7440-02-0	1 mg/L	95.3	70	130
		EG020A-W: Zinc	7440-66-6	1 mg/L	96.7	70	130
EG035W: Water Leachable Mercury by FIMS (QCLot: 569492)							
ES1618999-004	SPILLWAY	EG035W: Mercury	7439-97-6	0.01 mg/L	89.7	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1618999**	Page	: 1 of 5
Client	: **BROKEN HILL OPERATIONS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR LEONARD SHARP	Telephone	: +61-2-8784 8555
Project	: RASP MINE	Date Samples Received	: 26-Aug-2016
Site	: ----	Issue Date	: 02-Sep-2016
Sampler	: LEONARD SHARP	No. of samples received	: 4
Order number	: 37241	No. of samples analysed	: 4

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method		*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*			***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA055: Moisture Content								
Snap Lock Bag (EA055-103)								
WASTE ROCK TIPPLE, SPILLWAY	MILL MATERIAL,	**25-Aug-2016**	**----**	----	----	**30-Aug-2016**	08-Sep-2016	✓
EA150: Particle Sizing								
Snap Lock Bag (EA150H)								
MILL MATERIAL 2		**25-Aug-2016**	**----**	----	----	**31-Aug-2016**	21-Feb-2017	✓
EA150: Soil Classification based on Particle Size								
Snap Lock Bag (EA150H)								
MILL MATERIAL 2		**25-Aug-2016**	**----**	----	----	**31-Aug-2016**	21-Feb-2017	✓
EA152: Soil Particle Density								
Snap Lock Bag (EA152)								
MILL MATERIAL 2		**25-Aug-2016**	**----**	----	----	**31-Aug-2016**	21-Feb-2017	✓
EG005T: Total Metals by ICP-AES								
Snap Lock Bag (EG005T)								
WASTE ROCK TIPPLE, SPILLWAY	MILL MATERIAL,	**25-Aug-2016**	**30-Aug-2016**	21-Feb-2017	✓	**31-Aug-2016**	21-Feb-2017	✓
EG035T: Total Recoverable Mercury by FIMS								
Snap Lock Bag (EG035T)								
WASTE ROCK TIPPLE, SPILLWAY	MILL MATERIAL,	**25-Aug-2016**	**30-Aug-2016**	22-Sep-2016	✓	**31-Aug-2016**	22-Sep-2016	✓
EN60: Bottle Leaching Procedure								
Non-Volatile Leach: 28 day HT(e.g. Hg, CrVI) (EN60-Dla)								
WASTE ROCK TIPPLE, SPILLWAY	MILL MATERIAL,	**25-Aug-2016**	**31-Aug-2016**	22-Sep-2016	✓	**----**	----	----

Matrix: **WATER** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020W: Water Leachable Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-W)								
WASTE ROCK TIPPLE, SPILLWAY	MILL MATERIAL,	**31-Aug-2016**	**01-Sep-2016**	27-Feb-2017	✓	**01-Sep-2016**	27-Feb-2017	✓
EG035W: Water Leachable Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035W)								
WASTE ROCK TIPPLE, SPILLWAY	MILL MATERIAL,	**31-Aug-2016**	**----**	----	----	**01-Sep-2016**	28-Sep-2016	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type *Analytical Methods*	*Method*	*Count* QC	*Count* Regular	*Rate (%)* Actual	*Rate (%)* Expected	Evaluation	*Quality Control Specification*
Laboratory Duplicates (DUP)							
Moisture Content	EA055-103	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Total Mercury by FIMS	EG035T	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Total Mercury by FIMS	EG035T	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type *Analytical Methods*	*Method*	*Count* QC	*Count* Regular	*Rate (%)* Actual	*Rate (%)* Expected	Evaluation	*Quality Control Specification*
Laboratory Duplicates (DUP)							
Water Leachable Mercury by FIMS	EG035W	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Water Leachable Mercury by FIMS	EG035W	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Water Leachable Mercury by FIMS	EG035W	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Water Leachable Mercury by FIMS	EG035W	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Moisture Content	EA055-103	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Particle Size Analysis by Hydrometer	EA150H	SOIL	Particle Size Analysis by Hydrometer according to AS1289.3.6.3 - 2003
Soil Particle Density	* EA152	SOIL	Soil Particle Density by AS 1289.3.5.1-2006 : Methods of testing soils for engineering purposes - Soil classification tests - Determination of the soil particle density of a soil - Standard method
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Water Leachable Metals by ICP-MS - Suite A	EG020A-W	SOIL	In house: Referenced to APHA 3125; USEPA SW846 - 6020, AS 4439.3, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Water Leachable Mercury by FIMS	EG035W	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the TCLP solution. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals in DI Water Leachate	EN25W	SOIL	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Deionised Water Leach	EN60-DIa	SOIL	In house QWI-EN/60 referenced to AS4439.3 Preparation of Leachates
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)

Bm

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph 08 8359 0890 E adelaide@alsglobal.com
☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph 07 3243 7222 E samples.brisbane@alsglobal.com
☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph 07 7471 5600 E gladstone@alsglobal.com
☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph 07 4944 0177 E mackay@alsglobal.com
☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph 03 8549 9600 E samples.melbourne@alsglobal.com
☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph 02 6372 6735 E mudgee.mail@alsglobal.com
☐NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph 02 4968 9433 E samples.newcastle@alsglobal.com
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☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph 02 8784 8555 E samples.sydney@alsglobal.com
☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph 07 4796 0600 E townsville.environmental@alsglobal.com
☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph 02 4225 3125 E portkembla@alsglobal.com

CLIENT: Broken Hill Operations (ALS shortcode: BROHIL)	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☑ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):	[redacted]
OFFICE: PO BOX 5073, BROKEN HILL NSW 2880			
PROJECT: RASP MINE	ALS QUOTE NO.: SY/127/13	COC SEQUENCE NUMBER (Circle)	
ORDER NUMBER: 41541	Waste rock samples	COC: 1 2 3 4 5 6 7	
PROJECT MANAGER: Leonard Sharp	CONTACT PH: (08) 8088 9111	OF: 1 2 3 4 5 6 7	

SAMPLER: L.Sharp	SAMPLER MOBILE: 0414 347 125	RELINQUISHED BY: Len Sharp	RECEIVED BY: FAS	RELINQUISHED BY:	RECEIVED BY:
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 15/09/16 4.00pm	DATE/TIME: 10/09/16 12:30	DATE/TIME:	DATE/TIME:
Email Reports to (will default to PM if no other addresses are listed): leonardsharp@cbhresources.com.au					
Email Invoice to (will default to PM if no other addresses are listed): travisbow@cbhresources.com.au					

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

[redacted]

ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required)

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	S3	Jaw crush	Size fractioning	Moisture content					Additional Information: Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	1	15/09/2016	~~soil~~ / rock	10L bucket	1	X	X	X	X					possible high Pb and Zn
2	2	15/09/2016	~~soil~~ / rock	10L bucket	1	X	X	X	X					possible high Pb and Zn
3	3	15/09/2016	~~soil~~ / rock	10L bucket	1	X	X	X	X					possible high Pb and Zn
4	4	15/09/2016	~~soil~~ / rock	10L bucket	1	X	X	X	X					possible high Pb and Zn
5	5	15/09/2016	~~soil~~ / rock	10L bucket	1	X	X	X	X					possible high Pb and Zn
				TOTAL	5									

Environmental Division
Sydney
Work Order Reference
ES1622679

Telephone : + 61-2-8784 8555

Subcon / Forward Lab / Split WO
Lab / Analysis: Orange: crushing
Organised By / Date: ____________
Relinquished By / Date: ____________
Connote / Courier: ____________
WO No: ES1622679
Attach By PO / Internal Sheet: ______

please ensure moisture content is measured before crushing sample

~~Turnaround~~ ASAP will accept surcharge

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CERTIFICATE OF ANALYSIS

Work Order	: **ES1622679**	Laboratory	: Environmental Division Sydney
Client	: **BROKEN HILL OPERATIONS PTY LTD**	Contact	:
Contact	: MR LEONARD SHARP	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Address	: PO BOX 5073 BROKEN HILL NSW 2880		
Telephone	: +61 08 8088 9104	Telephone	: +61-2-8784 8555
Project	: RASP MINE	Date Samples Received	: 10-Oct-2016 12:30
Order number	: 41541	Date Analysis Commenced	: 14-Oct-2016
C-O-C number	: ----	Issue Date	: 18-Oct-2016 14:38
Sampler	: LEONARD SHARP		
Site	: ----		
Quote number	: ----		
No. of samples received	: 5		
No. of samples analysed	: 5		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
RICHARD TEA	Lab technician	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

Analytical Results

Sub-Matrix: **ROCK** (Matrix: **SOIL**)			Client sample ID	1	2	3	4	5
			Client sampling date / time	[15-Sep-2016]	[15-Sep-2016]	[15-Sep-2016]	[15-Sep-2016]	[15-Sep-2016]
Compound	CAS Number	LOR	Unit	**ES1622679-001**	**ES1622679-002**	**ES1622679-003**	**ES1622679-004**	**ES1622679-005**
				Result	Result	Result	Result	Result
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	<1.0	<1.0	<1.0	<1.0	<1.0
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	**9**	**241**	**34**	**26**	**75**
Barium	7440-39-3	10	mg/kg	**30**	**30**	**30**	**30**	**20**
Beryllium	7440-41-7	1	mg/kg	<1	<1	<1	<1	<1
Boron	7440-42-8	50	mg/kg	<50	<50	<50	<50	<50
Cadmium	7440-43-9	1	mg/kg	<1	**5**	**57**	**4**	**17**
Chromium	7440-47-3	2	mg/kg	**22**	**13**	**10**	**20**	**17**
Cobalt	7440-48-4	2	mg/kg	**9**	**16**	**14**	**10**	**11**
Copper	7440-50-8	5	mg/kg	**15**	**55**	**240**	**45**	**141**
Lead	7439-92-1	5	mg/kg	**57**	**905**	**9010**	**684**	**3030**
Manganese	7439-96-5	5	mg/kg	**91**	**258**	**405**	**174**	**188**
Nickel	7440-02-0	2	mg/kg	**18**	**18**	**12**	**19**	**18**
Selenium	7782-49-2	5	mg/kg	<5	<5	<5	<5	<5
Vanadium	7440-62-2	5	mg/kg	**22**	**18**	**14**	**28**	**22**
Zinc	7440-66-6	5	mg/kg	**222**	**1420**	**21500**	**973**	**4060**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	**0.1**	<0.1	<0.1

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1622679**	Page	: 1 of 4
Client	: **BROKEN HILL OPERATIONS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR LEONARD SHARP	Contact	:
Address	: PO BOX 5073 BROKEN HILL NSW 2880	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 8088 9104	Telephone	: +61-2-8784 8555
Project	: RASP MINE	Date Samples Received	: 10-Oct-2016
Order number	: 41541	Date Analysis Commenced	: 14-Oct-2016
C-O-C number	: ----	Issue Date	: 18-Oct-2016
Sampler	: LEONARD SHARP		
Site	: ----		
Quote number	: ----		
No. of samples received	: 5		
No. of samples analysed	: 5		

ilac-MRA NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
RICHARD TEA	Lab technician	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA055: Moisture Content (QC Lot: 617477)									
ES1622679-003	3	EA055-103: Moisture Content (dried @ 103°C)	----	1	%	<1.0	<1.0	0.00	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 618866)									
ES1622679-001	1	EG005T: Beryllium	7440-41-7	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Barium	7440-39-3	10	mg/kg	30	30	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	22	20	7.61	0% - 50%
		EG005T: Cobalt	7440-48-4	2	mg/kg	9	8	0.00	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	18	17	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	9	6	33.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	15	18	16.5	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	57	55	3.52	0% - 50%
		EG005T: Manganese	7439-96-5	5	mg/kg	91	88	3.04	0% - 50%
		EG005T: Selenium	7782-49-2	5	mg/kg	<5	<5	0.00	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	22	22	0.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	222	205	8.24	0% - 20%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 618867)									
ES1622679-001	1	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 618866)								
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	21.7 mg/kg	96.9	86	126
EG005T: Barium	7440-39-3	10	mg/kg	<10	143 mg/kg	95.0	85	115
EG005T: Beryllium	7440-41-7	1	mg/kg	<1	5.63 mg/kg	106	90	112628
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	4.64 mg/kg	92.8	83	113
EG005T: Chromium	7440-47-3	2	mg/kg	<2	43.9 mg/kg	90.5	76	128
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	16 mg/kg	99.3	88	120
EG005T: Copper	7440-50-8	5	mg/kg	<5	32 mg/kg	97.4	86	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	40 mg/kg	91.5	80	114
EG005T: Manganese	7439-96-5	5	mg/kg	<5	130 mg/kg	95.7	85	117
EG005T: Nickel	7440-02-0	2	mg/kg	<2	55 mg/kg	95.8	87	123
EG005T: Selenium	7782-49-2	5	mg/kg	<5	5.37 mg/kg	98.2	75	131
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	29.6 mg/kg	102	92	122
EG005T: Zinc	7440-66-6	5	mg/kg	<5	60.8 mg/kg	97.4	80	122
EG035T: Total Recoverable Mercury by FIMS (QCLot: 618867)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	2.57 mg/kg	76.2	70	105

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 618866)							
ES1622679-001	1	EG005T: Arsenic	7440-38-2	50 mg/kg	97.0	70	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	92.8	70	130
		EG005T: Chromium	7440-47-3	50 mg/kg	90.7	70	130
		EG005T: Copper	7440-50-8	250 mg/kg	93.1	70	130
		EG005T: Lead	7439-92-1	250 mg/kg	97.4	70	130
		EG005T: Nickel	7440-02-0	50 mg/kg	91.5	70	130
		EG005T: Zinc	7440-66-6	250 mg/kg	103	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 618867)							
ES1622679-001	1	EG035T: Mercury	7439-97-6	5 mg/kg	71.6	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1622679**	Page	: 1 of 4
Client	: **BROKEN HILL OPERATIONS PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR LEONARD SHARP	Telephone	: +61-2-8784 8555
Project	: RASP MINE	Date Samples Received	: 10-Oct-2016
Site	: ----	Issue Date	: 18-Oct-2016
Sampler	: LEONARD SHARP	No. of samples received	: 5
Order number	: 41541	No. of samples analysed	: 5

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method Container / Client Sample ID(s)	Extraction / Preparation Date extracted	Extraction / Preparation Due for extraction	Extraction / Preparation Days overdue	Analysis Date analysed	Analysis Due for analysis	Analysis Days overdue
EA055: Moisture Content						
Plastic bucket 1, 2, 3, 4, 5	----	----	----	14-Oct-2016	29-Sep-2016	**15**
EG035T: Total Recoverable Mercury by FIMS						
Plastic bucket 1, 2, 3, 4, 5	17-Oct-2016	13-Oct-2016	**4**	17-Oct-2016	13-Oct-2016	**4**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation Date extracted	Extraction / Preparation Due for extraction	Extraction / Preparation Evaluation	Analysis Date analysed	Analysis Due for analysis	Analysis Evaluation
EA055: Moisture Content							
Plastic bucket (EA055-103) 1, 2, 3, 4, 5	**15-Sep-2016**	**----**	----	----	**14-Oct-2016**	29-Sep-2016	✘
EG005T: Total Metals by ICP-AES							
Plastic bucket (EG005T) 1, 2, 3, 4, 5	**15-Sep-2016**	**17-Oct-2016**	14-Mar-2017	✓	**17-Oct-2016**	14-Mar-2017	✓
EG035T: Total Recoverable Mercury by FIMS							
Plastic bucket (EG035T) 1, 2, 3, 4, 5	**15-Sep-2016**	**17-Oct-2016**	13-Oct-2016	✘	**17-Oct-2016**	13-Oct-2016	✘

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Moisture Content	EA055-103	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Total Mercury by FIMS	EG035T	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Total Mercury by FIMS	EG035T	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Moisture Content	EA055-103	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)

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Aggregate/Soil Test Report

Report No: SYD1601652
Issue No: 1
This report replaces all previous issues of report no 'SYD1601652'.

Client:
Broken Hill Operations Pty Ltd
130 Eyre Street
Broken Hill NSW 2880

Project: 2125880

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 5/10/2016

Sample Details

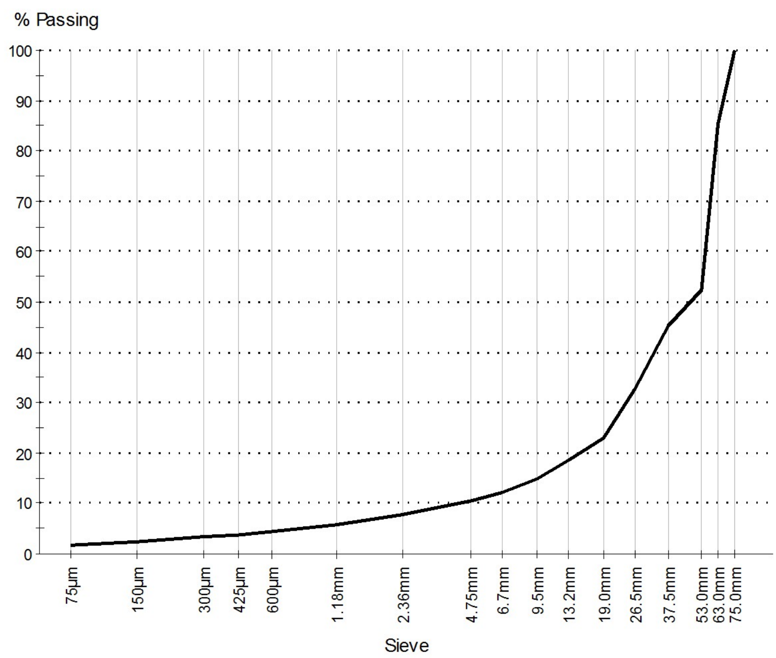
GHD Sample No	SYD16-0360-01
Client Sample ID	1
Date Sampled	22/09/2016
Sampled By	Supplied by Client
Location	CBH Resources Rasp Mine

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution

Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 29/09/2016
Note: Sample Washed



Sieve Size	% Passing	Limits
75.0mm	100	
63.0mm	85	
53.0mm	52	
37.5mm	45	
26.5mm	33	
19.0mm	23	
13.2mm	18	
9.5mm	15	
6.7mm	12	
4.75mm	10	
2.36mm	8	
1.18mm	6	
600µm	4	
425µm	4	
300µm	3	
150µm	2	
75µm	2	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1601653
Issue No: 1
This report replaces all previous issues of report no 'SYD1601653'.

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 5/10/2016

Client:
Broken Hill Operations Pty Ltd
130 Eyre Street
Broken Hill NSW 2880

Project: 2125880

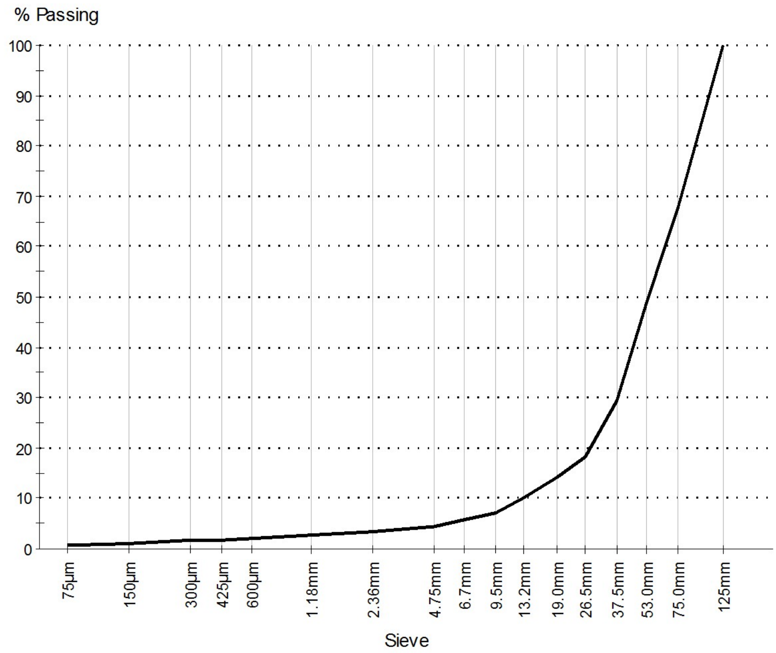
Sample Details

GHD Sample No	SYD16-0360-02
Client Sample ID	Sample 2
Date Sampled	22/09/2016
Sampled By	Supplied by Client
Location	CBH Resources Rasp Mine

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution



Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 29/09/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
125mm	100	
75.0mm	68	
53.0mm	49	
37.5mm	30	
26.5mm	18	
19.0mm	14	
13.2mm	10	
9.5mm	7	
6.7mm	6	
4.75mm	4	
2.36mm	3	
1.18mm	3	
600µm	2	
425µm	2	
300µm	2	
150µm	1	
75µm	1	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1601654
Issue No: 1
This report replaces all previous issues of report no 'SYD1601654'.

Client:
Broken Hill Operations Pty Ltd
130 Eyre Street
Broken Hill NSW 2880

Project: 2125880

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 5/10/2016

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

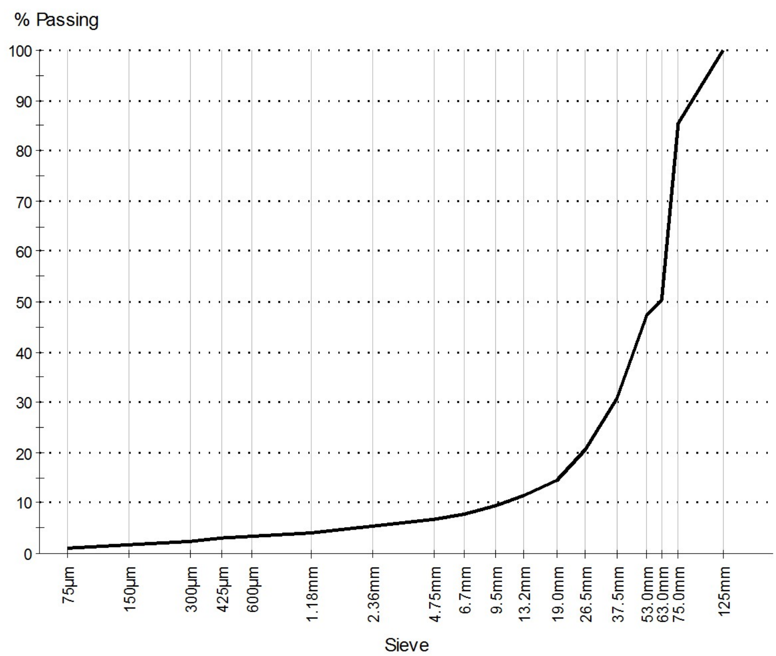
Sample Details

GHD Sample No	SYD16-0360-03
Client Sample ID	Sample 3
Date Sampled	22/09/2016
Sampled By	Supplied by Client
Location	CBH Resources Rasp Mine

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution



Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 29/09/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
125mm	100	
75.0mm	85	
63.0mm	50	
53.0mm	47	
37.5mm	31	
26.5mm	21	
19.0mm	15	
13.2mm	12	
9.5mm	9	
6.7mm	8	
4.75mm	7	
2.36mm	5	
1.18mm	4	
600µm	3	
425µm	3	
300µm	2	
150µm	2	
75µm	1	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1601655
Issue No: 1
This report replaces all previous issues of report no 'SYD1601655'.

Client:
Broken Hill Operations Pty Ltd
130 Eyre Street
Broken Hill NSW 2880

Project: 2125880

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 5/10/2016

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

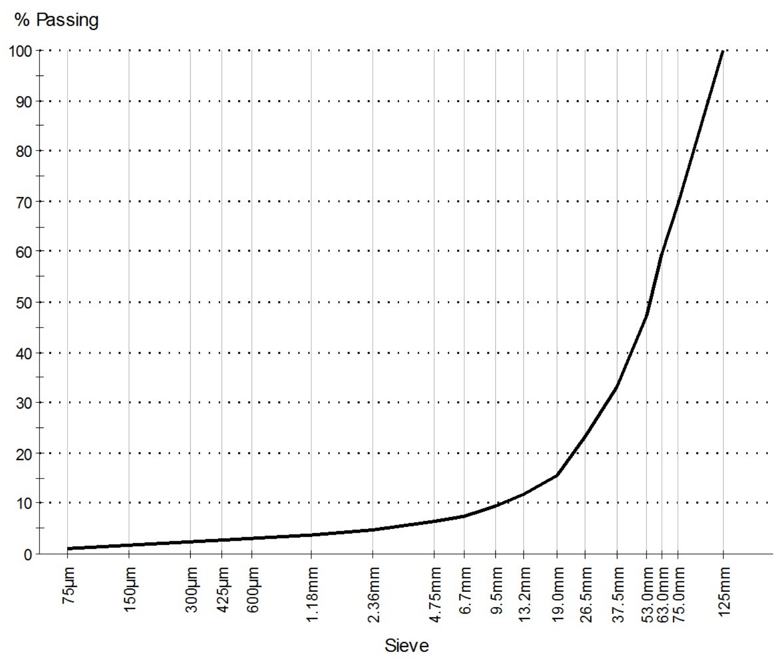
Sample Details

GHD Sample No	SYD16-0360-04
Client Sample ID	Sample 4
Date Sampled	22/09/2016
Sampled By	Supplied by Client
Location	CBH Resources Rasp Mine

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution



Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 29/09/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
125mm	100	
75.0mm	70	
63.0mm	60	
53.0mm	47	
37.5mm	33	
26.5mm	23	
19.0mm	16	
13.2mm	12	
9.5mm	9	
6.7mm	7	
4.75mm	6	
2.36mm	5	
1.18mm	4	
600µm	3	
425µm	3	
300µm	2	
150µm	2	
75µm	1	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1601656
Issue No: 1
This report replaces all previous issues of report no 'SYD1601656'.

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 5/10/2016

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Client:
Broken Hill Operations Pty Ltd
130 Eyre Street
Broken Hill NSW 2880

Project: 2125880

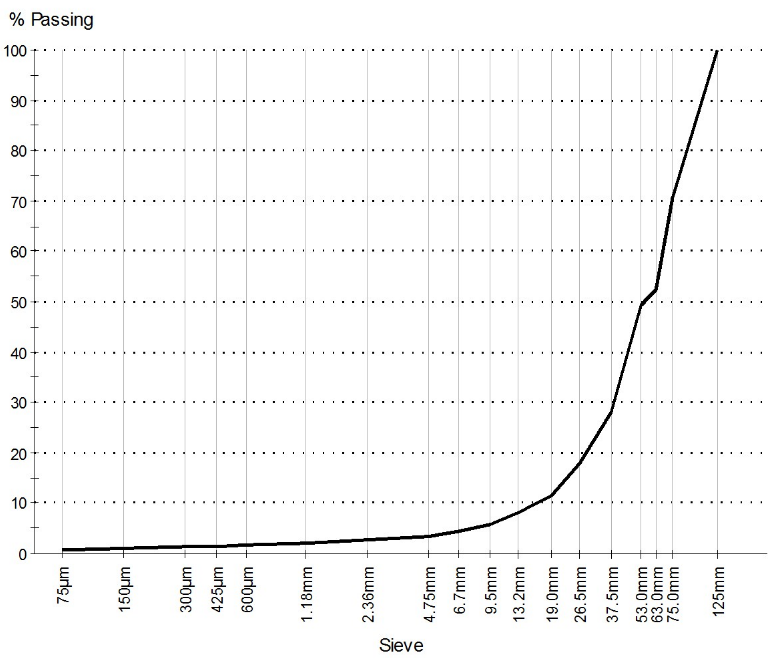
Sample Details

GHD Sample No	SYD16-0360-05
Client Sample ID	Sample 5
Date Sampled	22/09/2016
Sampled By	Supplied by Client
Location	CBH Resources Rasp Mine

Other Test Results

Description	Method	Result	Limits

Particle Size Distribution



Method: AS 1289.3.6.1
Drying by: Oven
Date Tested: 29/09/2016
Note: Sample Washed

Sieve Size	% Passing	Limits
125mm	100	
75.0mm	71	
63.0mm	52	
53.0mm	49	
37.5mm	28	
26.5mm	18	
19.0mm	11	
13.2mm	8	
9.5mm	6	
6.7mm	4	
4.75mm	4	
2.36mm	3	
1.18mm	2	
600µm	2	
425µm	1	
300µm	1	
150µm	1	
75µm	1	

Comments

N/A

Appendix C - Photographic Log

Photo 1: Part of the waste rock stockpile showing hard hat for rock size reference

Photo 2: Another area of the waste rock stockpile with hard hat for rock size reference

Photo 3: View of Kintore pit waste rock stockpile from west

Photo 4: Closer view of waste rock stockpile

Photo 5: Flat area on top of waste rock stockpile, mine vehicle for size reference

Photo 6: View from top of waste rock stockpile looking north at far wall of Kintore pit

Photo 7: Close up view of waste rock material, note: large degree of variation in sizes

Photo 8: Close up view of another area of the waste rock stockpile, note: size variation

Appendix C
TSF Spray System Details

Broken Hill Operations

RASP MINE PROJECT TAILINGS DAM SPRAY SYSTEM

Version 1.40 —13 June 2017

Prepared by:

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BROKEN HILL OPERATIONS

RASP MINE PROJECT TAILINGS DAM SPRAY SYSTEM

TABLE OF CONTENTS

INTRODUCTION

This document details the design for TSF2 Tailings Dam Dust Control Spray System for Broken Hill Operations Rasp Mine.

1.1. Design Requirements

The following are the design requirements for the system:

- Sprinklers to provide full coverage of the TSF2 including walls with adequate overlap to account for variable conditions.
- System to be able to apply water spray to the TSF2 in one hour.
- Water supply for the system be designed to ensure adequate water at the required pressure is available to run the spray system in all circumstances foreseen by the CBH and Wet Earth.
- System to be able to take multiple inputs (eg real time dust monitors, wind speed and direction sensors) to automatically start the spray system

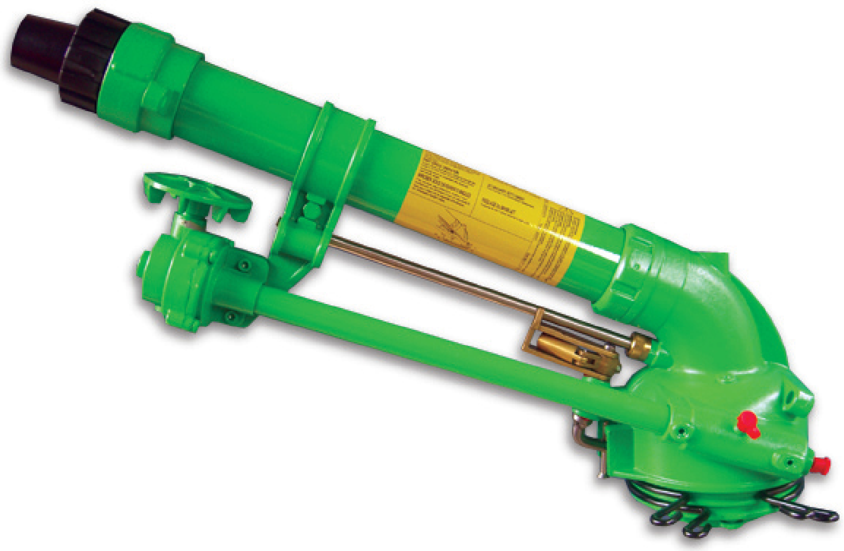
1.2. Summary

The following is a summary of the system design:

- 24 sprinklers with a throw distance of 64m to 67m provide full coverage of the TSF2
    - 16 sprinklers on the outside of the TSF
    - 8 sprinklers on the inside of the TSF
- will deliver 2L per m2 of water to the whole TSF2 in 48 minutes
- will be able to suppress dust using only water for almost 3 days based on historical January evaporation data
- will be able to apply a crusting agent to the complete TSF2 in 48 minutes
- will be able to suppress dust using water only for 2.5 days with no inflow from town water supply
- PLC based control system with the ability to control individual sprinklers
- will support the rising levels of the TSF2
- will be regularly tested
- has been designed for easy maintenance.
- system will have redundant pumps and backup power supply

DESIGN

2.1. Sprinkler



The Sime Mariner Mining sprinkler is recommended for this application because it is a robust anodised aluminium sprinkler that Wet Earth has used on mining projects with clients including:

- Barrick
- BMA Coal
- BHP
- CITIC Pacific
- Glencore
- Rio Tinto
- FMG

The performance point we recommend for the Sime Mariner for this project is a 34mm nozzle operating at between 7 and 8 bar pressure with a throw distance of 64m to 67m and a flow rate of max 130m3/hr.

The Sime Mariner Mining sprinkler is a customisation of the Sime Mariner sprinkler to harden it and make it more suitable to mining applications.

A datasheet for the Sime Mariner will be provided with this design.

2.2. Tailings Dam Sprinkler Layout

To ensure adequate coverage in variable wind conditions the spacing design was based on providing coverage of the complete TSF2 and walls assuming the sprinklers were only throwing 60m. We consider this provides an adequate over coverage considering the sprinklers will have a throw distance of between 64m and 67m.

The layout drawing of sprinkler locations on the TSF2 will be provided with this design but showing the 64m throw distance.

It is important to note that some sprinklers will be located inside the TSF2.

2.2.1. Sprinklers Located Inside TSF2

Piping for these sprinklers will be initially laid on the surface of the TSF2 and will ultimately be covered in tailings.

A sprinkler stand / supporting structure will be designed taking consideration the following factors

- compatibility with the tailings material
- capable of supporting the sprinkler with a height of between 0.5m and 4m above the tailings level
- easy to increase the height of the stand, supporting structure as tailings level increases.

The sprinkler stand / supporting structure will have its height increased every 12 months to ensure it is between 0.5m and 4m above the tailings level

Based on the client's advice the TSF2 is safe to walk when dry, so installation and planned maintenance of the sprinklers inside the Tailings Dam will be undertaken when the surface is dry.

Should maintenance be required when the surface is wet then a hovercraft will be used to access the sprinklers.

SPRAY SYSTEM OPERATION

3.1. Spray System Operation Constraints

The following are the design constraints on the system operation:

- Sime Mariner takes 180 seconds (at 5 bar) to rotate 360 degrees
- Sime Mariner delivers the following amount of water
  - ~1L per m2 in 6 minutes in 360 degree operation
  - ~1L per m2 in 3 minutes in 180 degree operation
- Sime Mariner uses 130m3/hr
- Sprinklers located and have arc coverage as shown on layout drawing.
  - 16 sprinklers rotating 180 degrees on outside of TSF2
  - 8 sprinklers rotating 360 degrees on inside of TSF2
- To deliver an adequate amount of crusting agent typically requires 2L per m2

3.2. Spray System Operation Detail

To deliver 2L per m2 for all the sprinklers requires a sprinkler run time of 192 minutes. To enable the system to deliver the 2L per m2 in one hour requires 4 sprinklers to run simultaneously.

With 4 sprinklers running simultaneously it will be able to deliver the 2L per m2 in 48 minutes.

3.3. Piping

The following are the piping requirements for this project (to support the delivery of 2L per m2 in 48 minutes). Please see 6. Appendix: System Pressure Calculations for summary of the system pressure loss calculations:

3.3.1. Sprinkler Support Piping

The piping to support the sprinkler will be 100mm pipe. This pipe will start at 4m high and be increased annually to ensure it is between 0.5m and 4m above the tailings level. The system has been designed to support a maximum pipe height of 15m from initial installation level.

3.3.2. Pipe from Sprinkler Support Base to TSF2 Ring Main

The sprinkler that are positioned in the TSF2 are connected to the TSF2 Ring Main using up to 100m of 200mm PN12.5 Metric Poly

3.3.3. TSF2 Ring Main

A ring main will run around the TSF2. Sprinklers located on the outside of the TSF2 will be connected to the ring main with a short piece of flexible rubber hose. Those that are located in the TSF2 will be connected as per the previous section.

3.3.4. Pipe from Pump / Mil Tank to Ring Main

The pipe from the Tank / Pump will need to be 400mm PN12.5 Thermopipe to accommodate the flow rates required to run 4 sprinklers simultaneously (520m3/hr) and to account for variability in pump pressure (up to 9.9 bar) and temperature derating of the pipe (9.9 bar at 45 degree C)

3.3.5. Piping Air Relief

Air relief valves will be located periodically and at high points along the main pipeline and ring main.

3.4. Pumping

The pumping system needs to be able to supply 520m3 per hour at a pressure of 9 bar.

We would recommend the site standard for pumps be used to ensure site support and spares. If the site does not have a site standard we would recommend the Grundfos NBG pumps due to their reputation, reliability and Australia wide support.

Grundfos NBG 150-125-250/265 2 Pole 200kW

Two identical pumps will be installed, wired and plumbed within the pumping room with the ability to quickly switch between the pumps should a pump fail.

A diesel generator will be available to provide backup power should mains electricity not be available to the pumps.

3.5. Water Supply

The water supply will be comprised of the following elements which are maintained at capacity using float valves:

- The New Mill Tank will have a capacity of 2.5ML and will be constructed for this project at the mill to add to the capacity of the existing Mill Raw Water Tank.
- The Existing Mill Raw Water Tank has a total capacity of 1.4ML of which 30% (0.4ML is reserved for firefighting). The Mill currently uses 0.1ML per day. This mean that there is 0.9ML available in this tank for the TSF Spray System. This tank is supplied from the Silver Tank at a rate of 1.7ML per 24hr period.
- The Silver Tank has a capacity of 6.4ML storage tank of which 0.7ML is used per day by the site (plus 0.1ML used by the mill). This is supplied from the town raw mains water at a rate of up to 1.2ML per day.

In summary, there is 3.4ML of water in the Mill tanks available for the TSF2 spray system plus an inflow of 1.7ML per day.

A single application of 2mm of water to the TSF2 will utilise 0.42ML. The average pan evaporation rate during summer is 12mm. To supply the equivalent of 12mm through the spray system would use 2.5ML per day.

This would allow almost 3 days of spraying water at 12mm per day before the spray system requirements outstripped the storage and inflows. See 7. Appendix: Mill Tank Water Level

The Silver Tank (6.4ML) would have the capacity to support the 1.7ML transfer to the Mill Tanks and 0.7ML of site usage (plus 0.1ML at the Mill). The inflow from the town raw water supply has historically been capable of at least 1.2ML per day.

Assuming max transfers of 1.7ML from the Silver Tank to the Mill Tanks per day, the capacity of the Silver Tank would provide 6 days of capacity with normal inflows or 2.5 days capacity with no inflows from the town supply.

3.6. Crusting Agent

The system will have the capacity to apply a crusting agent to the TSF2 through the sprinkler spray system.

This will be used for expected extreme conditions beyond the capability of the water sprays or in the event of extended conditions needing dust suppression when the water supply is predicted to be exhausted.

This will be used when the identified criteria are triggered - refer BHOP monitoring protocol. Criteria that will be considered include predictions of prolonged windy conditions, wind speed and water level remaining in tank.

The crusting agent will be delivered by a dosing system that injects the appropriate amount of crusting agent based on the system water flow.

The dosing system will have a variable speed pump controlled by a flow meter on both the water line and crusting agent supply line to ensure the correct concentration is dosed.

It will require 1 application of 2L per sqm of water (0.42ML) dosed with the crusting agent to crust the TSF2. This will take 48 minutes. It may be possible to only crust the dry parts of the TSF2 which are likely to release dust.

3.7. Control System

The control system will be based around an Allen Bradley PLC. The PLC will take inputs from:

- Air Quality Monitoring System (either individual sensors or from system)
- Users
- Main Line Flow Meter

The PLC will control the:

- Pump
- Dosing System
- Electric Valves which control water to individual sprinklers.

The PLC will also provide warnings such as:

- No water flow on mainline (eg Pump failure)
- Low water flow on mainline (eg sprinkler valve does not open)
- High water flow on mainline (eg sprinkler valve fails open)
- No dosing chemical (eg valve on dosing chemical tank closed)
- Sensor / communications failure

3.7.1. Bermad Valve

Each sprinkler will be controlled by its own Electric Valve. We have selected the Bermad 400 Series 150mm Ductile Iron Polymer Coated Valve as it is a high quality valve used commonly throughout the mining industry in Australia and throughout the world for this sort of application.

The 150mm version was selected as it would have (what we consider to be an acceptable) pressure loss of 0.09 bar when operating with a flow of 130m3/hr.

Valves for sprinklers located in the TSF2 will be located on the ring main to ensure easy access for maintenance or manual operation.

All valves will also have a lockable manual butterfly valve for physical isolation.

MAINTENANCE & TESTING

The system will be tested by running through each sprinkler monthly. The test system will be designed to run for 30 minutes to ensure that it is possible to check the full rotation performance of each sprinkler while minimise the amount of water used for the test.

RISKS

Risk	**Control**
Lack of reliability of town water supply	The existing Mill Raw Water Tank and New Mill Tank will be kept full. The Silver Tank is kept full and has more than 6 days storage capacity of maximum predicted usage including spraying the TSF2 use with normal inflows. The Silver Tank has 2.5 days of storage with the same usage and no inflows from the town raw water supply.
Pump failure	Backup pumps will be wired and plumbed so they can be easily switch over should the primary pump fail for both the Silver Tank to Mill Tanks supply pump and for the TSF spray system pump.
Electric supply failure	A diesel generator will be available to power the pumps should the mains electricity fail
Sprinkler / valve failure	The system will be tested monthly. It will be possible to access the wet areas of the TSF2 using a hovercraft for maintenance or during operation.
Increasing height of the TSF2	The height of the sprinklers inside the TSF will be increased each year to ensure they stay above the tailings
Control system failure	The pump will be able to be manually started and individual valves can be manually opened and closed – without power.
Ongoing extreme dust causing conditions	The crusting agent will be able to seal the tailings dam to prevent dust lift off. Triggers will be outlined in BHOP Monitoring Protocol.

Appendix: System Pressure Calculations

The following illustrates the pressure loss calculations in a worst-case model.

Item	Pressure Required	Pressure Total
Mariner located at 325 RL in middle of TSF2	7.00	7.00
Riser Piping for Mariner 130m3/hr , 15m x 4” pipe	0.32	7.32
Pipe from Mariner located in TSF2 to Ring Main 130m3/hr, 100m x 200mm PN12.5 Poly	0.13	7.45
Bermad 150mm Valve 130m3/hr	0.09	7.54
Ring Main 520m3/hr, 1,500m x 315mm PN12.5 Poly	0.34	7.88
Elevation Change from TSF2 325RL and New Mill Tank 315RL	1.0	8.38
Supply Pipe from New Mill Tank to TSF2 520m3/hr, 50m x 400mm PN2.5 Poly	0.05	8.93
Required Pump Pressure		**8.43 bar**

Appendix: Mill Tank Water Level

The following illustrates the water level of the Mill Storage Tanks when the TSF is being sprayed.

Day @ Time	Description	Water In	Water Out	Mill Storage Level
Day 1: 9:00	Starting Mill Storage available			3.4
Day 1: 10:00	Apply 2mm to TFSF2	0.07	0.42	3.05
Day 1: 11:00	Inflow from Silver Tank	0.07	0	3.12
Day 1: 12:00	Apply 2mm to TFSF2	0.07	0.42	2.77
Day 1: 13:00	Inflow from Silver Tank	0.07	0	2.84
Day 1: 14:00	Apply 2mm to TFSF2	0.07	0.42	2.49
Day 1: 15:00	Inflow from Silver Tank	0.07	0	2.56
Day 1: 16:00	Apply 2mm to TFSF2	0.07	0.42	2.21
Day 1: 17:00	Inflow from Silver Tank	0.07	0	2.28
Day 1: 18:00	Apply 2mm to TFSF2	0.07	0.42	1.93
Day 1: 19:00	Inflow from Silver Tank	0.07	0	2
Day 1: 20:00	Inflow from Silver Tank	0.07	0	2.07
Day 1: 21:00	Apply 2mm to TFSF2	0.07	0.42	1.72
Day 1: 22:00	Inflow from Silver Tank	0.07	0	1.79
Day 1: 23:00	Inflow from Silver Tank	0.07	0	1.86
Day 1: 24:00	Inflow from Silver Tank	0.07	0	1.93
Day 2: 1:00	Inflow from Silver Tank	0.07	0	2
Day 2: 2:00	Inflow from Silver Tank	0.07	0	2.07
Day 2: 3:00	Inflow from Silver Tank	0.07	0	2.14
Day 2: 4:00	Inflow from Silver Tank	0.07	0	2.21
Day 2: 5:00	Inflow from Silver Tank	0.07	0	2.28
Day 2: 6:00	Inflow from Silver Tank	0.07	0	2.35
Day 2: 7:00	Inflow from Silver Tank	0.07	0	2.42
Day 2: 8:00	Inflow from Silver Tank	0.07	0	2.49
Day 2: 9:00	Mill Daily Use	0.07	0.1	2.46
Day 2: 10:00	Apply 2mm to TFSF2	0.07	0.42	2.11
Day 2: 11:00	Inflow from Silver Tank	0.07	0	2.18
Day 2: 12:00	Apply 2mm to TFSF2	0.07	0.42	1.83
Day 2: 13:00	Inflow from Silver Tank	0.07	0	1.9
Day 2: 14:00	Apply 2mm to TFSF2	0.07	0.42	1.55
Day 2: 15:00	Inflow from Silver Tank	0.07	0	1.62
Day 2: 16:00	Apply 2mm to TFSF2	0.07	0.42	1.27
Day 2: 17:00	Inflow from Silver Tank	0.07	0	1.34
Day 2: 18:00	Apply 2mm to TFSF2	0.07	0.42	0.99
Day 2: 19:00	Inflow from Silver Tank	0.07	0	1.06

Day @ Time	Description	Water In	Water Out	Mill Storage Level
Day 2: 20:00	Inflow from Silver Tank	0.07	0	1.13
Day 2: 21:00	Apply 2mm to TFSF2	0.07	0.42	0.78
Day 2: 22:00	Inflow from Silver Tank	0.07	0	0.85
Day 2: 23:00	Inflow from Silver Tank	0.07	0	0.92
Day 2: 24:00	Inflow from Silver Tank	0.07	0	0.99
Day 3: 1:00	Inflow from Silver Tank	0.07	0	1.06
Day 3: 2:00	Inflow from Silver Tank	0.07	0	1.13
Day 3: 3:00	Inflow from Silver Tank	0.07	0	1.2
Day 3: 4:00	Inflow from Silver Tank	0.07	0	1.27
Day 3: 5:00	Inflow from Silver Tank	0.07	0	1.34
Day 3: 6:00	Inflow from Silver Tank	0.07	0	1.41
Day 3: 7:00	Inflow from Silver Tank	0.07	0	1.48
Day 3: 8:00	Inflow from Silver Tank	0.07	0	1.55
Day 3: 9:00	Mill Daily Use	0.07	0.1	1.52
Day 3: 10:00	Apply 2mm to TFSF2	0.07	0.42	1.17
Day 3: 11:00	Inflow from Silver Tank	0.07	0	1.24
Day 3: 12:00	Apply 2mm to TFSF2	0.07	0.42	0.89
Day 3: 13:00	Inflow from Silver Tank	0.07	0	0.96
Day 3: 14:00	Apply 2mm to TFSF2	0.07	0.42	0.61
Day 3: 15:00	Inflow from Silver Tank	0.07	0	0.68
Day 3: 16:00	Apply 2mm to TFSF2	0.07	0.42	0.33
Day 3: 17:00	Inflow from Silver Tank	0.07	0	0.4
Day 3: 18:00	Apply 2mm to TFSF2	0.07	0.42	0.05
Day 3: 19:00	Inflow from Silver Tank	0.07	0	0.12
Day 3: 20:00	Inflow from Silver Tank	0.07	0	0.19
Day 3: 21:00	Not Enough to Apply 2mm	0.07	0.42	-0.16

APPENDIX: WET EARTH PROFILE

Wet Earth has been operating since 2004 and focused on dust control in mining since 2006.

Wet Earth philosophy has always been to find the best solution to our customers' problems. This has resulted in the continual increase in our product range as customer identified new problems we needed to solve. This has resulted in Wet Earth being unique in the Australian market place as we can provide a vast range of different solutions to dust problems including:

- Fog Cannons® for airborne dust control
- DustExNet® for containment of dust
- Chemicals that can be applied to prevent the lift off of dust
- Automated spray systems to prevent the lift off of dust
- Nozzles & misting systems to prevent and control dust

Wet Earth has partnerships with leading international dust control solution providers to ensure it provides the best solutions to its customers. Some of these companies include:

- Ecology Srl (www.ecology.it)
- RST - Reynold Soil Technology (www.rstsolutions.com.au)
- Spraying Systems (www.spray.com)

Wet Earth continues to provide dust control solutions to leading mining companies including:

- BHP Billiton;
- Barrick Gold;
- Bechtel;
- Birla;
- BMA;
- CITIC Pacific;
- Ensham Resources;
- Fortescue Metal Group;
- Glencore Xstrata;
- Goldfields;
- Hillgrove Resources;
- MMG;
- MacMahon;
- NCIG;
- New Gold;
- Newcrest Mining Ltd;
- Newmont;
- Nystar;
- Rio Tinto;
- Sibelco;
- Thiess;
- Whitehaven Coal;

8.1. Key Personnel

Nicholas Marks

Nicholas has a Bachelor of Electrical Engineering and spent a number of years in corporate and operational roles at BHP Billiton before moving into Electronic Commerce and ultimately founding Wet Earth.

Nicholas experience with safety, environmental management and quality systems at BHP Billiton gave him a thorough understanding of the corporate requirements of mining companies.

The engineering mindset allows Nicholas to be solution focused when working with clients.

Stephen Martin

Stephen has a Bachelor of Science and spent a number of years in operational roles within agriculture, the food industry and irrigation before founding Wet Earth.

Similar to Nicholas, Stephens experience in the corporate environment has given him a thorough understanding of the requirements of mining companies.

Stephen also has a very technical mindset which has helped drive Wet Earths solution focused approach.

8.2. Relevant Project

The following are some of the larger spray system projects Wet Earth has undertaken using the Sime Mariner sprinklers:

- BMA Peak Downs: 2 x Waste Water Evaporation Projects
  144 Sime Skippers
  60 Sime Mariners
- BMA Saraji: 3 x Waste Water Evaporation Projects
  68 Sime Skipper
  58 Sime Mariner
  99 Sime Mariners
- Citic Pacific Mining: Stockpile Spray System:
  88 Sime Mariners
- Glencore Koniambo: Stockpile Spray System
  88 Sime Mariners
- FMG Cloudbreak
  21 Sime Mariners & 5 other Sime Sprinklers

8.3. Project History in Photos

BMA Peak Downs Tailings Dam Waste Water Evaporation

Viva Energy Stack Demolition Dust Suppression

BHP Billition Iron Ore: Yandi, Area C, Eastern Ridge, Jimblebar

Haul Road Dust Control – DustWorx Dosing System

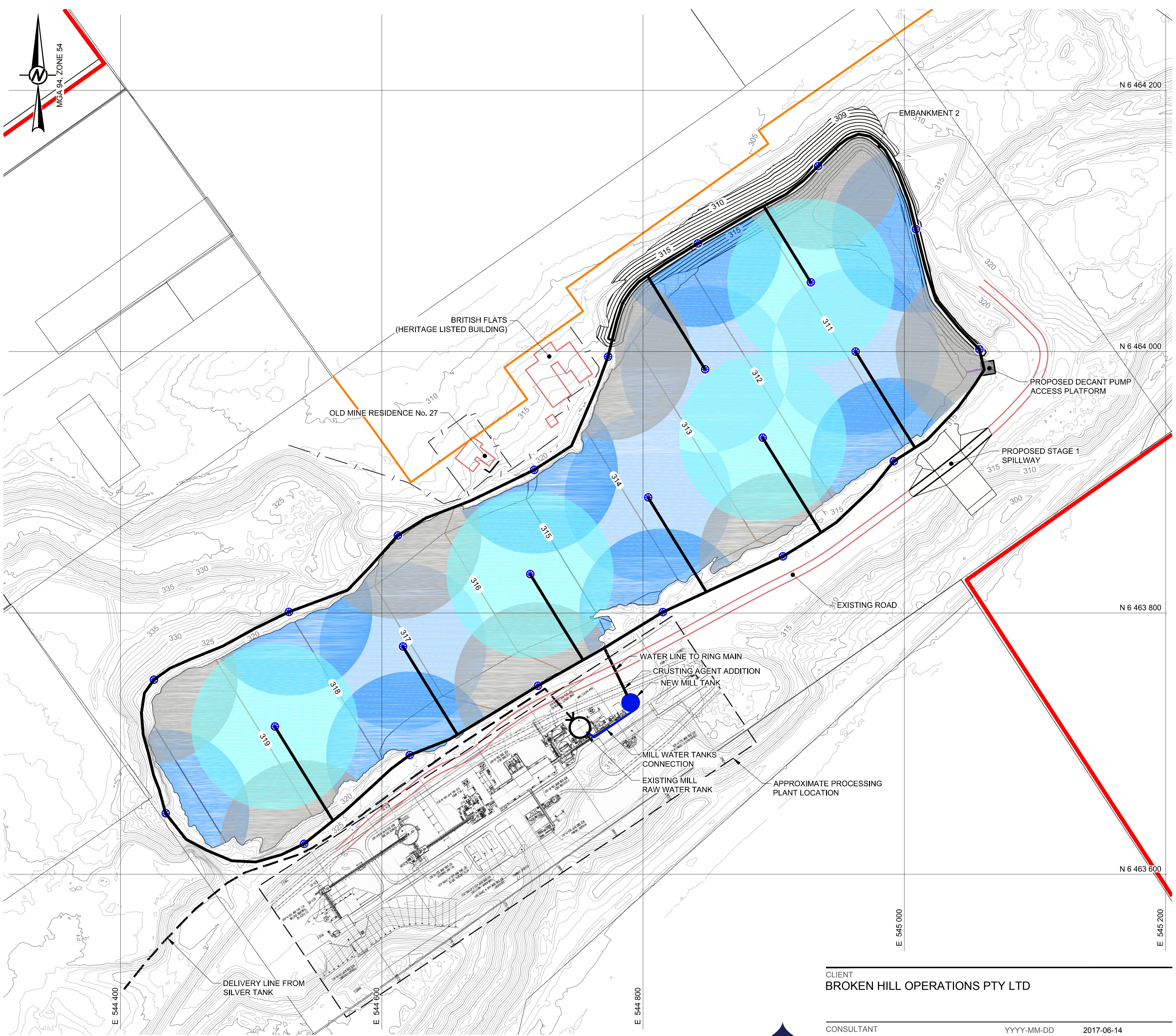
Barminco Underground Fog Cannon Dust Control

NCIG Fog Cannon Dust Control

BHP Mt Keith ROM Pad Dust Control

CITIC Pacific Mining Sino Project Mine Stockpile Dust Control

Rio Tinto Tom Price Fog Cannon



LEGEND

- EXISTING CONTOURS AT 1 m INTERVALS
- PROPOSED EMBANKMENT CONTOURS AT 1 m INTERVALS
- ANTICIPATED INTERMEDIATE TAILINGS CONTOURS AT 1 m INTERVALS
- DUST SUPPRESSION SPRINKLER LOCATION
- THROW RADIUS (TYP. 64 m) WITH OVERLAP
- LEASE BOUNDARY EXTENT
- SURVEYED CML7 SURFACE EXCLUSION BOUNDARY
- RING MAIN (BY OTHERS)

NOTE(S)

1. ALL LEVELS ARE REFERENCED IN METRES TO AUSTRALIAN HEIGHT DATUM (m AHD).

REFERENCE(S)

EXISTING SURVEY SHOWN FROM FILES: 160425 Tailings Dam 1m Contours.dxf AND 160425 RASP Tailings Dam Area.dxf (1 m CONTOURS), RECEIVED FROM CBH RESOURCES ON 11 MAY 2016.

SITE BOUNDARIES SHOWN FROM FILES: mga_cml7_lease_bdy.dwg, surf_leases_mga.dxf, RECEIVED FROM CBH RESOURCES ON 11 MAY 2016.

CML SURFACE EXCLUSION BOUNDARY SHOWN FROM FILES: GFH_D2319.DXF AND GFH_M25352.dxf, RECEIVED FROM CBH RESOURCES ON 22 AUGUST 2016.

APPROXIMATE PROCESSING PLANT LOCATION PROVIDED BY CBH RESOURCES, DRAWING: "RMP100M002", DATED: 20 OCTOBER 2011, RECEIVED: 7 JUNE 2017.

NOT FOR CONSTRUCTION

0 50 100
1:3,000 METRES

CLIENT
BROKEN HILL OPERATIONS PTY LTD

CONSULTANT

WET EARTH

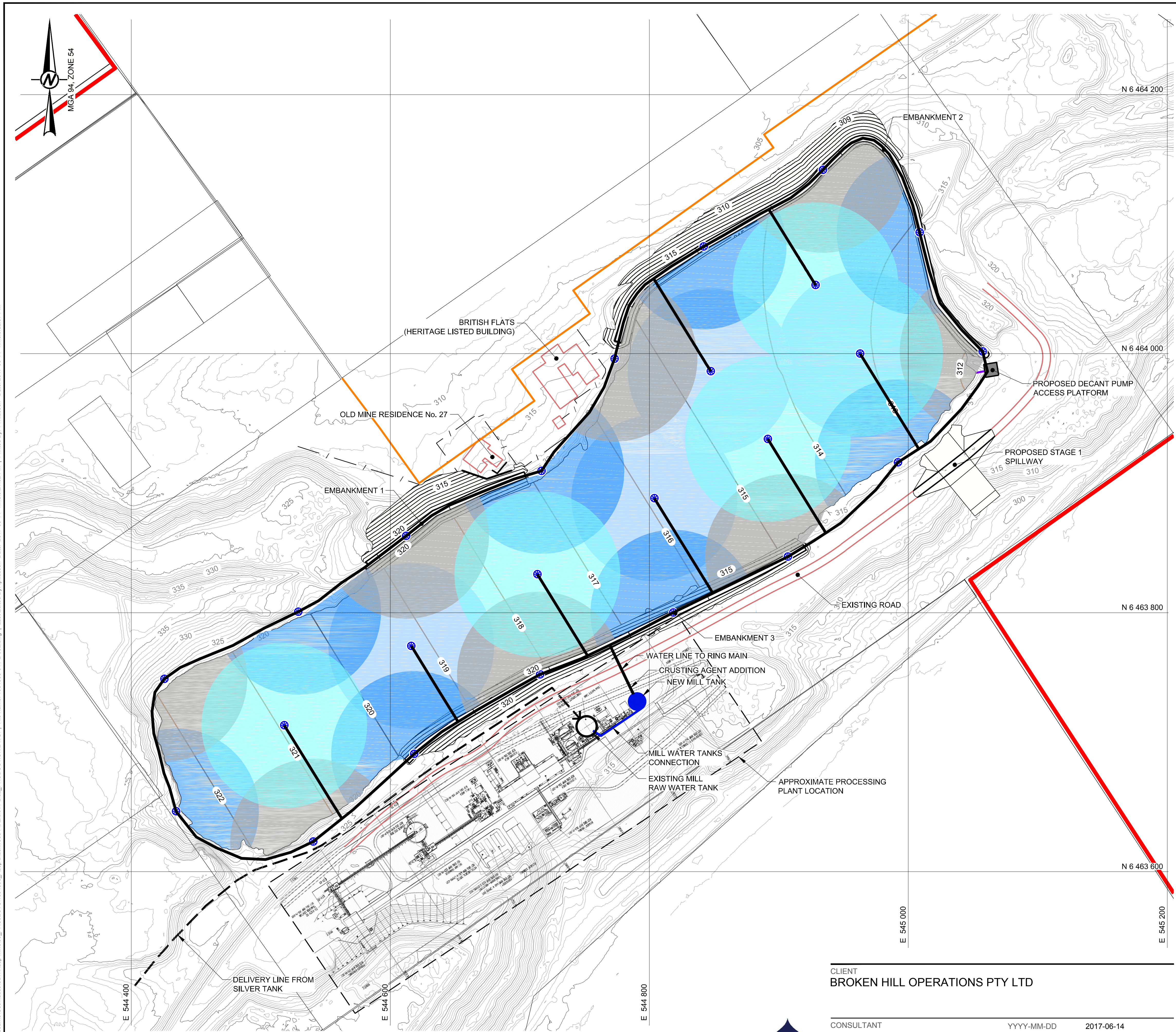
Golder Associates

YYYY-MM-DD	2017-06-14
DESIGNED	GRP
PREPARED	TAK
REVIEWED	FWG
APPROVED	FWG

PROJECT
BLACKWOOD PIT TAILINGS STORAGE FACILITY
RASP MINE, BROKEN HILL

TITLE
PROPOSED DUST SUPPRESSION SYSTEM AT STAGE 1

PROJECT NO.	CONTROL	REV.	FIGURE
1654895	011-L	3	1



LEGEND

	EXISTING CONTOURS AT 1 m INTERVALS
	PROPOSED EMBANKMENT CONTOURS AT 1 m INTERVALS
	ANTICIPATED FINAL TAILINGS CONTOURS AT 1 m INTERVALS
	DUST SUPPRESSION SPRINKLER LOCATION
	THROW RADIUS (TYP. 64 m) WITH OVERLAP
	LEASE BOUNDARY EXTENT
	SURVEYED CML7 SURFACE EXCLUSION BOUNDARY
	RING MAIN (BY OTHERS)

NOTE(S)

1. ALL LEVELS ARE REFERENCED IN METRES TO AUSTRALIAN HEIGHT DATUM (m AHD).

REFERENCE(S)

EXISTING SURVEY SHOWN FROM FILES: 160425 Tailings Dam 1m Contours.dxf AND 160425 RASP Tailings Dam Area.dxf (1 m CONTOURS), RECEIVED FROM CBH RESOURCES ON 11 MAY 2016.

SITE BOUNDARIES SHOWN FROM FILES: mga_cml7_lease_bdy.dwg, surf_leases_mga.dxf, RECEIVED FROM CBH RESOURCES ON 11 MAY 2016.

CML SURFACE EXCLUSION BOUNDARY SHOWN FROM FILES: GFH_D2319.DXF AND GFH_M25352.dxf, RECEIVED FROM CBH RESOURCES ON 22 AUGUST 2016.

APPROXIMATE PROCESSING PLANT LOCATION PROVIDED BY CBH RESOURCES, DRAWING: "RMP100M002", DATED: 20 OCTOBER 2011, RECEIVED: 7 JUNE 2017.

NOT FOR CONSTRUCTION

0 50 100
1:3,000 METRES

CLIENT
BROKEN HILL OPERATIONS PTY LTD

PROJECT
BLACKWOOD PIT TAILINGS STORAGE FACILITY
RASP MINE, BROKEN HILL

CONSULTANT

YYYY-MM-DD	2017-06-14
DESIGNED	GRP
PREPARED	TAK
REVIEWED	FWG
APPROVED	FWG

TITLE
PROPOSED DUST SUPPRESSION SYSTEM AT STAGE 2

PROJECT NO.	CONTROL	REV.	FIGURE
1654895	011-L	3	2

Appendix D
Particulate monitoring calibration certificates

Calibration certificates

ecotech

Ecotech Document Control
EMS 727 - 1405 - D
Date: 16/11/2015

1405-D TEOM Calibration Report

Notes:

Customer	Broken Hill Operations Pty Ltd
Instrument	TEOM 1405
ID No.	1405A213841103
System/Job No.	

Calibration Performed by	Marios Foukaridis	
Date	4-May-16	
Time Begin/End	10:25	14:05
Location	Blackwoods Pit.	

Test Equipment

	TE Number	Cal Due	Result
Flow Calibrator*	TE-353	23/05/2016	PASS
Temperature Calibrator	TE-352	8/08/2016	PASS
Pressure Calibrator	TE-565	17/05/2016	PASS
RH Calibrator	TE-516	15/08/2016	PASS
Digital Multimeter			Missing TE or Cal Due Date

* Note: If using a DryCal with Base Unit and Cells, record the ID of both base unit and cell(s) above.

Flow Audit and Leak Check (3-Monthly)

Virtual Impactor?	NO

Note: Virtual Impactor is attached between the sample head PM10 and splitter sample line

As-Found Flow Audit

Total Flow at inlet (16.67 L/min)		N/A

Note: Flow check must be within 2% of the setpoint for a pass

As-Found Leak Check

	Reading (L/min)	PASS/FAIL
Main Flow	0.09	PASS
PATH B (PM_{coarse})		N/A
BYPASS	0.15	PASS

Note: Do not fill the shaded cells

Note: If either the flow audit or leak check fails, repair any leaks and repeat the flow and leak checks until they pass. Perform the flow verification and complete the post maintenance check.

Flow Verification Using Wizard

	Main Flow (L/min)	PATH B (PM_{coarse}) Flow (L/min)	BYPASS Flow (L/min)
Reference Flow	3.01		13.85
Previous F-Adj Factor	1.000		0.989
Current F-Adj Factor	1.000		1.000
% drift since last Cal.	0.0%		0.2%
Result	PASS	N/A	PASS

Note: If the flow verification fails, a full calibration must be performed

Flow Calibration (6-Monthly)

Ambient Sensors

	Displayed	Reference	Error	Result
Temperature (°C)	17.53	17.6	0.07	PASS
Pressure (atm)	0.971	0.9693	-0.0017	PASS
RH				N/A

Note: Temperature error must be within 1°C
Pressure error must be within 0.00987 atm (7.5mmhg)
RH error must be within 4%

Page 1 of 2

Flow Multipoint Calibration

Main Flow (L/min)		PATH B (PM_{coarse}) Flow (L/min)		BYPASS Flow (L/min)	
Set Flow	Reference	Set Flow	Reference	Set Flow	Reference
3	3.001			13.67	13.65

Note: Do not fill in the shaded cells

Post Calibration Check

Main Flow (L/min)		PATH B (PM_{coarse}) Flow (L/min)		BYPASS Flow (L/min)	
Set Flow	Reference	Set Flow	Reference	Set Flow	Reference
3.00	3.001			13.67	13.65
Result	PASS	Result	N/A	Result	PASS

Note: Do not fill in the shaded cells

Total Flow at inlet (16.67 L/min)	16.65	PASS

Note: All flow errors must be within 2% of the set point

12-Monthly Calibration

K_0 Verification

Filter S/N	23849-1

	Stated K_0	Audit Filter Mass	Audit K_0	% Difference	Pass/Fail
$PM_{2.5}$	16992	0.9493	17492.3	2.9%	FAIL
PM_{coarse}					N/A

Zero Check	Date	Time
Zero Check Start		
Zero Check End		

Post Maintenance Check

Final Leak Check

	Reading (L/min)	PASS/FAIL
Main Flow	0.08	PASS
PATH B (PM_{coarse})		N/A
BYPASS	0.15	PASS

Note: Do not fill in the shaded cells

Technician Signature:		Date	4/05/2016

Page 2 of 2

ecotech

Ecotech Document Control
EMS 727 - 1405 - D
Date: 16/11/2015

1405-D TEOM Calibration Report

Notes:
Ambient Temperature sensor connected directly to the instrument as the extension cable is broken. A quotation will be sent for replacement.

Customer	Broken Hill Operations Pty Ltd
Instrument	TEOM 1405
ID No.	1405A213611103
System/Job No.	

Calibration Performed by	Marios Foukaridis	
Date	5-May-16	
Time Begin/End	08:00	10:20
Location	Essential water	

Test Equipment

	TE Number	Cal Due	Result
Flow Calibrator*	TE-353	23/05/2016	PASS
Temperature Calibrator	TE-352	8/08/2016	PASS
Pressure Calibrator	TE-565	17/05/2016	PASS
RH Calibrator	TE-516	15/08/2016	PASS
Digital Multimeter			Missing TE or Cal Due Date

* Note: If using a DryCal with Base Unit and Cells, record the ID of both base unit and cell(s) above.

Flow Audit and Leak Check (3-Monthly)

Virtual Impactor?	NO

Note: Virtual Impactor is attached between the sample head PM10 and splitter sample line

As-Found Flow Audit

Total Flow at inlet (16.67 L/min)		N/A

Note: Flow check must be within 2% of the setpoint for a pass

As-Found Leak Check

	Reading (L/min)	PASS/FAIL
Main Flow	0.04	PASS
PATH B (PM_{coarse})		N/A
BYPASS	0.4	PASS

Note: Do not fill the shaded cells

Note: If either the flow audit or leak check fails, repair any leaks and repeat the flow and leak checks until they pass. Perform the flow verification and complete the post maintenance check.

Flow Verification Using Wizard

	Main Flow (L/min)	PATH B (PM_{coarse}) Flow (L/min)	BYPASS Flow (L/min)
Reference Flow	2.93		13.22
Previous F-Adj Factor	1.000		1.000
Current F-Adj Factor	0.976		0.960
% drift since last Cal.	2.3%		3.3%
Result	PASS	N/A	PASS

Note: If the flow verification fails, a full calibration must be performed

Flow Calibration (6-Monthly)

Ambient Sensors

	Displayed	Reference	Error	Result
Temperature (°C)	23.3	23.3	0	PASS
Pressure (atm)	0.968	0.9678	-0.0002	PASS
RH				N/A

Note: Temperature error must be within 1°C
Pressure error must be within 0.00987 atm (7.5mmhg)
RH error must be within 4%

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Flow Multipoint Calibration

Main Flow (L/min)		PATH B (PM_{coarse}) Flow (L/min)		BYPASS Flow (L/min)	
Set Flow	Reference	Set Flow	Reference	Set Flow	Reference
3	2.998			13.67	13.68

Note: Do not fill in the shaded cells

Post Calibration Check

Main Flow (L/min)		PATH B (PM_{coarse}) Flow (L/min)		BYPASS Flow (L/min)	
Set Flow	Reference	Set Flow	Reference	Set Flow	Reference
3.00	2.998			13.67	13.69
Result	PASS	Result	N/A	Result	PASS

Note: Do not fill in the shaded cells

Total Flow at inlet (16.67 L/min)	16.68	PASS

Note: All flow errors must be within 2% of the set point

12-Monthly Calibration

K_0 Verification

Filter S/N	23849-1

	Stated K_0	Audit Filter Mass	Audit K_0	% Difference	Pass/Fail
$PM_{2.5}$	17527	0.9493	17823.9	1.7%	PASS
PM_{coarse}					N/A

Zero Check	**Date**	**Time**
Zero Check Start		
Zero Check End		

Post Maintenance Check

Final Leak Check

	Reading (L/min)	PASS/FAIL
Main Flow	0.02	PASS
PATH B (PM_{coarse})		N/A
BYPASS	0.23	PASS

Note: Do not fill in the shaded cells

Technician Signature:		Date	5/05/2016

Page 2 of 2

ecotech

Ecotech Document Control
Doc. ID: EMS 0578
Date: 5/05/2015

High Volume Air Sampler 3000 Volumetric Calibration Report

Note:

Customer	Broken Hill Operations Pty Ltd
Instrument	Hi-Vol 3000
ID No.	15-0504
System/Job No.	

Calibration Performed by	Marios Foukaridis	
Date	5-May-16	
Time Begin/End	9:00	10:30
Location	HiVol 1-Silver tank	

Calibration Equipment

Orifice Plate	596
Volumetric Orifice Const.	3.242

	TE Number	Cal Due	PASS/FAIL
Manometer	TE 0565	17/05/2016	PASS
Digital Barometer	TE 0565	17/05/2016	PASS
Digital Thermometer	TE 0352	15/08/2016	PASS

Instrument Parameters - Hidden Menu (Pre Calibration)

Flow Coeff 0		-6.0000
Flow Coeff 1		25.0000
Flow Coeff 2		1.9000
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0173
Temp Coeff 2	-2 to +2	0.0006

Press Coeff 0	50 to 100	80.2
Press Coeff 1	168.7	168.7
WS Coeff 0		0.0
WS Coeff 1		0.8
WD Coeff 0		0.0
WD Coeff 1		79.1

Instrument Parameters - Setup Menu (Pre Calibration)

Set Flow	70.0
Ref Temp (°C)	20.0

Ref BP (mmHg)	760.0
S/W Version	V2.18

Pre-Calibration check

	Reference Sensor			Instrument	Difference		Pass / Fail
Ambient Temp	26.1			28.0	-1.9	°C	Calibrate
Ambient Press	742.4	mmHg	742.4	735.0	7.4	mmHg	PASS

Note: Temperature shall be ± 1 degC of reference
Note: Pressure shall be ± 7.5 mmHg of reference
If the temperature or pressure sensors require re-calibration, perform the flow check and then adjust the coefficients

Flow Calibration Check:

	mmH2O	kPa
Expected (calculated) ΔH	154.3	1.51

Hour run meter initial	
Start Time	

	Display Reading (m3/hr)	Manometer reading (mmH2O)	Calculated Flow (m3/hr)	Error (%)	PASS / FAIL
Actual sample flow rate (blank filter fitted)	70	82	51.0	-27.1%	FAIL

Note: Precalibration check shall be within 10% of expected value

Page 1 of 2

Temperature and Pressure Calibration

Calibration required	REQUIRED

New Calculated coefficients	Coefficient 0	Coefficient 1	Coefficient 2
Temperature	Do Not Adjust	0.0186	0.0007
Pressure	87.6	Do Not Adjust	N/A

Apply new coefficients and re-test.

	Reference Sensor			Instrument	Difference		Pass / Fail
Ambient Temp	26.1			26.1	0.0	°C	PASS
Ambient Press	735	mmHg	735.0	735.1	-0.1	mmHg	PASS

Flow Calibration

	Initial ΔH (mmH2O)	Expected ΔH (mmH2O)	Final ΔH (mmH2O)	Sensor Voltage (V)
Calibration Point 1 (60 m3/hr)	80	113.3	113.0	2.9300
Calibration Point 2 (70 m3/hr)	95	154.3	153.0	3..5
Calibration Point 3 (80 m3/hr)	115	201.5	192.0	3.8800

Post Calibration Check

	Display Reading (m3/hr)	Manometer reading (mmH2O)	Calculated Flow (m3/hr)	Error (%)	PASS / FAIL
Actual sample flow rate (blank filter fitted)	70	153	69.7	-0.4%	PASS

Note: Post calibration check shall be within 3% of expected value

Hour run meter final	
Finish Time	

Instrument Parameters - Hidden Menu (Post Calibration)

Flow Coeff 0		94.5200
Flow Coeff 1		-36.5300
Flow Coeff 2		8.4262
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0185
Temp Coeff 2	-2 to +2	0.0007

Press Coeff 0	50 to 100	73.2
Press Coeff 1	168.7	168.7
WS Coeff 0		0.0
WS Coeff 1		0.8
WD Coeff 0		0.0
WD Coeff 1		79.1

Technicians Signature		Date	5/05/2015

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Ecotech Document Control
Doc. ID: EMS 0578
Date: 5/05/2015

High Volume Air Sampler 3000 Volumetric Calibration Report

Note:

Customer	Broken Hill Operations Pty Ltd
Instrument	Hi-Vol 3000
ID No.	15-0708
System/Job No.	

Calibration Performed by	Marios Foukaridis	
Date	4-May-16	
Time Begin/End	16:00	17:30
Location	HiVol 2 - Silver tank	

Calibration Equipment

Orifice Plate	596
Volumetric Orifice Const.	3.242

	TE Number	Cal Due	PASS/FAIL
Manometer	TE 0565	17/05/2016	PASS
Digital Barometer	TE 0565	17/05/2016	PASS
Digital Thermometer	TE 0352	15/08/2016	PASS

Instrument Parameters - Hidden Menu (Pre Calibration)

Flow Coeff 0		-6.0000
Flow Coeff 1		25.0000
Flow Coeff 2		1.9000
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0173
Temp Coeff 2	-2 to +2	0.0006

Press Coeff 0	50 to 100	80.2
Press Coeff 1	168.7	168.7
WS Coeff 0		0.0
WS Coeff 1		0.8
WD Coeff 0		0.0
WD Coeff 1		6.0

Instrument Parameters - Setup Menu (Pre Calibration)

Set Flow	70.0
Ref Temp (°C)	20.0

Ref BP (mmHg)	760.0
S/W Version	V2.18

Pre-Calibration check

	Reference Sensor			Instrument	Difference		Pass / Fail
Ambient Temp	24.3			20.0	4.3	°C	Calibrate
Ambient Press	733.2	mmHg	733.2	735.1	-1.9	mmHg	PASS

Note: Temperature shall be ± 1 degC of reference
Note: Pressure shall be ± 7.5 mmHg of reference
If the temperature or pressure sensors require re-calibration, perform the flow check and then adjust the coefficients

Flow Calibration Check:

	mmH2O	kPa
Expected (calculated) ΔH	153.3	1.50

Hour run meter initial	
Start Time	

	Display Reading (m3/hr)	Manometer reading (mmH2O)	Calculated Flow (m3/hr)	Error (%)	PASS / FAIL
Actual sample flow rate (blank filter fitted)	70	85	52.1	-25.5%	FAIL

Note: Precalibration check shall be within 10% of expected value

Page 1 of 2

Temperature and Pressure Calibration

Calibration required	REQUIRED

New Calculated coefficients	Coefficient 0	Coefficient 1	Coefficient 2
Temperature	Do Not Adjust	0.0142	0.0004
Pressure	78.28	Do Not Adjust	N/A

Apply new coefficients and re-test.

	Reference Sensor			Instrument	Difference		Pass / Fail
Ambient Temp	19.9			20.0	-0.1	°C	PASS
Ambient Press	735.2	mmHg	735.2	735.1	0.1	mmHg	PASS

Flow Calibration

	Initial ΔH (mmH2O)	Expected ΔH (mmH2O)	Final ΔH (mmH2O)	Sensor Voltage (V)
Calibration Point 1 (60 m3/hr)	80	112.6	113.0	2.9100
Calibration Point 2 (70 m3/hr)	95	153.3	154.0	3.5800
Calibration Point 3 (80 m3/hr)	115	200.2	201.0	4.0800

Post Calibration Check

	Display Reading (m3/hr)	Manometer reading (mmH2O)	Calculated Flow (m3/hr)	Error (%)	PASS / FAIL
Actual sample flow rate (blank filter fitted)	70	154	70.2	0.2%	PASS

Note: Post calibration check shall be within 3% of expected value

Hour run meter final	
Finish Time	

Instrument Parameters - Hidden Menu (Post Calibration)

Flow Coeff 0		75.5120
Flow Coeff 1		-21.4300
Flow Coeff 2		5.5420
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0186
Temp Coeff 2	-2 to +2	0.0007

Press Coeff 0	50 to 100	69.5
Press Coeff 1	168.7	168.7
WS Coeff 0		0.0
WS Coeff 1		0.8
WD Coeff 0		0.0
WD Coeff 1		79.1

Technicians Signature		Date	4/05/2015

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Ecotech Document Control
Doc. ID: EMS 0578
Date: 5/05/2015

High Volume Air Sampler 3000 Volumetric Calibration Report

Note:
Temperature sensor were missing. Found late 5th of May 2016 and Unit had properly calibrated.

Customer	Broken Hill Operations Pty Ltd
Instrument	Hi-Vol 3000
ID No.	07-0910
System/Job No.	

Calibration Performed by	Marios Foukaridis	
Date	5-May-16	
Time Begin/End	14:00	15:30
Location	HiVol 3 Blackwood pit	

Calibration Equipment

Orifice Plate	596
Volumetric Orifice Const.	3.242

	TE Number	Cal Due	PASS/FAIL
Manometer	TE 0565	17/05/2016	PASS
Digital Barometer	TE 0565	17/05/2016	PASS
Digital Thermometer	TE 0352	15/08/2016	PASS

Instrument Parameters - Hidden Menu (Pre Calibration)

Flow Coeff 0		-55.4500
Flow Coeff 1		55.3770
Flow Coeff 2		-4.4760
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0173
Temp Coeff 2	-2 to +2	0.0006

Press Coeff 0	50 to 100	68.0
Press Coeff 1	168.7	168.7
WS Coeff 0		0.0
WS Coeff 1		0.8
WD Coeff 0		0.0
WD Coeff 1		79.1

Instrument Parameters - Setup Menu (Pre Calibration)

Set Flow	70.0
Ref Temp (°C)	20.0

Ref BP (mmHg)	760.0
S/W Version	V2.18

Pre-Calibration check

	Reference Sensor			Instrument	Difference		Pass / Fail
Ambient Temp	23.4			-42.5	65.9	°C	Calibrate
Ambient Press	733.2	mmHg	733.2	735.1	-1.9	mmHg	PASS

Note: Temperature shall be ± 1 degC of reference
Note: Pressure shall be ± 7.5 mmHg of reference
If the temperature or pressure sensors require re-calibration, perform the flow check and then adjust the coefficients

Flow Calibration Check:

	mmH2O	kPa
Expected (calculated) ΔH	153.8	1.51

Hour run meter initial	
Start Time	

	Display Reading (m3/hr)	Manometer reading (mmH2O)	Calculated Flow (m3/hr)	Error (%)	PASS / FAIL
Actual sample flow rate (blank filter fitted)	69.9	80	50.5	-27.8%	FAIL

Note: Precalibration check shall be within 10% of expected value

Temperature and Pressure Calibration

Calibration required	REQUIRED

New Calculated coefficients	Coefficient 0	Coefficient 1	Coefficient 2
Temperature	Do Not Adjust	-0.0314	0.0020
Pressure	66.09	Do Not Adjust	N/A

Apply new coefficients and re-test.

	Reference Sensor			Instrument	Difference		Pass / Fail
Ambient Temp	23.4			23.4	0.0	°C	PASS
Ambient Press	735	mmHg	735.0	735.0	0.0	mmHg	PASS

Flow Calibration

	Initial ΔH (mmH2O)	Expected ΔH (mmH2O)	Final ΔH (mmH2O)	Sensor Voltage (V)
Calibration Point 1 (60 m3/hr)	60	113.0	113.0	3.2500
Calibration Point 2 (70 m3/hr)	87	153.8	153.0	3.9000
Calibration Point 3 (80 m3/hr)	90	200.8	200.0	4.3800

Post Calibration Check

	Display Reading (m3/hr)	Manometer reading (mmH2O)	Calculated Flow (m3/hr)	Error (%)	PASS / FAIL
Actual sample flow rate (blank filter fitted)	70	153	69.8	-0.2%	PASS

Note: Post calibration check shall be within 3% of expected value

Hour run meter final	
Finish Time	

Instrument Parameters - Hidden Menu (Post Calibration)

Flow Coeff 0		62.8100
Flow Coeff 1		-15.4200
Flow Coeff 2		4.4405
Temp Coeff 0	0.3810	0.3810
Temp Coeff 1	-2 to +2	0.0173
Temp Coeff 2	-2 to +2	0.0006

Press Coeff 0	50 to 100	69.5
Press Coeff 1	168.7	168.7
WS Coeff 0		0.0
WS Coeff 1		0.8
WD Coeff 0		0.0
WD Coeff 1		79.1

Technicians Signature		Date	5/05/2015

Page 2 of 2

Appendix E
Rasp Mine Field Analyses Report

14 March 2017

Gwen Wilson
Broken Hill Operations Pty Ltd

Dear Gwen,

Re: Rasp Mine Wind Erosion Field Testing

1 INTRODUCTION

Pacific Environment has been commissioned by Broken Hill Operations Pty Ltd (BHOP), a wholly owned subsidiary of CBH Resources Ltd (CBH), to undertake a field survey of wind erosion potential from exposed surface areas at the Rasp Mine, Broken Hill (the Site).

The Rasp Mine is an underground silver/zinc/lead operation located within the city limits of Broken Hill, NSW. The Mine also has the facilities to process the ore and dispatch concentrate products from the site by rail. There are a number of auxiliary facilities including maintenance workshops, inventory, chemical and explosives storage, backfill plant and rail siding.

BHOP is currently seeking to modify the Rasp Mine approval to:

- Install a Concrete Batching Plant (CBP) for the manufacture of fibrecrete and concrete for use at the Mine site; and
- Extend the life of the Blackwood Pit Tailings Storage Facility ('the TSF') by installing embankments and a retaining wall at low points along its perimeter.

During the operational phase of the TSF, tailings are progressively pumped as a slurry into the pit. Given that the TSF is both open to ambient environment, and contains heavy metals, the potential for tailings material to be mobilised during wind erosion events is of interest.

Relevant to wind erosion potential, the in-situ tailings material is typically saturated with moisture, or alternatively dried to a crusted surface. Both of these conditions act to restrict the amount of material that is able to be mobilised during wind erosion events.

To provide a quantitative understanding of these effects, a field analysis has been undertaken, as documented within this letter.

2 TESTING METHODS

This field testing has been completed with the specific objectives of identifying:

- The control efficiency (expressed as a percentage of uncontrolled conditions) of moisture and crusting in restricting particulate emissions from wind erosion.
- The specific meteorological conditions under which wind erosion has the potential occur.

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Two testing methods have been applied to achieve these objectives. These are:

- The Confined Air Burst Chamber for measuring relative control efficiency; and
- The USEPA AP-42 sieving method for determination of threshold friction velocity.

Detail of these methods is provided in the following sections.

2.1 Confined Air Burst Chamber (CABC) for Measuring Relative Control Efficiency

MRIGlobal has developed a test method known as the 'Confined Air Burst Chamber' (CABC) test **(Cowherd, 2012)**. This is a simple, semi-quantitative technique that can be used to characterise the relative dust emission potential of various surface types subject to wind erosion, and the effectiveness of measures for controlling dust. The method provides an estimate of the percentage control efficiency of control techniques such as the seeding of overburden dumps or the use of chemical dust suppressants.

The method can be used to estimate either the relative dust emission potential of different surface types, or the effectiveness of measures for controlling dust on a given surface type (% Control Efficiency). In the latter case, the method is reliant on a measurement for a base case 'uncontrolled' scenario, against which the control efficiency is quantified.

The CABC test is designed to produce a cloud of dust within a small, open-floored sampling chamber (volume = 9.4 litres; diameter = 200 mm, height = 300 mm) by forcing a jet of air onto the test surface (**Figure**).

The chamber is connected by a tube to a hand pump equipped with a pressure gauge, and the tube is fitted with a valve release switch. The pump is used to pressurise the tube, and once the pressure has reached a set value the valve is opened and air is forced onto the test surface. An open orifice prevents the build-up of pressure in the chamber during the injection period.

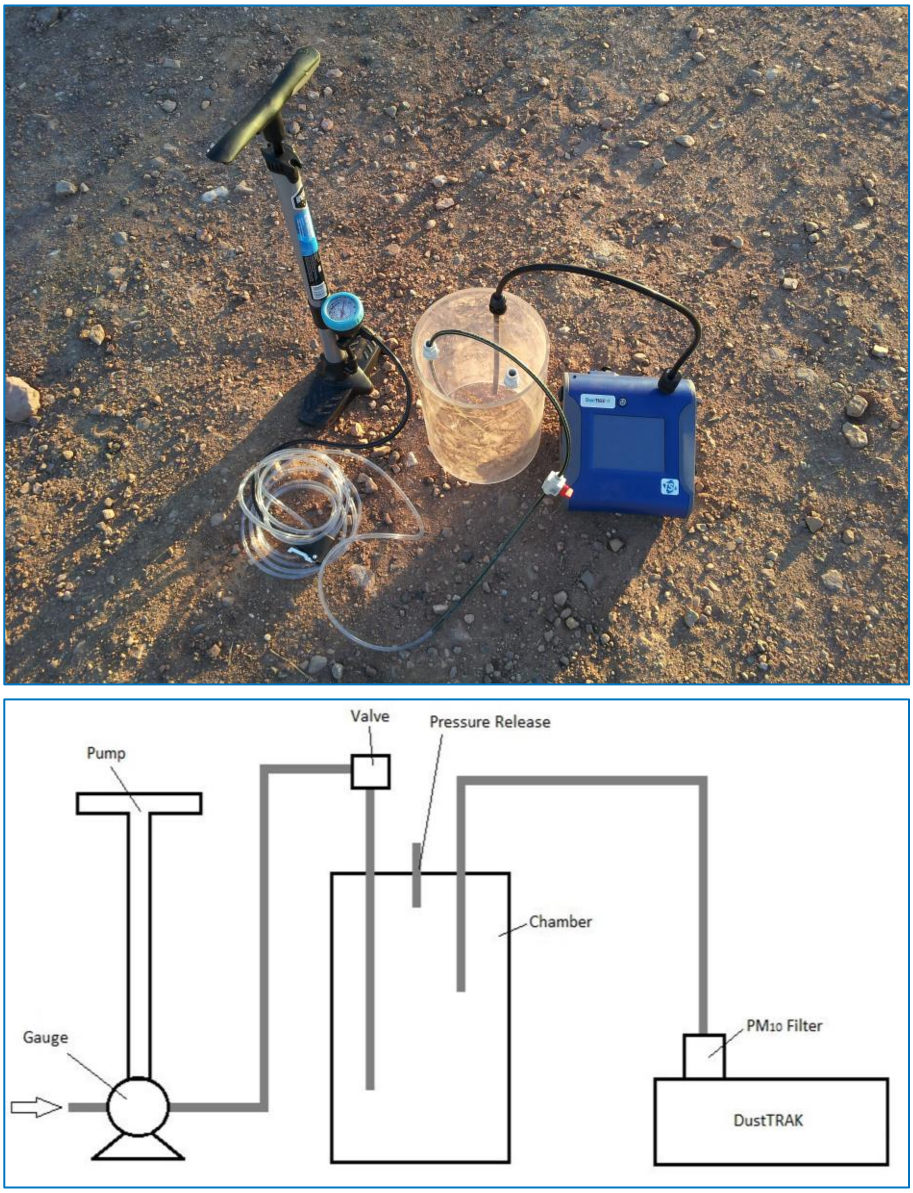

Figure 1: Confined air burst chamber test equipment and schematic

The disturbance of particulate causes the production of (often visible) dust within the chamber. A portable battery-operated laser photometer records the time history of the particulate matter less than 10 micrometres in aerodynamic diameter (PM_{10}) concentration in the chamber following the injection of air (**Figure 2**).

The maximum[1] PM_{10} concentration in the chamber is applied as being representative of the amount of particulate matter on the surface that is available to be eroded (*i.e.* the emission potential of the surface).

[1] The peak PM_{10} concentrations in CABC tests are generally higher than the atmospheric concentrations generated during high winds. This is because the vertical forces created by the air burst are much larger than those created by wind passing over the surface.

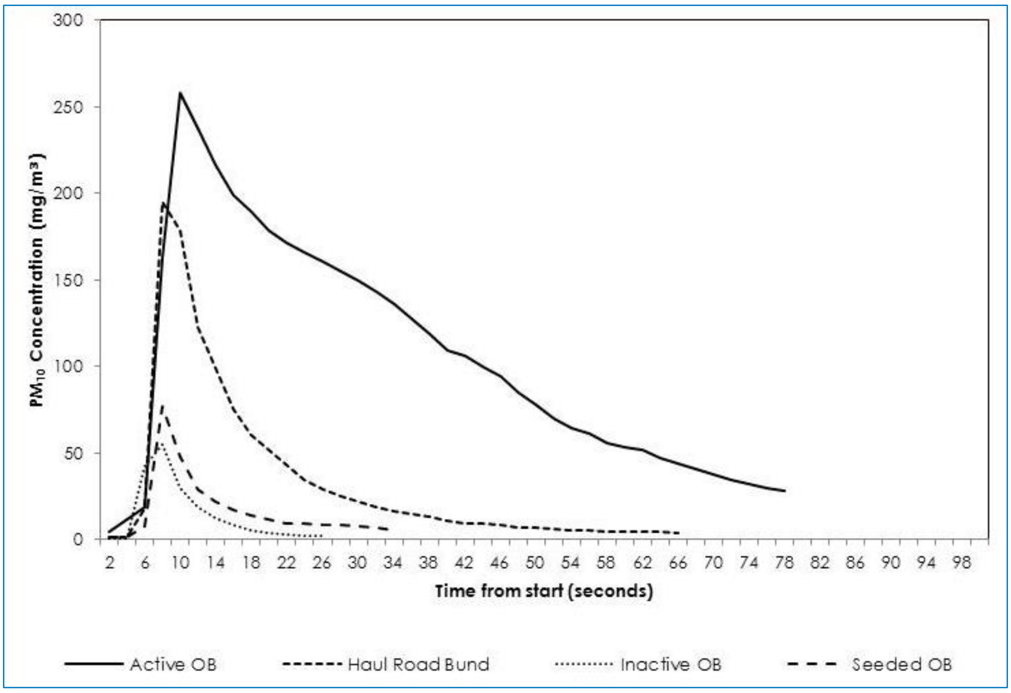

Figure 2 - Example of PM_{10} concentration profiles in CABC test

2.2 USEPA Sieving Test for Determination of Threshold Friction Velocity

Section 13.2.5 of (USEPA, 2006) *AP-42 Compilation of Air Pollutant Emission Factors* provides the methodology for the determination of site-specific threshold friction velocities based on a sieving method. At a high level, the method involves the following:

- Collecting a representative sample of material from the surface to be tested.
- Sieving of the material through a graded set of five stacked Tyler sieves (sizes: 4.0, 2.0, 1.0, 0.5, 0.25 mm and base plate).
- Inspection of the relative quantities of material within each sieve with identification of the mode sieve (the sieve containing the largest proportion of the sample).

Figure 3 provides an example of the USEPA sieving test, with the mode sieve indicated by the position of the hand trowel.

Figure 3 - Example of the USEPA sieving method (mode sieve indicated by position of hand trowel)

Table 1 presents the designation of liftoff surface friction velocity threshold by sieve mode (USEPA, 2006). The lift-off wind speed threshold is presented for an elevation of 10 m above ground level using Equation 4 of USEPA (2006).

Table 1 –Designation of lift-off threshold velocity by sieve mode

Sieve Mode (mm)	Particle Midpoint (mm)	Lift-off Surface Friction Velocity Threshold (m/s)	Lift-off Wind Speed* Threshold (m/s)
4.0	-	-	-
2.0	3	1.00	18.9
1.0	1.5	0.76	14.3
0.5	0.75	0.58	10.9
0.25	0.375	0.43	8.1

*Wind speed at 10 m above ground level.

3 FIELD TESTING

Testing was conducted on in-situ samples at various areas on the Site. A total of 56 CABC tests and four sieve tests were conducted in dry weather between the 10th and 11th of November 2016.

USEPA Sieve testing was conducted for the following surfaces:

- Dry tailings
- Dry fines in drainage gullies
- Wet tailings
- Dry tailings (repeat)

The CABC testing covered the materials and emission controls outlined in **Table 2**.

Table 2 – Summary of erosion surfaces and control measures tested using CABC method

Erosion Surface	Control Measure
Tailings storage facility	Crusting
	Maintenance of moisture content
	Covering with waste rock
Uncontrolled free areas	Crusting
	Dust suppressant (aged)
Unsealed (active) areas	Crusting
	Dust suppressant (fresh)

4 RESULTS

This section presents the results of the testing for both CABC and USEPA sieving methods.

4.1 CABC Testing

Table 3, 4 and **5** present the results of the CABC testing for tailings, uncontrolled free areas and unsealed areas (respectively).

Table 3 – Wind erosion control efficiencies: Tailings storage

Erosion Surface	Control Measure	Efficiency
Tailings (dry, disturbed) – Base Case	N/A	N/A
Tailings (dry, crusted)	Crusting	99.7%
Tailings (wet)	Maintenance of moisture content	100.0%
Waste rock	Covering with waste rock	99.7%

N/A: Not Applicable to base case measurement.

Table 4 – Wind erosion control efficiencies: Uncontrolled free areas

Erosion Surface	Control Measure	Efficiency
Uncontrolled free area (dry, disturbed) – Base Case	N/A	N/A
Uncontrolled free area (dry, crusted)	Crusting	96.6
Uncontrolled free area (5 month old RST Total Ground Control)	Dust suppressant (aged)	98.9

N/A: Not Applicable to base case measurement.

Table 5 – Wind erosion control efficiencies: Unsealed areas

Erosion Surface	Control Measure	Efficiency
Unsealed area (dry, disturbed) – Base Case	N/A	N/A
Unsealed area (dry, crusted)	Crusting	90.0
Unsealed area (fresh dust suppressant).	Dust suppressant (fresh)	99.2

N/A: Not Applicable to base case measurement.

4.2 USEPA Sieve Testing

Table 6 presents the results of the USEPA sieving method to derive lift-off threshold wind speeds for tailings under various conditions.

Table 6 – Results of USEPA Sieve Testing

Sieve Test	Erosion Surface	Tyler Sieve Mode (Opening - mm)	Lift-off Threshold Wind Speed* (m/s)

#1	Dry tailings	1 mm	14.3
#2	Dry fines in drainage gullies	0.5 mm	10.9
#3	Wet tailings	> 4mm	N/A
#4	Dry tailings	1 mm	14.3

*Wind speed at 10 m above ground level.

5 CONCLUSIONS

Based on the testing undertaken, the following conclusions are made:

5.1 Tailings Storage

The results of the testing indicate that observed levels of moisture at the TSF are adequate for operational dust control. For moist surfaces within the TSF, the CABC testing indicated a 100% control efficiency, whilst the USEPA sieving method classified the material as being non-conducive to wind erosion. Dry, crusted areas were also observed to provide a high level of control relative to disturbed surfaces, equivalent to the proposed final waste rock cover.

The above conclusion assumes that crusted tailings remain undisturbed, however. On that basis, the use of waste rock cover is considered a more resilient, and less readily disturbed surface for the long-term containment of TSF material after the point at which the TSF is no longer active.

The field testing can be used to inform future operational dust control measures for the TSF, as follows:

- The threshold wind velocity for TSF material has been determined empirically and can be used for future alerts / alarms when combined with local wind speed observations.
- Selective use of dust suppressant in TSF spray system will aid control of the TSF when used in the proposed TSF spray system, particularly at the end of the TSF's operational life.
- Alerts / alarms can be set up on existing instrumentation to inform the use of TSF spray system
- As an additional safeguard, alerts can be set both for critical PM concentrations and wind velocities recorded in proximity to the TSF surface.

5.2 Uncontrolled Free Areas

The results of the testing indicate that natural crusting of unsealed surfaces observed within the uncontrolled free areas provides an effective reduction in wind erosion potential relative to disturbed material within the area. Beyond this, it was observed that the application of dust suppressant provides an additional level of control, combined with a more resilient, less readily disturbed surface, as observed 5 months after application.

Accordingly, the use of dust suppressants, and the restriction of vehicle movements to designated vehicle paths are considered effective dust emission controls applicable to the uncontrolled free areas.

5.3 Unsealed Areas

The results of the unsealed area testing indicate that observed natural crusting of the surface provides an effective reduction in wind erosion potential relative to disturbed soils within the area. Noting the disturbance of surface soils present on active haul roads, and the observed effectiveness of dust suppressants, it is considered that application of dust suppressant forms an effective means of minimising emissions from wind erosion from trafficked areas such as haul roads. The results also demonstrate the importance of restricting vehicle movements to designated vehicle paths where practicable.

Finally, control factors and threshold friction velocities established through the site-specific, empirical testing detailed above have been incorporated within the current atmospheric dispersion modelling, and are recommended to be adopted for any future characterisation of the site's atmospheric emission inventory.

Should you have any questions regarding this work, please do not hesitate to contact me.

Yours sincerely,

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6 REFERENCES

Cowherd (2012) *Procedure for Testing with Confined Air Burst Chamber*, Cowherd, MRIGlobal, Internal Report, 2012.

USEPA (2006) *AP-42 Compilation of Emission Factors, Section 13.2.5: Industrial Wind Erosion*, United States Environmental Protection Agency, 2006.

APPENDIX A. PHOTOGRAPHS OF TESTING LOCATIONS

Figure A1 – CABC Testing Locations: Tailings Storage

<table>
<tr><th>Dry Tailings – Disturbed (Base Case)</th><th>Dry Tailings – Crusted</th></tr>
<tr><td></td><td></td></tr>
<tr><th>Wet Tailings</th><th>Waste Rock Trial</th></tr>
<tr><td></td><td>
</td></tr>
</table>

Figure A2 – CABC Testing Locations: Uncontrolled Free Areas

Disturbed (Base Case)	Crusted
	

5 Month Old RST Total Ground Control

Figure A3 – CABC Testing Locations: Unsealed Areas

Disturbed (Base Case)	Crusted
	

Fresh RST Total Ground Control

Figure A4 – USEPA Sieving Tests

Test 1 - Dry Tailings

Test 2 - Dry fines in drainage gullies

Test 3 - Wet Tailings

Test 4 - Dry Tailings

Appendix F
Emission Source Characteristics

Emission Source Characteristics

Table 1-6 Emission Source Characteristics

Source type	Source number	Scenario	Description	Base Elevation (m)	X Coordinate (m)	Y Coordinate (m)
VOLUME	POINT1	Mod 4	TSF	299	544464	6463705
VOLUME	POINT2	Mod 4	TSF	299	544522	6463696
VOLUME	POINT3	Mod 4	TSF	298	544559	6463755
VOLUME	POINT4	Mod 4	TSF	296	544638	6463762
VOLUME	POINT5	Mod 4	TSF	296	544660	6463826
VOLUME	POINT6	Mod 4	TSF	294	544729	6463812
VOLUME	POINT7	Mod 4	TSF	293	544759	6463878
VOLUME	POINT8	Mod 4	TSF	300	544823	6463843
VOLUME	POINT9	Mod 4	TSF	292	544804	6463962
VOLUME	POINT10	Mod 4	TSF	292	544873	6463922
VOLUME	POINT11	Mod 4	TSF	301	544950	6463920
VOLUME	POINT12	Mod 4	TSF	290	544907	6464031
VOLUME	POINT13	Mod 4	TSF	290	544969	6464001
VOLUME	POINT1	Baseline	TSF	299	544464	6463705
VOLUME	POINT2	Baseline	TSF	299	544522	6463696
VOLUME	POINT3	Baseline	TSF	298	544559	6463755
VOLUME	POINT4	Baseline	TSF	296	544638	6463762
VOLUME	POINT5	Baseline	TSF	295	544660	6463826
VOLUME	POINT6	Baseline	TSF	294	544729	6463812
VOLUME	POINT7	Baseline	TSF	293	544759	6463878
VOLUME	POINT8	Baseline	TSF	300	544823	6463843
VOLUME	POINT9	Baseline	TSF	290	544804	6463962
VOLUME	POINT10	Baseline	TSF	291	544873	6463922
VOLUME	POINT11	Baseline	TSF	301	544950	6463920
VOLUME	POINT12	Baseline	TSF	290	544907	6464031

VOLUME	POINT13	Baseline	TSF	289	544969	6464001
VOLUME	POINT1	Mod 4	Mining activities	314	543270	6462082
VOLUME	POINT2	Mod 4	Mining activities	320	543260	6462166
VOLUME	POINT3	Mod 4	Mining activities	320	543338	6462291
VOLUME	POINT4	Mod 4	Mining activities	316	543427	6462369
VOLUME	POINT5	Mod 4	Mining activities	316	543500	6462463
VOLUME	POINT6	Mod 4	Mining activities	312	543562	6462583
VOLUME	POINT7	Mod 4	Mining activities	322	543640	6462739
VOLUME	POINT8	Mod 4	Mining activities	322	543672	6462870
VOLUME	POINT9	Mod 4	Mining activities	330	543698	6462974
VOLUME	POINT10	Mod 4	Mining activities	328	543745	6463031
VOLUME	POINT11	Mod 4	Mining activities	324	543875	6463094
VOLUME	POINT12	Mod 4	Mining activities	330	544006	6463172
VOLUME	POINT13	Mod 4	Mining activities	339	544115	6463251
VOLUME	POINT14	Mod 4	Mining activities	334	544225	6463303
VOLUME	POINT15	Mod 4	Mining activities	329	544350	6463376
VOLUME	POINT16	Mod 4	Mining activities	331	544428	6463433
VOLUME	POINT17	Mod 4	Mining activities	331	544501	6463532
VOLUME	POINT18	Mod 4	Mining activities	328	544590	6463595
VOLUME	POINT19	Mod 4	Mining activities	320	544689	6463657
VOLUME	POINT20	Mod 4	Mining activities	313	544777	6463741
VOLUME	POINT21	Mod 4	Mining activities	317	544897	6463798
VOLUME	POINT22	Mod 4	Mining activities	312	544997	6463876
VOLUME	POINT23	Mod 4	Mining activities	314	545085	6463949

VOLUME	POINT24	Mod 4	Mining activities	317	545075	6464033
VOLUME	POINT25	Mod 4	Mining activities	309	544997	6464106
VOLUME	POINT26	Mod 4	Mining activities	310	544944	6464168
VOLUME	POINT27	Mod 4	Mining activities	304	544845	6464095
VOLUME	POINT28	Mod 4	Mining activities	314	545085	6464168
VOLUME	POINT29	Mod 4	Mining activities	310	545226	6464205
VOLUME	POINT30	Mod 4	Mining activities	306	545294	6464179
VOLUME	POINT31	Mod 4	Mining activities	331	543677	6463110
VOLUME	POINT32	Mod 4	Mining activities	334	543682	6463245
VOLUME	POINT33	Mod 4	Mining activities	322	543635	6462776
VOLUME	POINT34	Mod 4	Mining activities	303	543562	6462687
VOLUME	POINT35	Mod 4	Mining activities	302	543442	6462609
VOLUME	POINT36	Mod 4	Mining activities	288	543369	6462661
VOLUME	POINT37	Mod 4	Mining activities	273	543395	6462792
VOLUME	POINT38	Mod 4	Mining activities	275	543474	6462917
VOLUME	POINT39	Mod 4	Mining activities	254	543484	6462833
VOLUME	POINT40	Mod 4	Mining activities	331	543682	6463313
VOLUME	POINT41	Mod 4	Mining activities	335	543703	6463282
VOLUME	POINT42	Mod 4	Mining activities	332	543667	6463277
VOLUME	POINT43	Mod 4	Mining activities	302	544904	6464116
VOLUME	POINT44	Mod 4	Mining activities	304	544778	6464020
VOLUME	POINT45	Mod 4	Mining activities	308	545021	6464036
VOLUME	POINT46	Mod 4	Mining activities	313	545056	6464000
VOLUME	POINT47	Mod 4	Mining activities	314	543270	6462082

VOLUME	POINT48	Mod 4	Mining activities	320	543260	6462166
VOLUME	POINT49	Mod 4	Mining activities	320	543338	6462291
VOLUME	POINT50	Mod 4	Mining activities	316	543427	6462369
VOLUME	POINT51	Mod 4	Mining activities	316	543500	6462463
VOLUME	POINT52	Mod 4	Mining activities	312	543562	6462583
VOLUME	POINT53	Mod 4	Mining activities	322	543640	6462739
VOLUME	POINT54	Mod 4	Mining activities	322	543672	6462870
VOLUME	POINT55	Mod 4	Mining activities	330	543698	6462974
VOLUME	POINT56	Mod 4	Mining activities	328	543745	6463031
VOLUME	POINT57	Mod 4	Mining activities	324	543875	6463094
VOLUME	POINT58	Mod 4	Mining activities	330	544006	6463172
VOLUME	POINT59	Mod 4	Mining activities	339	544115	6463251
VOLUME	POINT60	Mod 4	Mining activities	334	544225	6463303
VOLUME	POINT61	Mod 4	Mining activities	329	544350	6463376
VOLUME	POINT62	Mod 4	Mining activities	331	544428	6463433
VOLUME	POINT63	Mod 4	Mining activities	331	544501	6463532
VOLUME	POINT64	Mod 4	Mining activities	328	544590	6463595
VOLUME	POINT65	Mod 4	Mining activities	320	544689	6463657
VOLUME	POINT66	Mod 4	Mining activities	313	544777	6463741
VOLUME	POINT67	Mod 4	Mining activities	317	544897	6463798
VOLUME	POINT68	Mod 4	Mining activities	312	544997	6463876
VOLUME	POINT69	Mod 4	Mining activities	314	545085	6463949
VOLUME	POINT70	Mod 4	Mining activities	317	545075	6464033
VOLUME	POINT71	Mod 4	Mining activities	309	544997	6464106

VOLUME	POINT72	Mod 4	Mining activities	310	544944	6464168
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VOLUME	POINT76	Mod 4	Mining activities	306	545294	6464179
VOLUME	POINT77	Mod 4	Mining activities	331	543677	6463110
VOLUME	POINT78	Mod 4	Mining activities	334	543682	6463245
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VOLUME	POINT80	Mod 4	Mining activities	303	543562	6462687
VOLUME	POINT81	Mod 4	Mining activities	302	543442	6462609
VOLUME	POINT82	Mod 4	Mining activities	288	543369	6462661
VOLUME	POINT83	Mod 4	Mining activities	273	543395	6462792
VOLUME	POINT84	Mod 4	Mining activities	275	543474	6462917
VOLUME	POINT85	Mod 4	Mining activities	254	543484	6462833
VOLUME	POINT86	Mod 4	Mining activities	331	543682	6463313
VOLUME	POINT87	Mod 4	Mining activities	335	543703	6463282
VOLUME	POINT88	Mod 4	Mining activities	332	543667	6463277
VOLUME	POINT89	Mod 4	Mining activities	302	544904	6464116
VOLUME	POINT90	Mod 4	Mining activities	304	544778	6464020
VOLUME	POINT91	Mod 4	Mining activities	308	545021	6464036
VOLUME	POINT92	Mod 4	Mining activities	313	545056	6464000
VOLUME	POINT1	Baseline	Mining activities	297	545206	6464235
VOLUME	POINT2	Baseline	Mining activities	311	543254	6462085
VOLUME	POINT3	Baseline	Mining activities	314	543267	6462206

VOLUME	POINT4	Baseline	Mining activities	315	543361	6462336
VOLUME	POINT5	Baseline	Mining activities	313	543478	6462443
VOLUME	POINT6	Baseline	Mining activities	314	543575	6462550
VOLUME	POINT7	Baseline	Mining activities	307	543595	6462714
VOLUME	POINT8	Baseline	Mining activities	286	543441	6462623
VOLUME	POINT9	Baseline	Mining activities	262	543387	6462764
VOLUME	POINT10	Baseline	Mining activities	242	543458	6462904
VOLUME	POINT11	Baseline	Mining activities	226	543488	6462834
VOLUME	POINT12	Baseline	Mining activities	323	543280	6462383
VOLUME	POINT13	Baseline	Mining activities	319	543662	6462847
VOLUME	POINT14	Baseline	Mining activities	330	543725	6462988
VOLUME	POINT15	Baseline	Mining activities	325	543845	6463085
VOLUME	POINT16	Baseline	Mining activities	332	543972	6463152
VOLUME	POINT17	Baseline	Mining activities	331	544120	6463232
VOLUME	POINT18	Baseline	Mining activities	331	544213	6463292
VOLUME	POINT19	Baseline	Mining activities	331	544323	6463366
VOLUME	POINT20	Baseline	Mining activities	299	544511	6463349
VOLUME	POINT21	Baseline	Mining activities	330	544427	6463483
VOLUME	POINT22	Baseline	Mining activities	325	544521	6463593
VOLUME	POINT23	Baseline	Mining activities	318	544668	6463670
VOLUME	POINT24	Baseline	Mining activities	319	544818	6463733
VOLUME	POINT25	Baseline	Mining activities	317	544929	6463824
VOLUME	POINT26	Baseline	Mining activities	316	545025	6463911
VOLUME	POINT27	Baseline	Mining activities	316	545129	6463991

VOLUME	POINT28	Baseli ne	Mining activities	314	545022	6464094
VOLUME	POINT29	Baseli ne	Mining activities	306	545086	6464195
VOLUME	POINT30	Baseli ne	Mining activities	299	545109	6464302
VOLUME	POINT31	Baseli ne	Mining activities	298	545199	6464235
VOLUME	POINT32	Baseli ne	Mining activities	298	544574	6463349
VOLUME	POINT33	Baseli ne	Mining activities	297	544504	6463272
VOLUME	POINT34	Baseli ne	Mining activities	298	544574	6463349
VOLUME	POINT35	Baseli ne	Mining activities	297	544504	6463272
VOLUME	POINT36	Baseli ne	Mining activities	339	542976	6462600
VOLUME	POINT37	Baseli ne	Mining activities	341	542883	6462493
VOLUME	POINT38	Baseli ne	Mining activities	339	542933	6462393
VOLUME	POINT39	Baseli ne	Mining activities	339	542896	6462262
VOLUME	POINT40	Baseli ne	Mining activities	325	543123	6462804
VOLUME	POINT41	Baseli ne	Mining activities	332	543240	6462891
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VOLUME	POINT43	Baseli ne	Mining activities	327	543789	6463419
VOLUME	POINT44	Baseli ne	Mining activities	331	543658	6463315
VOLUME	POINT45	Baseli ne	Mining activities	317	543524	6463195
VOLUME	POINT46	Baseli ne	Mining activities	331	543615	6463145
VOLUME	POINT47	Baseli ne	Mining activities	341	543896	6462934
VOLUME	POINT48	Baseli ne	Mining activities	340	543862	6462827
VOLUME	POINT49	Baseli ne	Mining activities	341	543742	6462724
VOLUME	POINT50	Baseli ne	Mining activities	350	544049	6463359
VOLUME	POINT51	Baseli ne	Mining activities	350	544160	6463369

VOLUME	POINT52	Baseline	Mining activities	336	544337	6463763
VOLUME	POINT53	Baseline	Mining activities	338	544354	6463677
VOLUME	POINT54	Baseline	Mining activities	320	544557	6463596
VOLUME	POINT55	Baseline	Mining activities	325	544644	6463570
VOLUME	POINT56	Baseline	Mining activities	335	544567	6463486
VOLUME	POINT57	Baseline	Mining activities	333	544447	6463429
VOLUME	POINT58	Baseline	Mining activities	324	545122	6464098
VOLUME	POINT59	Baseline	Mining activities	322	545226	6464098
VOLUME	POINT60	Baseline	Mining activities	339	543016	6462410
VOLUME	POINT61	Baseline	Mining activities	340	542966	6462272
VOLUME	POINT62	Baseline	Mining activities	339	542926	6462219
VOLUME	POINT63	Baseline	Mining activities	318	542953	6462082
VOLUME	POINT64	Baseline	Mining activities	315	543143	6462062
VOLUME	POINT65	Baseline	Mining activities	324	543200	6462239
VOLUME	POINT66	Baseline	Mining activities	322	543290	6462376
VOLUME	POINT67	Baseline	Mining activities	329	543224	6462603
VOLUME	POINT68	Baseline	Mining activities	301	543431	6462490
VOLUME	POINT69	Baseline	Mining activities	329	543334	6462878
VOLUME	POINT70	Baseline	Mining activities	330	543534	6463021
VOLUME	POINT71	Baseline	Mining activities	240	543478	6462908
VOLUME	POINT72	Baseline	Mining activities	251	543397	6462734
VOLUME	POINT73	Baseline	Mining activities	288	543484	6462640
VOLUME	POINT74	Baseline	Mining activities	300	543595	6462837
VOLUME	POINT75	Baseline	Mining activities	331	543668	6463018

VOLUME	POINT76	Baseline	Mining activities	329	543738	6463322
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VOLUME	POINT79	Baseline	Mining activities	332	543996	6463188
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VOLUME	POINT81	Baseline	Mining activities	322	544397	6463272
VOLUME	POINT82	Baseline	Mining activities	299	544698	6463449
VOLUME	POINT83	Baseline	Mining activities	302	544755	6463586
VOLUME	POINT84	Baseline	Mining activities	318	544735	6463697
VOLUME	POINT85	Baseline	Mining activities	343	544283	6463626
VOLUME	POINT86	Baseline	Mining activities	317	544989	6463894
VOLUME	POINT87	Baseline	Mining activities	306	545062	6464211
VOLUME	POINT88	Baseline	Mining activities	306	545149	6464225
POINT	STCK1	Baseline	Vent	329	543616	6463201
POINT	STCK2	Baseline	Baghouse	318	544736	6463699
POINT	STCK3	Baseline	Vent6	326	543303	6462437

Table 1-7 Stack Source Characteristics

ID	Description	Height [m]	Diameter [m]	Exit Velocity [m/s]	Exit Temp [K]	Release Type
STCK1	Vent	4	4.73	10.4	22.75	HORIZONTAL
STCK2	Baghouse	5	0.7	19.78	0	VERTICAL
STCK3	Vent 6	8	4	4.9	23	VERTICAL

Table 1-8 Receptor Characteristics

Receptor ID	Y Coordinate (m)	X Coordinate (m)	Base Elevation (m)	Location

R1	544110	6462598	313	Piper Street North
R2	543763	6462312	309	Piper Street Central
R3	543555	6462322	312	Eyre Street North
R4	543324	6462003	310	Eyre Street Central
R5	543140	6461859	310	Eyre Street South
R6	542833	6462000	321	South Road
R7	542604	6462718	320	Carbon Lane
R8	542923	6462744	317	Old South Road
R9	542926	6463052	318	South Rd
R10	543158	6463633	315	Cnr Garnet & Blende Streets
R11	543150	6461692	307	Alma Bugldi Preschool
R12	543587	6461665	302	Playtime Pre-school
R13	543631	6461566	302	Alma Primary School
R14	543019	6463916	320	Broken Hill High School
R15	543133	6465290	311	Broken Hill Hospital
R16	544570	6465713	298	N. Broken Hill Primary School
R17	543245	6464378	318	Broken Hill Public School
R18	542815	6461151	303	Rainbow Pre-school
R19	544599	6466299	297	Willyama High School
R20	543420	6465782	313	Morgan Street Primary School
R21	544212	6462762	311	Eyre Street North
R22	544288	6462828	310	Eyre Street North
R23	544456	6462974	307	Eyre Street North
R24	544591	6463090	302	Eyre Street North
R25	544460	6462723	323	Water tank, Lawton Street #
R26	544723	6463208	300	Quarry offices
R27	544666	6463926	309	Proprietary Square
R28	544731	6463988	313	Proprietary Square
R29	544592	6464026	313	Iodide Street
R30	544728	6464112	312	Iodide Street
R31	544503	6464328	304	Crystal Street
R32	544637	6464415	302	Crystal Street
R33	545231	6464450	308	Brownes Shaft Dwelling
R34	543572	6463746	312	Crystal Street
R35	543748	6463873	311	Crystal Street
R36	543934	6464002	311	Crystal Street
R37	544127	6464141	309	Crystal Street
R38	542459	6462467	311	Gypsum Street
R39	542512	6462581	311	Gypsum Street

R40	543099	6463321	321	Silver City Hwy
R41	543249	6463439	320	Silver City Hwy
R42	543394	6463551	313	Silver City Hwy
R43	544679	6464220	306	Bowling Green
R44	544220	6461171	296	Playground
R45	543633	6461720	304	Playground
R46	542596	6460928	297	Playground
R47	543679	6464287	308	Playground
R48	544414	6465523	302	Playground
R49	544217	6466339	303	Playground

Appendix G
Details of TSF2 Decommissioning Phase

Decommissioning Phase

See below for information regarding the decommissioning strategy of the TSF2 provided by Broken Hill Operations Pty Ltd.

EA MOD4

10.10 Rehabilitation Strategy

The Mine rehabilitation strategy generally remains unchanged for this Modification. The existing / approved rehabilitation principles and objectives for the Mine are to return the site to suitable commercial and / or educational uses, preserving the heritage value of the site and heritage buildings as agreed with regulators, the community and the Mine.

The following mine specific rehabilitation objectives were developed in response to regulatory and community requirements and identified risks. These objectives are consistent with those listed in the current Project Approval, Schedule 3 Conditions 34 and 35:

- *Conserve heritage items, as agreed, and make them accessible;*
- *Undertake closure stormwater management initiatives to minimise erosion and restrict the potential for off-site pollution;*
- *Provide final landforms that are safe, stable, non-polluting and sympathetic to the mining heritage of Broken Hill;*
- *Install covers which enhance landform stability, minimise dust generation and adequately contain potentially hazardous material within the landform;*
- *Seal and/ or treat 'free areas' of the site and other potential sources of wind-blown dust to prevent the emission of dust following closure;*
- *Install barriers to restrict access to potentially hazardous locations (i.e. decline, shafts or open cut pits); and*
- *Meet the expectations and preferences, where possible, of the local community for post-mining land use for tourism.*

These rehabilitation objectives have yet to be agreed with DRE. The rehabilitation proposals provided below for the CBP and TSF2 are consistent with the DRE Rehabilitation Cost Estimate (RCE) required by the DRE in January 2015.

10.10.1 Concrete Batching Plant

The CBP would be erected in an area that is already highly disturbed and has been denuded of any vegetation. The area has been included in the current mine footprint. Along with all other non-heritage listed structures on CML7, the CBP would be demolished when the Mine ceases operation and waste rock would be placed over any areas that may have the capacity for dust entrainment by wind to reduce the potential for dust deposition over the township of Broken Hill. The noise abatement bund would be left in-situ as it is consistent with the current historic profile of the Hill and its removal would result in excessive unnecessary dust.

10.10.2 TSF2

The surrounding area of TSF2 is already highly disturbed and has been included in the original footprint disturbance. Embankment 1 would be placed partially over a small area close to the Old Mining Residence No. 27, which would result in an increase to the land disturbance footprint (0.2 Ha).

The primary objectives for closure of TSF2 are to manage the following:

- ***Safety** – providing a final surface, which does not expose the public to chemical and physical hazards, particularly from the generation of dust.*
- ***Stability** – ability for the landform to remain stable over an extended period beyond closure, e.g. withstand large earthquakes and flood events, as well as continuous erosion forces from air and water.*
- ***Seepage and groundwater** – managing infiltration such that transportation of contaminants either to groundwater and/or surface water bodies will not impact receptors adversely.*
- ***Erosion and sediment load** – resistance to wind and water energy which may degrade the final surface and result in transportation of sediments to the external environment.*
- ***Aesthetics** – ability to blend into the natural environment and support intended end land uses.*

In the final stages of tailings deposition the delivery system would be realigned to also discharge tailings from along the crest of Embankment 2 shaping the surface to direct runoff towards the spillway. The tailings beach surface near the spillway would be shaped by selective tailings placement from Embankment 2 to fill the environment containment freeboard to a point that the remaining depression below the spillway level would contain the 1:100 year 72 hour rainfall runoff event from the TSF2 catchment area.

Following deposition of the tailings to the designed level an application of chemical dust suppressant would be applied through the water spray system to minimise dust entrainment by wind while the tailings are allowed to settle and consolidate. Ponding water would be allowed to evaporate or be recirculated over the dryer part of the beach to remove the water from the low areas and promote drying of the tailings prior to the placement of cover material. It is expected that the tailings beach may be accessible for construction works within a few months after final placement of tailings.

The surface of the TSF2 would be covered progressively with waste rock sourced from Kintore Pit. Access over the tailing would be by end tipping the waste rock material on previously spread material with vehicles travelling on the previously placed material only. No vehicles would be permitted to travel directly on the tailings surface and disturb the dust control crust on the tailing surface. During these activities monitoring would continue from the monitoring station located adjacent to the Pit (and at other monitoring stations across the site).

A conceptual design of the cover layer has been prepared and comprises:

- *A 200 mm thick capillary break layer formed of screened waste rock placed over the tailings surface.*
- *A 300 mm thick cover formed of compacted run of mine waste rock. The mine waste rock would contain sufficient fines to create a well graded rockfill after compaction. The rockfill would be watered and compacted using heavy smooth drum compaction equipment. The cover would be robust and resistant to wind and water erosion. Studies would be conducted to determine if a further in-fill layer is required and the thickness of this additional layer (the current rehabilitation cover thickness allows for 1 m).*

The cover layer would be constructed over the entire tailings surface and be integrated into the in-situ rock on the Pit rim and the embankment rockfill. The surface would be shaped to shed water towards the low area near the spillway, with runoff in excess of 1 in 100 year events discharging through the spillway.

The embankments are designed with 2.5H:1V downstream slopes which are appropriate for closure and long term stability of the rockfill embankments. The embankments would be constructed from durable compacted rockfill. Wind and rain erosion of the embankments is expected to be minimal. No further rehabilitation of the downstream embankment slopes is envisaged.

Seepage flow rate from the collection system within the embankments will be monitored periodically. Where the seepage rate has stopped the sumps may be decommissioned and removed. Removed sumps and any other removed materials would be disposed as part of the mine rehabilitation procedure to underground voids or other tailings storage facility.

The proposed stormwater management of TSF2 at closure is presented in the figure below.

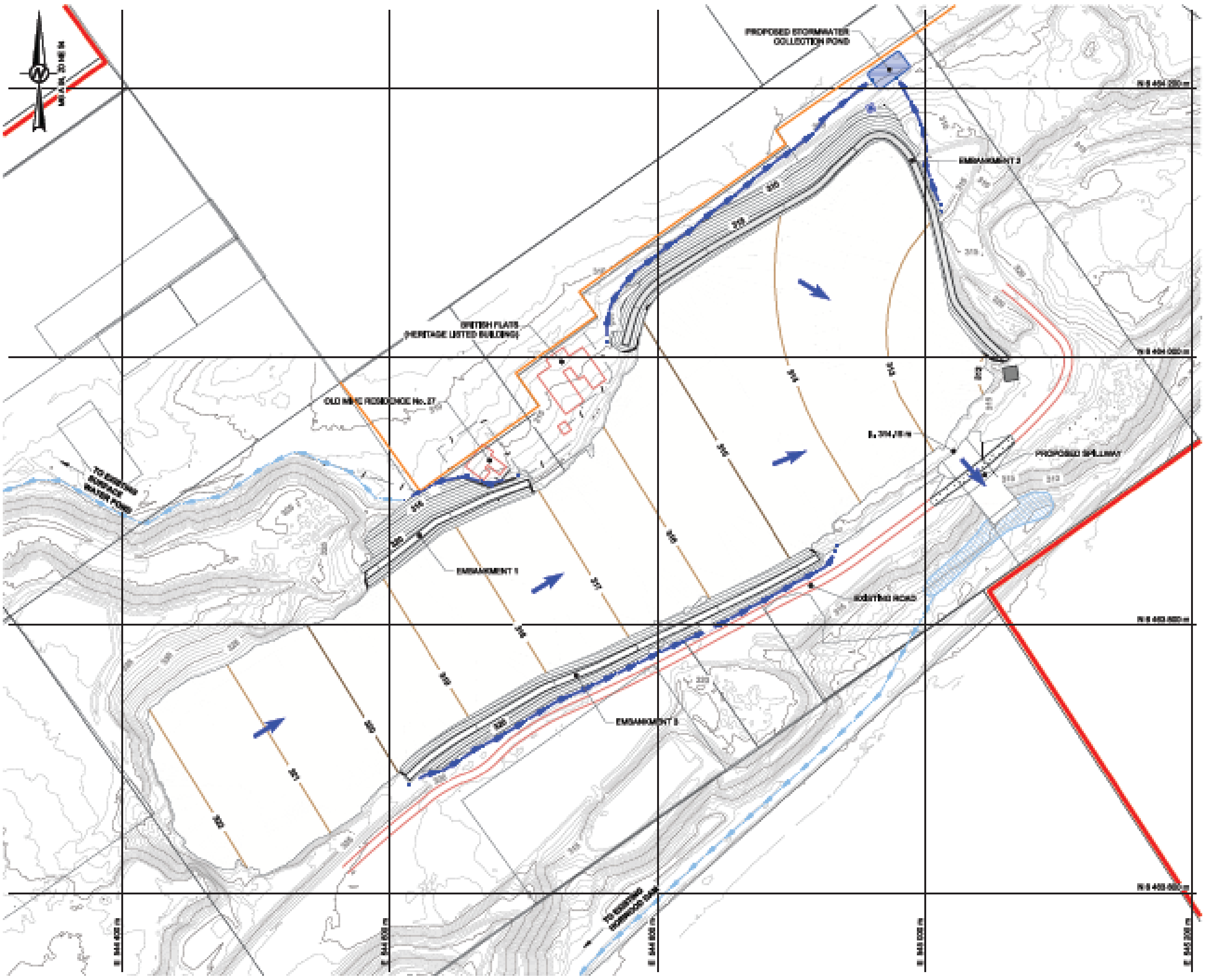


Figure 1-10 Stormwater Management at Closure

Appendix H
Operational Controls for TSF 2 Dust Supression

OPERATIONAL CONTROLS FOR TSF2 DUST SUPPRESSION

1. PURPOSE

CBH Resources has both a community and regulatory responsibility to minimise dust emissions from the site.

2. SCOPE

This Work Procedure is to ensure appropriate and timely intervention actions are enacted to reduce the incidence of fugitive dust emissions from the Rasp Mine Tailings Storage Facility #2 (TSF 2) . This procedure applies to the suppression of dust on exposed areas of TSF 2 and surrounding land.

3. RESPONSIBILITIES

<u>Production Manager</u>

Has the responsibility to ensure operational activities are planned and implemented to limit dust emissions.

Must ensure this procedure is disseminated and appropriate work instructions are complied with to meet this procedure.

Must also ensure there is adequate spray coverage provided in the TSF 2 to effectively provide dust suppression.

<u>Control Room Operator</u>

Must obtain weather forecasts, determine if weather conditions within the next 3 days are likely to result in dust, and using the Dust TARP attached to this document determine the appropriate response.

Will ensure that automatic sprays have been operated so that all exposed areas of the TSF 2 covered by the sprays are damp at the time of the expected weather conditions.

<u>Environmental Manager</u>

Must ensure that the TSF 2 spray system is operated in accordance with the plan and records of suppression activities are kept.

4. DEFINITIONS

Fugitive Dust – small particles distributed in air contributing to visual clouds or deposition. Originating from diffuse or multiple sources and escaping from the original site

Strong Wind Event – wind speeds reaching gusts of 40 km/h (10.9 m/s), as measured 10m above the surface of the TSF.

Extreme Wind Event - wind speeds reaching gusts of 50 km/h (14.3 m/s), as measured 10m above the surface of the TSF.

Dust Trigger Level 1 – one-hour average PM_{10} concentrations above 80µg/m^3.

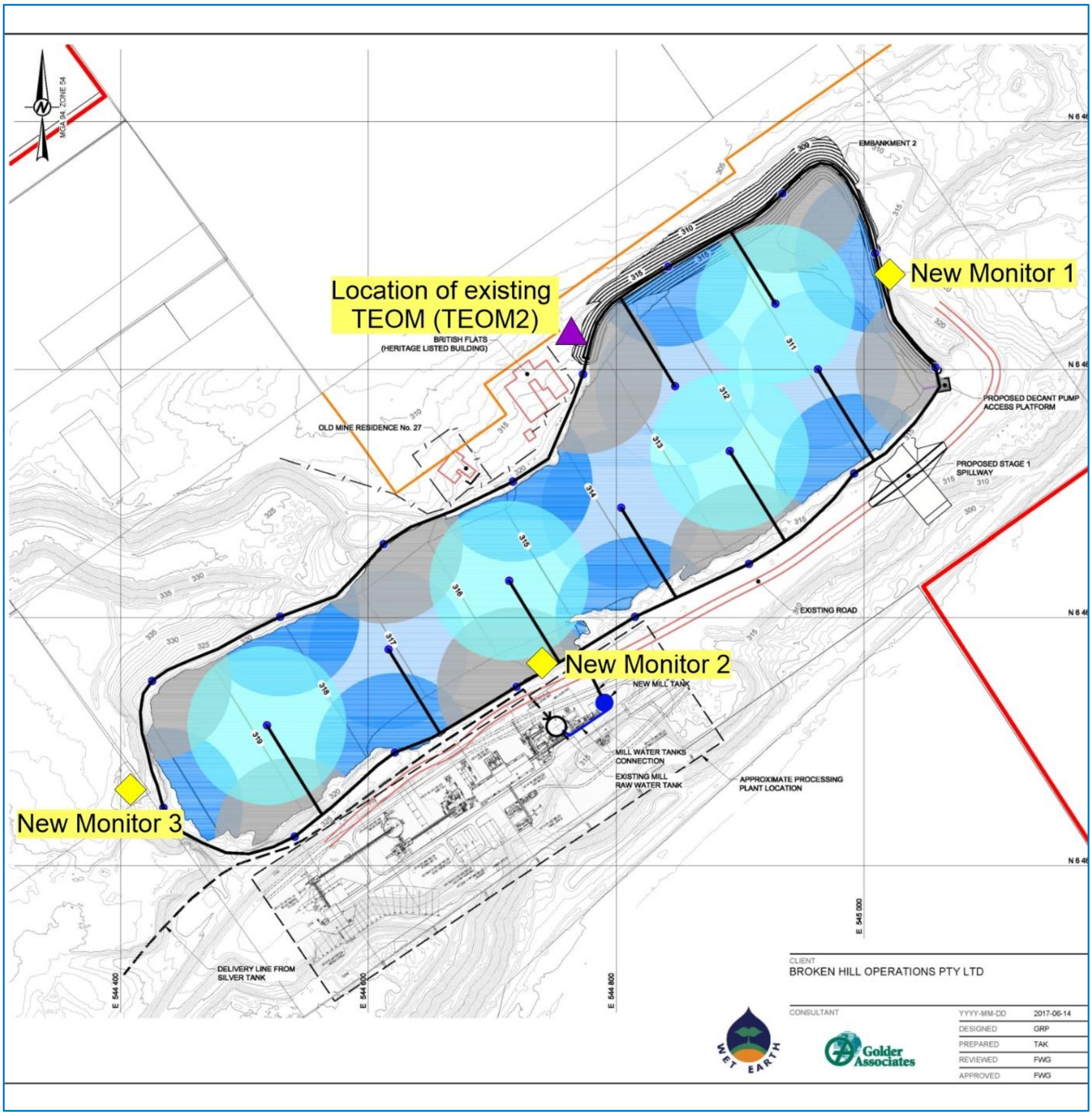
Dust Trigger Level 2 – one-hour average PM_{10} concentrations above 100µg/m^3.

Dust Management Software – CBH's meteorological forecasting and data management system that allows forecast wind events and dust triggers to engage TSF 2 spray system automatically via Programmable Logic Controller (PLC).

TSF 2 Spray System – Static water spray system and ring main surrounding the TSF 2 with the ability for chemical dust suppressant dosing.

Chemical Dust Suppressant – Proprietary product used as an additive to TSF 2 spray system when additional dust suppression beyond the use of water sprays is required at the TSF 2. Typically a PVA-based formulation diluted with existing spray system water supply.

PM Monitors – Network of particulate matter (PM) monitors surrounding the TSF 2, with locations documented below.



5. PROCEDURE

5.1 Weather Alerts

Forward warning of wind and other climatic conditions that may contribute to wind blown dust is critical in allowing appropriate and timely response.

The Production Manager will source the appropriate 3 day weather forecast from the Dust Management Software at the commencement of each day shift and allocate resources. He will also monitor weather conditions throughout the day especially if storm fronts/weather change is forecast. He will also source an update for the afternoon and next day to plan resources.

Forward forecasts of weather conditions up to three days ahead are automatically provided via the Dust Management Software.

Real-time information can be sourced from the site's 10m meteorological mast and from anemometers co-located with the site's PM monitors. This information is displayed in real-time using the site's Dust Management Software.

5.2 High risk conditions for dust events

The likelihood of dust events is based on the combination of a number of conditions:

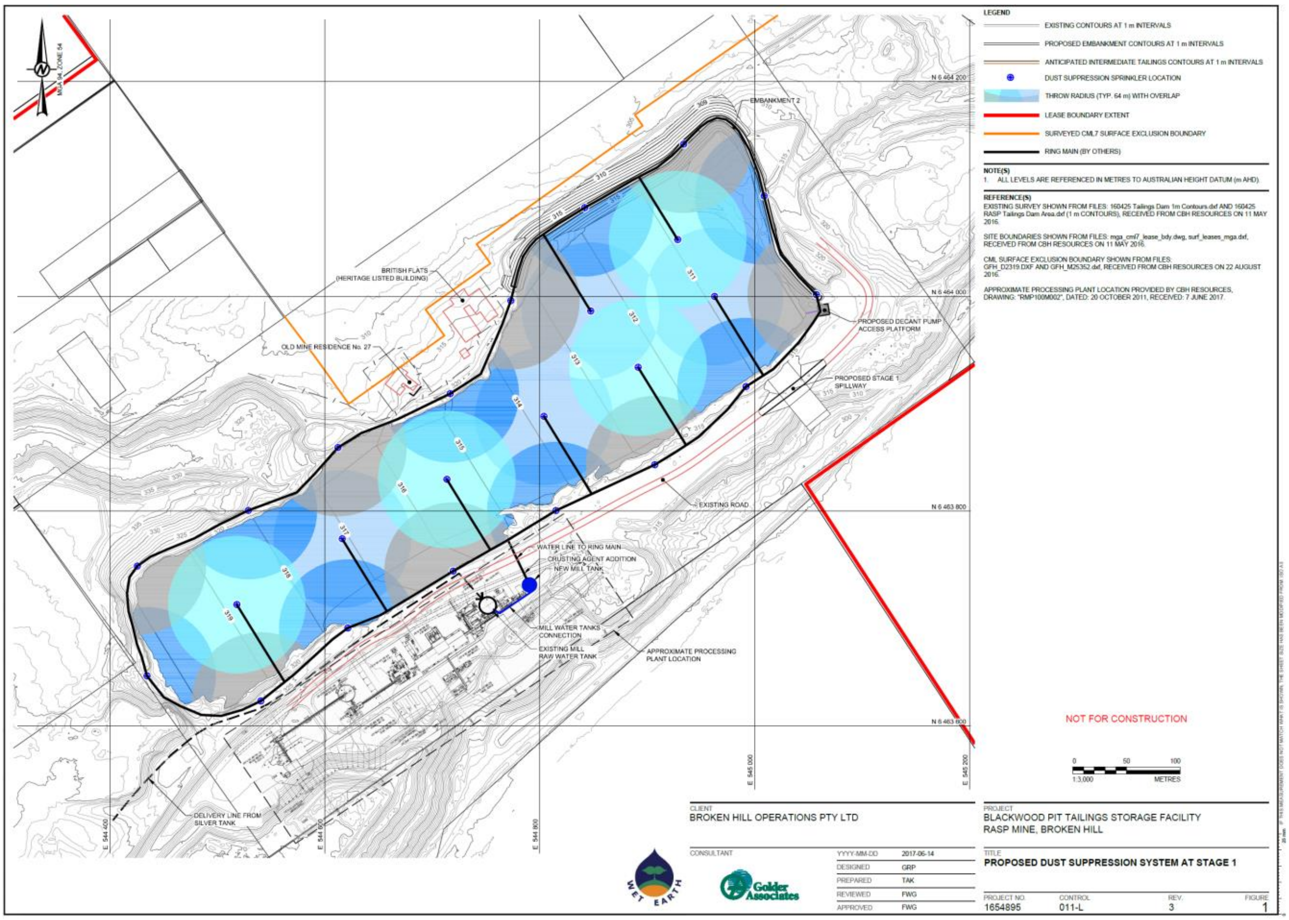
- Weather conditions – temperature, humidity, wind speed and direction.
- Preceding weather conditions – time since significant rainfall, occurrences of high winds and drying conditions
- Dust forming activities – mechanical action such as disturbance of the TSF 2 surface. Natural processes such as wind erosion and decrepitation (break down through wetting and drying)

Warm and dry conditions provide the atmospheric conditions for uplift and extended carry distance of dust under a strong wind event (gusts above 40 km/h).

5.3 TSF 2 Spray System

The TSF 2 spray system is the principal method of dust suppression for the TSF 2, providing spray coverage across the whole TSF using a network of static sprays.

A diagram of the TSF 2 spray system is provided below



The Production Manager will allocate resources to utilise the spray system to wet down for dust suppression prior to strong wind events.

The use of sprays should be a regular activity, particularly during hot and dry conditions when there is potential for areas of the TSF to dry out. Specifically, when wind strengths within the 3 day forecast period are predicted to realise a high wind event (gusts exceed 40kph), plans for use of the spray system must be prepared and implemented unless conditions are such that there is a very high level of confidence that the expected wind will not result in dust being created. Rain forecast to accompany strong winds and a weather change will not usually provide the level of confidence that justifies not operating the sprays.

The best and longest lived results will come from achieving a depth of damp material rather than a wetted skin that will dry quickly and can be disturbed by vehicles and plant.

When an extreme wind event (gusts exceed 50kph) is forecast within the 3 day forecast period, the use of Chemical Dust Suppressant within the TSF 2 spray system should be implemented unless there is a very high level of confidence that the expected wind will not result in dust being created.

5.4 PM Monitors

A network of PM Monitors is located as close to the four cardinal directions of the compass as practicable surrounding the TSF 2.

The principal purpose of these PM Monitors is to provide alerts of Dust Trigger Levels to the Control Room Operator and Environmental Manager via the Dust Management Software, and to automatically engage the TSF 2 spray system when a Dust Trigger Level 2 event occurs.

5.5 Notification / Response to Dust Incidents

On occasion enquiries or complaints related to dust events may be received from the EPA, or direct from community. The recipient of the complaint must record and respond in a timely manner.

All incidents/complaints are to be recorded as per the Complaints Procedure, with actions documented within the Dust Management Software. This requires an initial response within 24 hours and often further detailed response as determined from the initial communication.

In most instances the Production Manager will be required to provide details of wetting down and dust suppression activities at and leading up to the time of the incident.

5.6 Fugitive Dust – Trigger, Action, Response Plan (TARP)

The TARP has been developed to provide a tool for predicting the likelihood of a dust event and outline the required escalated response to the event based on the conditions and risk. It also serves as a tool for forward predicting conditions to allow planning of responses and resources.

	Acceptable Conditions Little Risk	**Preparatory Stage Low Risk**	**First Stage Dust Suppression High Risk**	**Second Stage Dust Suppression Extreme Risk**
Alert measures	Sufficient wetting in recent period (TSF surface visibly wet)	Low drying weather, TSF damp from water sprays within previous 24 hours	Forecast wind gusts > 40kph, Dust Trigger Level 1	Forecast wind gusts >50kph, Dust Trigger Level 2
Activities	Monitor conditions, visual inspection	Monitor conditions, visual inspection	Active wetting down using TSF 2 spray system	Pre-planned activities (use of water sprays and Chemical Dust Suppressants) Continuous spraying
Existing Conditions	Surface of TSF 2 is visibly wet	Visual evidence of TSF dampness – recent rainfall or spraying	TSF surface visibly dry – evidence of crusting or rapid drying following spraying or rainfall	Surface dry and friable – evidence of significant fine, loose material on TSF surface
Weather Forecast	Periods of rain, WS < 20kph	Drizzle, showers, WS < 30kph	Fine, Mild, Wind gusts > 40kph	Hot, dry, Wind gusts > 50kph
PM Monitors	one-hour average PM_{10} concentrations below 30µg/m^3	one-hour average PM_{10} concentrations below 50µg/m^3	One-hour average PM_{10} concentrations above 80µg/m^3	One-hour average PM_{10} concentrations above 100µg/m^3

	Acceptable Conditions Little Risk	**Preparatory Stage Low Risk**	**First Stage Dust Suppression High Risk**	**Second Stage Dust Suppression Extreme Risk**
Production Manager	Monitor weather forecast and plan dust suppression activities	Monitor weather forecast and plan dust suppression activities	Alert Control Room Operator to engage TSF water spray system if not automatically engaged.	Alert Control Room Operator to dose TSF water spray system with Chemical Dust Suppressant prior to spraying.
Control Room Operator	Monitor conditions, visual inspection	Monitor conditions, visual inspection, implement dust suppression plans	Check that TSF water spray system has been engaged	Check that Chemical Dust Suppressant has been used within TSF water spray system
Environmental Manager	Monitor conditions, visual inspection	Monitor conditions, visual inspection	Check that TSF water spray system has been engaged, update corrective actions taken within Dust Management Software	Check that Chemical Dust Suppressant has been used within TSF water spray system, update corrective actions taken within Dust Management Software