FINAL REPORT

Broken Hill Operations Pty Ltd

Rasp Mine

Environmental Assessment

Report – Volume 1

Application No 07_0018

July 2010

SUBMISSION OF ENVIRONMENTAL ASSESSMENT

This EA is prepared under Part 3A of the Environmental Planning and Assessment Act 1979

EA PREPARED BY

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PROJECT PLAN APPLICATION

Applicant Name: *Broken Hill Operations Pty Ltd*

Applicant Address:

Eyre Street	*PO Box 5073*
Broken Hill	*Broken Hill*
NSW 2880	*NSW 2880*

Land to be developed: *Property description of land to be developed is contained in the EA.*

Proposed development: *Project approval is sought for the expansion of mining and the construction of a processing plant at the Rasp Mine in Broken Hill, NSW. The Proposal is described in Chapter 2 of this EA.*

ENVIRONMENTAL ASSESSMENT *An EA is attached which addresses all matters listed under Part 3A of the Environment Planning and Assessment Act 1979.*

CERTIFICATE *I certify that the contents of this EA have been prepared and to the best of my knowledge:*

- *Contains all available information that is relevant to the environmental assessment of the development to which the EA relates; and*
- *Is true in all material particulars and does not, by its presentation or omission of information, materially mislead.*

Name: *Gwendalynn Wilson*

Date: *July 2010*

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF ANNEXURES

ACRONYMS

Abbreviation	Description
ABS	Australian Bureau of Statistics
AEMR	Annual Environmental Management Report
Ag	silver
AGO	Australian Greenhouse Office
ALM	Adult Lead Methodology
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	average recurrence interval
ARTC	Australian Rail Track Corporation
AS	Australian Standard
ASX Code	Australian Stock Exchange
ATSDR	Agency for Toxic Substance and Disease Registry, USA
BAc	Bioaccessibility
BHCC	Broken Hill City Council
BHOP	Broken Hill Operations Pty Limited
BHP	Broken Hill Proprietary Company Limited
Broken Hill LEP	Broken Hill Local Environmental Plan
CBH	CBH Resources Limited
CH_4	methane
CML7	Consolidated Mining Lease 7
CO_2	carbon dioxide
CRA	Conzinc Rio Tinto of Australia Ltd
dB	decibels
DCP	Development Control Plan
DEWH&A	Department of Environment, Water, Heritage and the Arts
DGRs	Director Generals Requirements
dL	Decilitres
DoP	Department of Planning
DP	Deposited Plan
DPI	Department of Primary Industries
EA	Environmental Assessment
EAR	Environmental Assessment Report
ECRTN	Environmental Criteria for Road Traffic Noise
EMGA	Environmental Management Group Australia Pty Limited
EMS	Environmental Management System
ENCM	Environmental Noise Control Manual
ENM	Environmental Noise Model
ENVIRON	ENVIRON Australia Pty Ltd
EPA	Environmental Protection Authority
EP&A Act	Environmental Planning and Assessment Act
EPBC Act	Environment Protection and Biodiversity Conservation Act
EPIs	Environmental Planning Instruments
EPL	Environment Protection Licence
ERM	Environmental Resources Management Australia Pty Limited
ESD	Ecological Sustainable Development
Fe	iron
FEL	front end loader
GSD	geometric standard deviation
GWAHS	Greater Western Area Health Service
GWP	global warming potential
HFCs	hydrofluorocarbons
HHRA	Human health risk assessment
HI	Hazard Index
HIA	Health Impact Assessment
HIL	Health Based Investigation Level
HQ	Hazard Quotient
I&I NSW	Department of Industry and Investment
INP	Industrial Noise Policy
IPCC	Intergovernmental Panel of Climate Change
IEUBK	US integrated exposure uptake and biokinetic model

Abbreviation	Description
kg	kilograms
km	kilometres
Kph	kilometres per hour
LHD	load haul dump
LEP	Local Environment Plan
LGA	Local Government Area
LOHS	Long open hole stoping
LOLA	Line of Lode Association
m	metre
Major Projects SEPP	State Environmental Planning Policy Major Projects 2005
Mg/L	milligrams per litre
MIC	maximum instantaneous charge
ML	megalitre
MMM	Minerals, Mining and Metallurgy
m/s	metres per second
mm/s	millimetres per second
MOP	Mining Operation Plan
MR	main road
Mt	million tonnes
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NES	National Environmental Significance
NHMRC	National Health and Medical Research Council
NOHSC	National Occupational Health and Safety Committee
NPI	National Pollutant Inventory
NSW	New South Wales
N_2O	nitrous oxide
Pb	lead
PBET	physiologically based extraction test
PbS	galena
PFCs	perfluorocarbons
$PM_{2.5}$	particular matter with equivalent aerodynamic diameter of 2.5 µm
PM_{10}	particular matter with equivalent aerodynamic diameter of 10 µm
PMP	probable maximum precipitation
POEO Act	Protection of the Environment Operations Act
PTWI	Provisional tolerable weekly intake
RBL	rating background levels
REF	Review of Environmental Factors
ROM	run of mine
SA	South Australia
SEE	Statement of Environmental Effects
SEPP	State Environmental Planning Policies
SF_6	sulphur hexafluoride
SH	State Highway
SIPX	sodium iso propyl xanthate
SMP	Stormwater Management Plan
t	tonnes
TDS	Total dissolved solids
TDI	Tolerable daily intake
Toxikos	Toxikos Pty Ltd
tpa	tonnes per annum
TSC Act	Threatened Species Conservation Act
TSF	tailings storage facility
TSP	total suspended particulates
TWADI	time weighted average daily intake
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
UK EA	United Kingdom Environment Agency
µg/dL	microgram/decilitre
µg/m^3	microgram/cubic metre
WRI	World Resources Institute
Zn	Zinc

EXECUTIVE SUMMARY

Background

Broken Hill Operations Pty Ltd (BHOP) is seeking Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for expansion of operations at its Rasp Mine. BHOP proposes to extend the areas for underground mining to include the Western Mineralisation, Centenary Mineralisation and additional Main Lode Pillars, and to expand mining production to 750,000 tpa. The Rasp Mine is located on Consolidated Mining Lease 7 (CML7), Broken Hill NSW.

Mining and associated operations have been conducted at the site for over 125 years and the site contains substantial tonnages of unmined zinc-lead-silver mineralisation and remnants left behind by previous mining. This has been confirmed by a detailed drilling and evaluation programme conducted by BHOP. New mining technologies and design options are now available and will enable the resource to be extracted economically.

The purpose of this Environmental Assessment Report (EAR) is to describe potential threats to the environment and community posed by the Project and detail the strategies which BHOP intends to use to manage those risks in accordance with regulation and industry good practice.

The Director General's Requirements were developed by the Department of Planning (DoP) in concert with a range of other government agencies to focus the assessment on the significant aspects of the Project. These were updated in March 2009. This EAR addresses these requirements and will accompany the Project Application to be submitted to the Minister for Planning for determination.

Project

The following lists the major components of the proposed Project:

- mining of 8,450,000 tonnes (t) of ore-
  - 7,200,000 t from underground mining in the Western and Centenary Mineralisation accessed by the Rasp Decline; and
  - 1,250,000 t from underground mining of Main Lode Pillars also accessed via the Rasp Decline
- planned (temporary) crushing, stockpiling and transport of ore off-site to the Endeavor Mine;
- construction and/or extension of associated infrastructure, plant and equipment, including upgrade of internal roads and construction of an on-site noise abatement barrier;
- transport of ore to the surface in haul trucks;
- ore processing using crushing, milling and flotation;
- tailings management, including deposition at an existing tailings storage facility (TSF1) and into Blackwood Pit (TSF2), and used as back fill for underground mining voids;
- works for surface water management; and
- reinstatement of a rail spur and transport of concentrate in covered rail wagons to a smelter and/or port.

The Department of Industry and Investment has provided approval (December 2009) for BHOP to recommence underground mining of Main Lode Pillars at a rate of 120,000 tpa. The ore is to be crushed, stockpiled and transported off site for processing. It is proposed to continue this mining until a mineral processing plant has been constructed at the site. It is also proposed to extend underground mining to include the Western Mineralisation, Centenary Mineralisation and further development of the Main Lode Pillars, and in addition to expand mining production to 750,000 tpa with a 13 year mine life.

The proposed hours of operation include; construction activities to be conducted during dayshift only (7am to 7pm); underground mining to operate 24 hours a day, 7 days a week; crushing and screening to take place between, 7am to 7pm, 7 days a week; shunting to take place 7 days/week, 7am to 6pm. All processed ore will be transported from the site by rail. The Project will allow for the extraction of 8,450,000 t of ore.

Details of the Project are described in *Chapter 2*.

Need for the Project

The Project will make an important contribution to Broken Hill's economy over a 15 year time frame with Project construction, mining operations and closure activities.

The Western Mineralisation and Centenary Mineralisation comprise a separate large orebody to the north-west of the Line of Lode (historically mined in Broken Hill) and will be mined in conjunction with the substantial resources of Main Lode Pillar ore within the original mining areas (which includes high grade zinc-lead-silver lenses - refer *Chapter 2* for resource description and detailed Project description.). The Centenary Mineralisation is a continuation of the Western Mineralisation orebody at depth and is divided from the Western Mineralisation by the Globe Vauxhall Shear Zone.

BHOP aims to recover the Western Mineralisation and Centenary Mineralisation, and Main Lode Pillars; re-establishing a supply of high quality zinc and lead concentrates for smelting, thereby realising financial benefits for Australia and the company.

The Project will have environmental, social and economic benefits including:

- provision of employment for Broken Hill residents, with approximately 107 people to be directly employed during construction and commissioning and approximately 143 people during full-scale mining operations;
- training of Broken Hill residents as miners, trades workers and professionals for BHOP's operations;
- indirect and induced employment (346) generated via support services such as maintenance workers and short term sub-contractors;
- economic benefits to the Broken Hill community via capital injection and value added spending;
- enhancement of the economic position of CBH which in turn will fuel investment in other projects;
- extraction of a valuable mineral resource before the site reverts to other uses, thus preventing its sterilisation;
- extension of the life of Broken Hill mining ensuring continued provision of government royalties; and
- preservation of the historical heritage of the site for future generations.

Stakeholder Engagement and Identification of Key Issues

A stakeholder engagement programme has been developed to enable individuals, groups and agencies with an interest in the Project to have access to up-to-date, relevant information regarding the Project, as well as providing a means for stakeholders to raise issues and concerns, and BHOP with the means to respond.

BHOP has conducted direct consultation with the public, neighbours, representatives of interested parties and regulatory agencies. Presentations and information sessions were held to provide stakeholders with an overview of the Project as well as information on potential impacts and how they will be managed. These sessions also provided a mechanism for participant feedback.

A summary of the points raised during these discussions and presentations is provided in *Chapter 4*. Comments from the government agencies provided following the Planning Focus Meeting and from ongoing discussions are also included in *Chapter 4*.

The key environmental issues associated with the Project were identified as:

- airborne dust and lead bearing dust;
- storage of tailings;
- noise from operations;
- vibration and overpressure from blasting activities; and
- maintenance of heritage values along the Line of Lode.

Accordingly, significant consideration was given to designing Project components to minimise impacts arising from these key environmental issues by identifying mitigation and management measures.

Airborne Dust and Lead Bearing Dust

BHOP commissioned ENVIRON Australia Pty Ltd (ENVIRON) to undertake an air quality assessment for the Project. A summary of the assessment can be found in *Chapter 8* of this EAR and the air quality assessment report in *Annexure H*.

The air quality assessment focussed on emissions of total suspended particulates (TSP), particulate matter less than 10 microns and 2.5 microns in aerodynamic diameter (PM_{10} and $PM_{2.5}$ respectively), dust deposition and a range of individual metals/metalloids. The air quality assessment was undertaken in accordance with DECCW (2005) *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales*.

A health risk assessment was also conducted (discussed below).

Proposed dust management

In view of the proposed Project's proximity to sensitive receptors, combined with the potential impacts associated with the production of the lead and zinc concentrates, BHOP have committed to best practice dust controls for the duration of the Project. Such practices include:

- extensive sealing of haul routes;
- application of chemical dust suppression for unsealed roads, ROM stockpile and exposed areas;
- enclosure of crushing operations venting under negative pressure to a baghouse;

- enclosure of all generating conveyors and transfer points pre the grinding circuit as these may be dust generating;
- installation of real-time air quality monitoring to assist in the active management of emissions;
- installation of rubber curtains on the concentrate loading facility with all train wagons washed prior to leaving site;
- application of water spray systems with added chemical dust suppressant and wind breaks (where applicable) across other key areas of operation, including tailings storage facilities (both during construction and operation), ROM stockpile area, exposed areas and assorted construction and ancillary surface activities; and
- installation of wagon and vehicle wash facilities.

Existing Air Quality Environment

The local region surrounding the Project site was reviewed to identify sources that may contribute pollutants to the local air shed. Additionally, historic observational data for notable dust storm activity was resourced from the Bureau of Meteorology. On the basis of the scale and nature of the surrounding particulate-generating activities, it was considered that the wind-generated suspension of particulate matter, such as dust storm events, is the likely dominant influence on baseline air quality for the Broken Hill area.

Air quality monitoring data for the area was resourced from a number of sources including:

- 24-hour average TSP concentrations recorded by BHOP at the Project site between May 2007 and January 2010;
- monthly dust deposition levels from a network of dust deposition gauges maintained by BHOP about the Project site;
- measured lead content in BHOP-recorded TSP and dust deposition samples; and
- 24-hour average PM_{10} concentrations recorded by Bemax Resources Limited between May 2007 and January 2010 at the Broken Hill Mineral Separation Plant, 4 km to the west-southwest of the Rasp Project site.

No monitoring data for ambient $PM_{2.5}$ or metals (excluding lead) were available for the Broken Hill region.

Emissions Inventory

In order to conduct dispersion modelling for the key aspects of the Project, the following scenarios were developed:

- Project Construction phase; and
- Project Operational phase under maximum production.

Additionally, in order to provide a partial estimate of baseline metal concentration/deposition, simulations were undertaken for the existing free areas assuming the implementation of future controls with a control efficiency of 80% (conservative estimate based on manufacuturers recommendation of 90 to 95% efficiency).

Emissions from all key construction and operational sources of particulate matter were estimated based on published US-EPA AP-42 literature. Where applicable, emission reduction factors were applied to account for the proposed best practice dust management techniques.

Air Quality Assessment

Dispersion simulations were undertaken and results analysed for TSP, PM_{10}, $PM_{2.5}$ and a range of heavy metal concentrations and dust deposition. Simulations were also undertaken for gaseous emissions from the planned ventilation shaft to be situated in the Little Kintore Pit.

Dispersion modelling of particulate emissions from the Project was conducted utilising the US-EPA regulatory model AERMOD for two complete calendar years, 2008 and 2009. Local meteorological conditions recorded at the nearby Bureau of Meteorology Broken Hill Airport automatic weather station were integrated into the dispersion modelling process. To assess the performance of the Project, dispersion modelling predictions for a range of local sensitive receptor locations will be compared with relevant NSW Department of Environment, Climate Change and Water (DECCW) assessment criteria.

Summary of assessment results

Air quality modelling results for construction and operations are presented in *Figures 8.5* to *8.10.*

Results for Predicted Suspended Particulate Concentrations

Predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ are below the applicable NSW DECCW assessment criteria for both construction and operational phases of the Project for 24-hour and annual average concentrations.

Application of the recorded PM_{10} concentrations for the Broken Hill area indicated that the cumulative impact of the Project and ambient concentrations could result in the exceedance of DECCW criterion of 50 µg/m^3 for 24-hour average PM_{10}. However, review of the ambient PM_{10} monitoring data suggested that ambient concentrations would be in exceedance of the DECCW criterion approximately 35 days per year, without the inclusion of the Project.

Analysis of the concurrent AERMOD-predicted and measured 24-hour average PM_{10} concentrations throughout 2008 and 2009 indicated that, in addition to the existing exceedances within the PM_{10} dataset, the DECCW criterion would be exceeded an additional one and two times at the two closest sensitive receptors over the entire 2008 and 2009 modelling period. However, analysis of the frequency of the predicted incremental 24-hour average PM_{10} concentrations indicated that the likelihood of an additional exceedance of the DECCW criterion is low.

Results for Predicted Dust Deposition

Predicted annual average monthly dust deposition levels were predicted for both modelling scenarios. The predicted incremental increase in dust deposition across both modelled years is below the NSW DECCW incremental criterion of 2 g/m^2/month at all surrounding sensitive receptors. It is expected that the cumulative dust deposition criterion of 4 g/m^2/month will be exceeded, however it is noted that, based on provided monitoring data, the existing dust deposition levels in the Broken Hill area range between 3.3 and 7.2 g/m^2/month, likely due to the arid setting of the region.

Results for Predicted Heavy Metal Concentrations

Predicted concentrations of assorted metals were found to satisfy the relevant NSW DECCW assessment criteria at all surrounding sensitive receptors for both construction and operational phases of the Project.

Air Quality Monitoring

A number of key recommendations in respect to air quality monitoring have been made within the air quality assessment, including the following:

- source based measurements (road silt loading, control technology performance, etc);
- establishment of realtime air quality monitoring for PM_{10} at key surrounding receptors;
- additional dust deposition monitoring locations established away from the Project to provide a more robust indication of typical background levels for Broken Hill.
- continuation of the sampling of lead in TSP and dust deposition monitoring samples, along with the analysis of additional metals covered in this study; and
- review and amendment of the Air Quality Management Plan aligned to the proposed changes and recommendations.

Storage of Tailings

The storage of tailings has been identified as an area of concern by the local community due to dust emissions from historic storage facilities. The waste stream from ore processing (tailings) will be thickened and separated by cycloning to produce two waste streams. The coarser stream will be redirected underground to backfill mine voids and stopes. The finer stream will be pumped to the existing tailings storage facility (TSF1) for containment and settling and, once this is filled to free-board capacity, tailings will be deposited in the Blackwood Pit (TSF2).

When in full production fifty percent of tailings will be directed underground via boreholes and fill lines and fifty percent will be deposited in the two separate surface storage facilities.

It is proposed to commence depositing tailings in TSF1 to allow assessment and mining of remnant ore in the base of the Blackwood Pit (TSF2). TSF1 has a capacity of 970,000 t (with an assumed density of 1.3 t/m^3) deposited over 4.25 years The construction of TSF1 will commence by raising the existing tailings dam embankment from RL 322.0 m to RL 332.0 m. Construction is proposed in two stages with an initial starter embankment of 6 m followed by a subsequent lift of 4 m. The embankments will be constructed of waste rock to eliminate dust generation from the side walls. Waste rock will be moisture conditioned prior to embankment placement to gain required compaction and reduce the potential for dust generation.

The height of the facility will be aligned to the local topography and will be 10 m less than that of the adjacent historic tailings storage facility known as Mt Hebbard to the west.

The recommissioned TSF will comprise two cells of approximately equal size separated by a dividing wall, encompassing an area of 10 hectares. The cells are shown on *Figure 2-11* and designated as ‘south cell’ and ‘north cell’. Tailings will be deposited from spigots located on the embankments surrounding the cells and will be cycled between the two cells to facilitate consolidation and stabilisation of the tailings. The spigots have been located (25 m) to minimise the potential for the tailings to dry out and become dust generating. The design of TSF1 allows for a beach to be developed towards the north of the cells adjacent to an internal access road.

A chemical dust suppressant will be sprayed over the tailings to prevent dust lift off for the one to two weeks whilst tailings are deposited in the other cell. The chemical dust suppressant coating forms a crust with the tailings resulting in a surface that does not release fine dust particles. The chemical dust suppressant will be applied via irrigation sprays located at strategic points around each cell to ensure coverage of the entire cells. These sprays will also be available, individually or concurrently, to act as water sprays in the event of downtime or breakdowns in the mill that prevent tailings deposition.

A Tailings Construction and Operations Manual (TCOM) will be prepared for the deposition of tailings into TSF1. It will be a comprehensive plan and will address:

- location and operation of spigots;
- deposition strategy for the north and south cells to maximise consolidation and stabilisation of tailings;
- management of supernatant water ponds and decant dam;
- management and application of the polymer crusting agent and use of water sprays; and
- monitoring and inspection requirements.

Following completion of tailings disposal to the cells, a final covering of inert waste rock will be placed over the top of the cells to avoid the potential for dust generation as the tailings consolidate and stabilise. Based on geotechnical work and the TSF design, preliminary embankment stability modelling results indicate that the proposed raises to the TSF satisfy safety requirements.

At TSF2 the tailings will be deposited into the disused Blackwood Pit. This will occur following investigations and recovery of remnant ore that is located in the base of the Pit. The capacity for tailings deposition assumes no ore recovery and is based on current surface levels. TSF2 has a capacity of 3,120,000 t (with an assumed density of 1.3 t/m^3) deposited over 8.75 years (deposition of tailings is currently planned for 1,680,000 over 5.75 years). TSF2 is located to the north east of TSF1. The height of the pit floor can increase from approximately RL 274 to RL 307.5, capacity. Additional capacity is available above RL 308.5 with an engineered bund wall at the eastern end of the Pit.

No wall construction is required at TSF2 as tailings are disposed in-pit. Some construction activity would be required to place the spigotting bench pipe and to ensure the safety bund is adequate for operations. The potential environmental risks (wind erosion and dust generation) are minimal due to in-pit disposal of tailings. As the tailings rise closer to surface level the potential for dust and wind erosion increases and the dust management as proposed for TSF1 will be undertaken.

The Tailings Construction and Operations Manual for TSF2 will be based on the TCOM for TSF1. The manual will describe measures for the facilitation of stabilisation and consolidation of the tailings and to minimise the potential for dust generation. Additionally, the manual for TSF2 will include:

- potential inrush of water / tailings into old workings;
- controlled delivery of tailings to the pit floor during facility start-up; and
- minimisation of stormwater runoff into TSF2 from surrounding landforms. Dust suppression measures will be utilised consistent with TSF1, as appropriate.

Air Quality Assessment Summary

The air quality assessment highlights that operations will be in compliance with DECCW air quality impact guidelines with the possibility of some exceptions when excessive dust storms occur.

BHOP has proposed a number of management measures to ensure that emissions to atmosphere from its operations and the free areas of the Project site are minimised. BHOP will implement an air quality management program to confirm that the results presented in this EA are an accurate representation of emissions to atmosphere from the Project as well as using this data to inform and develop operational controls to minimise impacts to local air quality. In addition, on-going management of the facility will adopt environment management measures to ensure that predicted levels are not exceeded.

The potential impact on greenhouse gas emissions has been assessed as low and details of this assessment are also outlined in *Chapter 8*.

Health Risk Assessment

BHOP have commissioned Toxikos Pty Ltd (Toxikos) to complete a health risk assessment (HRA) for the proposed Project. A more detailed summary of the assessment can be found in *Chapter 9* of this EAR and the health risk assessment report in *Annexure I*.

Toxikos was provided with the results of dust air dispersion modelling which predicted dust and lead concentrations at discrete locations around the mine. This included airborne concentrations of lead and other metals in total suspended particulates (TSP) and fine particulates (PM_{10}), and also annual deposition rates of lead and metals at the receptors. Toxokos considered two major sources of dust; dust from the 'free areas' those areas that will not be disturbed by BHOP and can generate dust (these areas will be controlled by BHOP with a chemical dust suppressant which was given an 80% efficiency rating in the air quality assessment); dust arising from ore processing activities. Data was provided for the relative proportion of 'free area' dust and 'mine process activity' for lead bearing dust was provided. The bioaccessibility of lead in these dust sources was determined which allowed receptor specific bioaccessibility in airborne dust and soil to be estimated according to the source apportionment of the lead.

A number of worst case or high end exposure assumptions were incorporated into estimations of lead exposure at representative receptors. Not the least of which was calculation of lead accumulation in receptor soil resulting from deposition from TSP and assuming no loss of the deposited lead over the 15 year operation period of the proposed mine.

The risk characterisation has been undertaken in two ways:

- Comparison of conservative intake of lead and other metals with their respective tolerable daily intakes (TDI) established by either Australian health authorities or the World Health Organisation (WHO); and

- Prediction of blood lead levels in children.

Risk characterisation using the tolerable daily intake (TDI):

Calculating the intake of a substance from all exposure pathways and comparing the resulting intake to the TDI is a standard risk characterisation procedure commonly performed in human health risk assessments.

Because human uptake of environmental chemicals is dependent in part on age related behaviour and physiological factors the calculation of metal intake was estimated for four age groups; infants/toddlers (0.5 up to 3 years), children (3 up to 13 years), adolescents (13 up to18 years) and adults (18 up to 70 years).

The intake estimations for the life stage daily intake of lead included ingestion, inhalation and dermal exposure pathways to environmental media. These were soil at lead concentrations calculated to be present after 15 years of mine operation assuming no loss of the deposited lead plus assumed background (i.e. existing soil lead concentrations); soil lead concentrations were dependent upon proximity to the mine site both in terms of deposition rate from the proposed mine and existing background soil concentrations. Also included were high end background intake from diet, intake of lead from the Broken Hill articulated water supply, and intake by inhaling airborne PM_{10} lead (incremental from dispersion modelling plus background). No consideration was given to exposure to lead based paint as no data was available.

Lead intake was greatest for a toddler/child, being about 3 – 5 times greater than an adult. Of the exposure pathways evaluated ingestion contributed 95 – 98% of the total intake; the majority (again 95 – 98%) of this was the result of background intake assumptions. Nevertheless the total daily intake by a child was only approximately 35 – 40% of the TDI for lead, the range being due to the risk zone (i.e. background soil lead concentrations) in which the receptor was located. Compared to the TDI, incremental lead intake due to the cumulative exposure from the mine lease area (i.e. exposure to dust from free areas 80% controlled plus mine activities) was negligible for most receptors. Even for the most impacted receptors (R8 & R3) incremental intake was less than 5% of the TDI and much of this was dust from the free areas.

Since at the most affected receptors the total lead intake, including very conservative estimates of background intake from existing soil and diet, was only about 50% of the TDI it is concluded lead exposure resulting from the proposed mine presents little risk to the health of nearby residents.

Despite the fact there is no firm evidence that an additive interaction is expected from the metals evaluated in the HRA, the incremental hazard quotients were summed to give a cumulative exposure hazard index. This was only 0.1, with 60% due to lead, signifying little health risk from combined exposure to metals in dust from the proposed mine.

In summary, it is concluded that since conservative high end exposure assumptions for the most impacted receptor resulted in lead intake by a child that was about half of the TDI, lead emissions from the proposed mine are unlikely to result in health effects for the surrounding community.

Blood lead levels:

The National Health and Medical Research Council (NHMRC) of Australia has recently determined that all Australians should have a blood lead level of less than 10 µg/dL in order that public health impacts of environmental lead exposure be minimised.

The US Integrated Exposure Uptake and Biokinetic model (IEUBK) was used to predict blood lead levels in children due to accumulation of lead in soil over 15 years of mine operation and exposure to mine emissions, and/or assumed background concentrations of lead in soil. This model has been validated and is regularly updated by the US EPA, it is extensively applied in North America to predict blood lead concentrations in children exposed to lead in their environment. It caters for exposure via ingestion of soil and indoor dust, diet, and water, and inhalation of airborne outdoor and indoor lead.

The blood lead modelling for various age groups showed the 1 -2 year old child as potentially having the highest incremental blood lead increase. This is consistent with conventional risk assessment wisdom in which this age group is considered to be the most susceptible to environmental chemicals. It is also consistent with the risk characterisation using the TDI.

For the most affected receptor (R8) the incremental increase in blood lead after 15 years of mine operation is predicted to be 0.75 µg/dL, and for receptor 3 (the second most affected receptor) the increase is 0.31 µg/dL. These predictions assume exposure is the result of dust from the free areas plus dust from mine operation activities, it is also assumed accumulated soil concentrations of deposited lead at the receptors incur no loss over the 15 year period. These increases in blood lead are however 2 – 5 times less than that which is predicted to occur if the lease site is left in its present condition and the proposed mine does not proceed. The difference is due to the additional dust control that the mine operation will bring to the free areas of the lease site.

The extent to which control of free area dust will lower predicted blood lead levels, relative to blood levels which may occur if the free areas are not dust controlled, is dependent upon existing exposures to lead. That is, the benefit will depend on existing soil lead concentrations at the receptor locations.

A benefit matrix for amelioration of increases in blood lead concentrations over the life of the proposed mine has been constructed. The matrix consists of low, medium and high existing soil concentrations determined from 2004 – 2008 soil lead data and location of receptors in historically established risk zones of Broken Hill. These assumed existing soil lead concentrations are juxtaposed to low, medium or high lead deposition for receptors in the designated risk zones. The benefit of additional dust control of the free areas was judged as poor, good or very good according to the percentage decrease in predicted blood lead level that would otherwise occur if the mine did not proceed; these terms are respectively linked to decreases in the rise of blood lead levels of 10%, 10 – 20% and >20%. The greatest benefit of 'free area' dust controls occurs at receptor locations where existing soil lead concentrations are low or medium and the lead deposition in those areas is medium or high.

In summary, with worst case, or high end exposure assumptions, the predicted increments in child blood lead levels that would occur as a result of mine approval are quite low. Indeed, compared with blood lead concentrations that may occur if the mine lease site is left in its present condition, a net benefit on blood lead concentrations is anticipated. This is due to the additional dust controls that would occur if the mine proceeds.

Noise and Vibration

A noise and vibration impact assessment has been undertaken for the Project covering construction activities, general site operations in particular blasting, crushing and internal traffic, and rail shunting movements. The potential noise impacts associated with off-site rail movements and mine-related traffic on the roads surrounding the site were also included in the noise assessment (*Chapter 7*).

The noise assessment was undertaken by N Ishac who was employed by ERM to complete their 2007 report (*Annexure G(A))* and by EMGA to complete their 2009 report (*Annexure G(B)).*

Given the Project site is located in the centre of Broken Hill, due consideration was given to address potential noise impacts to the surrounding neighbours. Consultation was ongoing with the local community, Project engineers and noise consultants to design the Project so that unacceptable levels of noise were mitigated and managed.

As a result the following design elements have been included in the Project:

- limiting selected operational activities to dayshift (7:00am to 7:00pm), for example crushing and rail shunting;
- installing a noise suppression kit on the front-end-loader that operates at the ROM pad;
- locating the processing area within a depression, being 10m below site surface to the north west;
- enclosing crushers and screens in a purpose built building;
- re-design of mine truck haulage on-site from an eastern to a western alignment, leading to greater separation distances to south residences;
- re-locating surface ventilation fans from the preferred location on the north west boundary, north of the main railway tracks, to within an existing pit (Little Kintore Pit). In addition, provision for manufacturer supplied noise suppression on the two ventilation fan arrangements;
- installing four metre high earth bunding along the western haul road alignment;
- installing four metre high earth bunding along the eastern haul road alignment, including the area south of Little Kintore Pit, further shielding the ventilation fans; and
- installing a four metre high solid wall running north-south along the eastern edge of the proposed reagent handling structure.

Summary of assessment results

Noise modelling results for construction and day-time operations under calm weather conditions and receiver locations are presented in *Figures 7-2 to 7-5*.

Construction

The results of construction noise predictions are summarised in *Table 7-3* for representative residential locations, identified in the ERM Report 2007. Results are also presented graphically as noise contours in *Figure 7-2*. The results demonstrate that typical construction activities are expected to satisfy the adopted ICNG criteria at all representative residential locations. To that end, predicted noise levels in *Table 7-3* are generally below background noise levels at corresponding residential locations (refer to *Table 7-1*) Therefore on-site construction noise is not expected to be audible at most residential locations for most of the time. The extension of construction hours to between 7am and 7pm seven days per week is therefore not considered unreasonable.

Operations – Day

The noise modelling results for day-time operations under calm weather conditions are presented as noise contours in *Figure 7-3*. *Table 7-4* summarises these results against the Project Specific Operational Noise Criteria (*Table 7-2*) and concluded:

- For underground mining and surface processing activities without the operation of the rail spur, all but one of the representative receivers meet the criteria. The predicted noise level at receiver A2 is marginally above the daytime criteria by 1 dB(A).

- For underground mining and surface processing activities with the operation of the rail spur, all but two of the representative receivers meet the daytime criteria. The predicted noise level at receiver A2 is marginally above the criteria by 1 dB(A), and at A7 a similar marginal breach of 2 dB(A) is predicted for the daytime. It should be noted that the rail spur is unlikely to be used during the one hour evening shoulder period. Hence discussions of impacts during the shoulder period with the rail spur are not relevant.

These exceedances are not considered to be significant as they are below or within 2 dB of the relevant DECCW criteria, after application of reasonable and feasible mitigation. In addition, the rail spur will only operate twice per day over a 15 minute period and will be indistinguishable from the current rail traffic.

Operations – Evening and Night

The noise modelling results for evening and night-time operations under calm weather conditions are presented and summarised against Project Specific Noise Criteria in *Figure 7-4*.

In the case of underground mining with surface processing plant the results indicate that for calm weather conditions the criteria is met for all representative receivers during the evening and is exceeded at one location during the night-time. At location A4, noise criteria is exceeded by 1dB, which is considered negligible.

Under various weather conditions, noise levels experienced at a particular location may increase or decrease from those experienced during calm weather conditions. To assess the worst case scenario, noise levels from the Project were assessed under moderate inversion (3℃/100m) conditions during the night. The results presented in *Table 7-4* and *Figure 7-5* indicate, that evening and night time noise impact is not likely at most receivers.

At times of adverse weather, criteria exceedances of 1 dB may occur at one location, A6 in the evening. At night, exceedances due to adverse weather are predicted at five locations A3, A4 and A10 by 1 dB(A), A2 by 2 dB(A) and A6 by 3 dB(A). These exceedance levels are within 5 dB of the criteria and therefore not considered significant, consistent with the INP's definition.

Underground blasting

Site specific MICs required to satisfy night-time and daytime ANZECC (1990) limits for overpressure are presented in *Table 7-9* for a range of blast-receptor distances upward of the identified minimum separation distance to residences from the portal i.e. 607 m. These were calculated using the results of 2007 monitoring of underground blasts for decline development, conducted at 209 m, 433 m and 491 m from the decline portal (i.e. source of noise overpressure). It should be noted that decline depth and orientation will change in future which would reduce overpressure noise escaping through the portal to residential areas from their current levels.

The results demonstrate that strict control of MIC values is needed to achieve the 95 dBL night time noise overpressure criteria at receptors. These MIC values should be used as a guide for proposed blasts.

Rail and road

Based on expected traffic volumes and distribution, the residences most likely to be affected by road traffic noise from the Project are those on Eyre Street to the east of Comstock Street.

Expected traffic noise levels were calculated for a representative residence of Eyre Street (i.e. façade 20 m from the road) and are presented in *Table 7-8*. The results indicate that during the busiest hour of the day or night, the environmental criteria for road traffic noise will be met at the potentially most affected residence and therefore no significant road traffic noise impacts are anticipated.

Section 14.4 discusses the impacts from rail movements. Rail movements for the transport of concentrate can be accommodated within the current variations of normal train operations on the main rail line. Therefore, no net change in noise impact or exposure is generally anticipated from operations along the main line.

The current noise, vibration and overpressure management plan will be updated to take into account the changes from Project activities. This includes amendments to the procedures for blasting, noise monitoring and compliance assessment. This plan will be updated regularly to reflect any further changes to the operations.

Monitoring will include attended as well as unattended noise recordings in specified locations and under various operating conditions. Similarly, all blasts, vibration and overpressure, will be monitored.

Noise levels generated by the Project are not expected to significantly exceed relevant DECCW criteria at sensitive receivers and can be managed by implementation of management and monitoring measures outlined in *Section 7.5*. Night time operations are not expected to cause sleep disturbance and no significant noise impacts from road or main rail line traffic generated by the Project are predicted. Blast design will incorporate control on the charge masses and implementation of management procedures, including monitoring of all blasts, to enable acceptable limits to be maintained with respect to airblast noise overpressure and ground vibration at nearby sensitive receptors.

Historic Heritage

Mining and related activities have been carried out in Broken Hill and in the Project Area since the 1880s. A substantial amount of the mining infrastructure from various mining phases is retained *in situ*. This remnant mining infrastructure is predominately located along the Line of Lode which extends to the north and south of the Project Area. This has contributed to Broken Hill's industrial heritage and tourism significance. The following items have been identified as historically significant:

State Heritage Register:

- BHP chimney ruins of first offices

Register of National Estate:

- Line of Lode
- Kintore Shaft

NSW National Trust Register:

- Nos 4 and 7 Winding Houses and Headframes

NSW National Trust Industrial Archaeology Sites List:

- Broken Hill South Mine
- Kintore Shaft Group (Nos 4 and 7 Winding Houses and Headframes)
- BHP Mine (Delprat Shaft); and
- North Broken Hill Ltd mine remains

Broken Hill LEP Development Control Plan (DCP) No 3 Heritage Development 1997:

The Broken Hill heritage provisions outlined in the LEP and DCP are aimed at protecting places and buildings of archaeological or heritage significance within the City of Broken Hill. Schedule 1 contains 356 individual items, of these 61 items located within the BHOP surface areas of CML7 have been identified as of heritage significance. Some of these items, for example the change house and underground offices have already been substantially altered form their original state. The items are listed in *Table 11-1* and their locations indicated on *Figure 11-1 and 11-2*.

A heritage impact assessment was undertaken to assess the potential impacts to historically significant heritage located across the Project Area (*Chapter 11 and Annexure L*).

Design of the proposed processing plant layout has been sensitive to the importance of existing heritage items. The processing infrastructure is not expected to adversely impact heritage items as it will be located within the large vacant area to the south west of the old mill building. This general area has historically been used as a mill area.

The new mining equipment and infrastructure will add a modern layer of processing technology to the site. As the historical buildings will be retained, new and old buildings will co-exist. This will add value by demonstrating temporal technological advances in the mining industry.

The proposed uses for heritage listed items are outlined in *Table 11-2*. Ten buildings are to be adaptively re-used. Three of these buildings will be renovated and used for administrative office purposes and five will be repaired and used for storage. The electrical workshop is to be used as maintenance offices and fixed plant workshop. The changehouse is to be refitted as a crib room, training room, first aid centre and underground office.

Measures have been identified to mitigate potential impacts to heritage values arising from the Project and maintain the cultural and industrial heritage significance of the Rasp Mine. These measures will be included in a conservation management plan to be prepared for the Project Area.

BHOP is cognizant that the City of Broken Hill has sought registration from the Department of Environment, Water, Heritage and the Arts for the City of Broken Hill to be known as an historical town recognised for its mining contributions. BHOP supports this application and is in on-going discussion with DEWHA. BHOP discussions with DEWHA and BHCC have concluded that there will be no significant impact on its proposed operations.

Other Environmental Issues

The environmental assessment also addresses issues of water management, including surface and groundwater, visual impacts, ecology, traffic, waste management and rehabilitation. The principles of ESD are addressed in *Chapter 19*.

Summary

In addition to design considerations, management and monitoring measures have been presented throughout this report to manage any potential adverse environmental impacts. Key management and monitoring measures include:

- attended as well as unattended noise monitoring in specified locations and operating conditions;
- continuous and real time air quality monitoring with alarm systems to enable rapid response;
- a comprehensive Lead Management Plan;
- a detailed Heritage Management Plan; and
- water management measures to maximise recycling and reduce potential impacts on the town water supply and manage stormwater events.

A summary of BHOP proposed management measures to minimise and / or prevent potential environmental impacts is provided in Chapter 18, Statement of Commitments.

As a result of the extensive mining history of the site, the site is highly modified and disturbed. The original landform has been significantly altered, all original native vegetation has been removed and soils have been degraded. However, the site has a highly significant heritage value and therefore the mine closure strategy aims to enhance this value.

Implementation of the rehabilitation and mine closure management strategy will preserve the historic mining character of the site for future generations and minimise the potential long-term adverse impacts. Environmental outcomes from the strategy will include rehabilitation of disturbed area, preservation of historic heritage values and implementation of appropriate drainage and erosion controls.

This Project will allow for the extraction of a valuable resource whilst not significantly impacting on the environment. The Project will generate both local and regional employment opportunities and will benefit the community of Broken Hill.