CHAPTER 2 DESCRIPTION OF THE PROJECT

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2 DESCRIPTION OF THE PROJECT

This chapter details the geology and resource upon which the Project is based and the components and processes to be applied in the implementation of the Project from construction to closure.

2.1 GEOLOGY AND RESOURCE DESCRIPTION

2.1.1 Regional geology

The Broken Hill orebody consists of several discrete stratiform lodes or lenses that carry economic quantities of zinc and lead sulphides accompanied by silver minerals and traces of copper.

The deposit lies in a thick sequence of highly metamorphosed and deformed Proterozoic sedimentary and volcanic rocks. The sequence is called the Willyama Supergroup and was laid down in shallow marine and continental conditions between 1642 and 1710 million years ago. Following deposition of the sediments and the ore, the sequence was intensely folded and sheared in several episodes during and after the main granulite facies metamorphic event. An early fold overturned the sequence in much of the district, including Broken Hill, and on this were later superimposed steep, sharp folds, followed by lesser cross folds and many shears. The deposit lies in these steeply folded, overturned rocks.

The Willyama Supergroup forms the core of the uplifted and dissected Broken Hill Domain, the edges of which are faulted or flanked and concealed by younger rocks. It is well exposed within a radius of 80 km of Broken Hill and contains many minor occurrences of lead, zinc, silver, iron, manganese, copper, cobalt, nickel, tungsten, uranium and tin.

2.1.2 Orebody and resource description

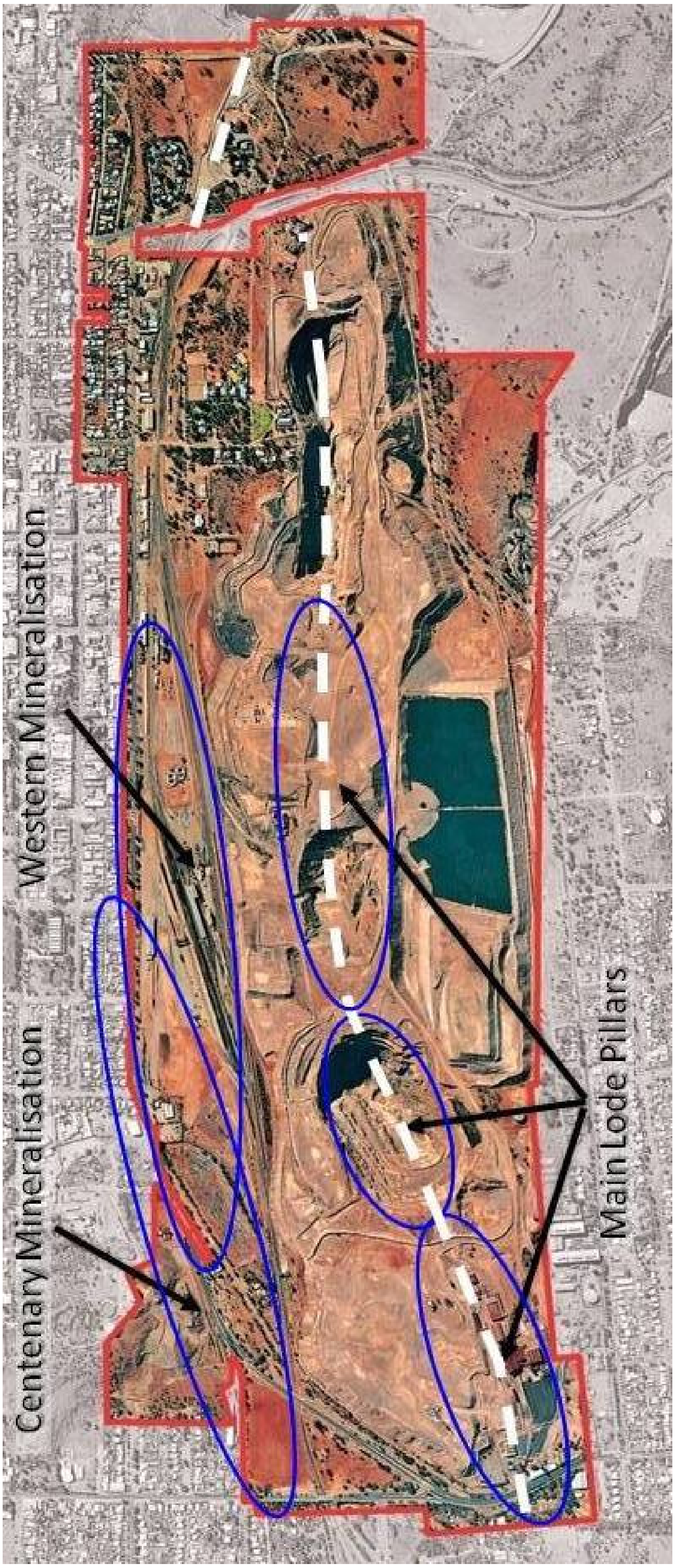
The historic orebody, known locally as the Line of Lode, is more than 8 km in length, with a maximum width of 250 m. Before mining, the deposit would have contained more than 300 Mt of high grade sulphide ore and has been the subject of historical mining due to its silver rich lead lodes.

During the period 1884 to 1991 a total of 58 Mt of ore has been mined from CML7 containing around 20 percent lead+zinc and 200 grams per tonne of silver, with 80 per cent from underground workings.

The remaining resources, including potential resources, within CML7 can be divided into three broad groups; the Western Mineralisation, the Centenary Mineralisation and the Main Lode Pillars. These resources can be accessed via the Rasp Decline located at the northern end of the Kintore Pit. A plan indicating the extent of identified resources from these groups is provided in Figure 2-1.

CBH has employed a number of consultants who have used both current and historical data for the modelling of the CML7 orebody. The grade and nature of the orebody is best described by the resource definition work completed by Colin Lutherborrow of Zilloc Pty Ltd in 2006 and is described below.

Figure 2-1 Location of Resources and Ore Bodies



Legend

Approximate Area of Orebody & Resource

CML7 Boundary

Broken Hill Operations Pty Ltd

Source: BHOP

Scale: Not to scale

Figure 2-2 Typical geological cross-section – looking north

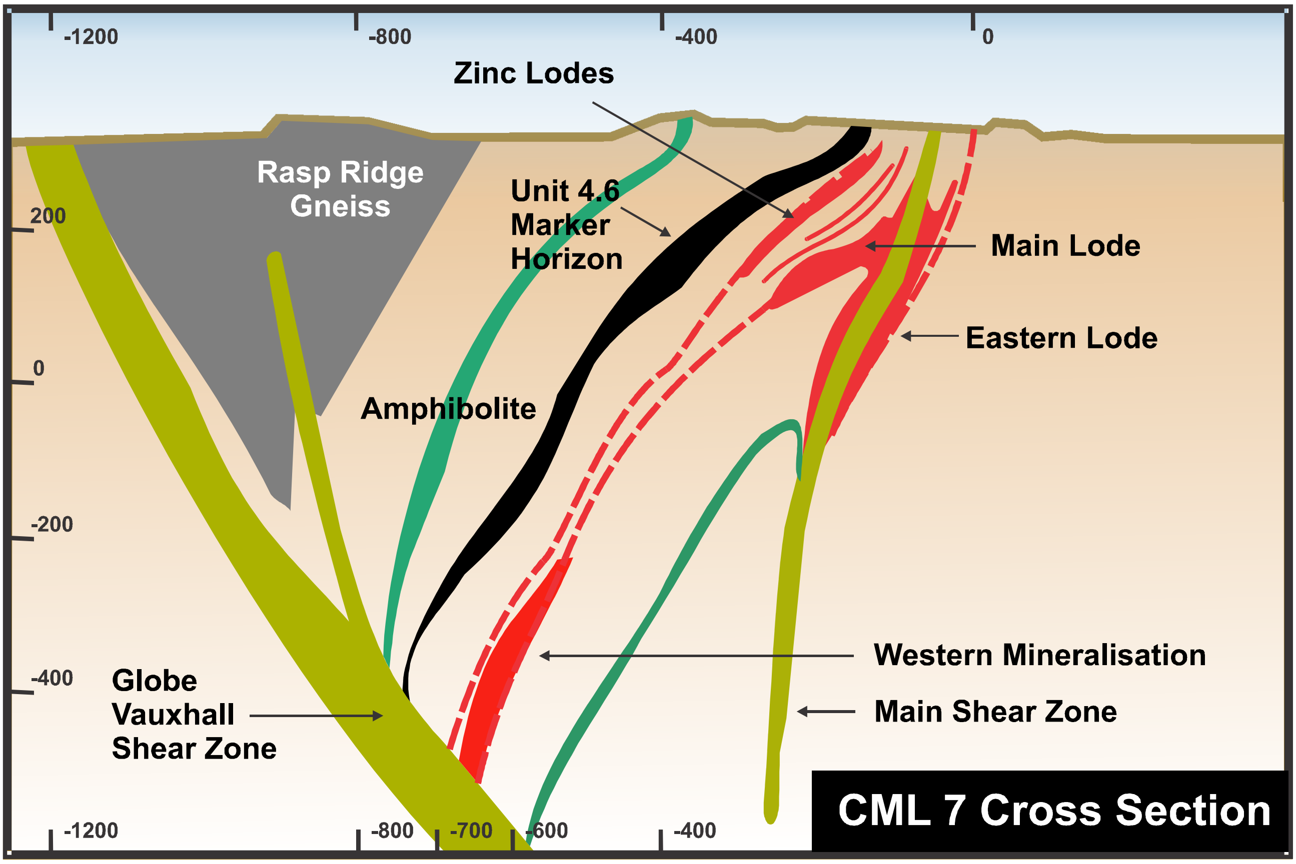


Table 2-1 contains the stated ore reserve and *Table 2-2* the mineral resources for CML7.

Table 2-1 Ore reserve as at 30 June 2009

	Category	'000 t	Zn%	Pb%	Ag g/t
Western Mineralisation	Probable	2,650	5.5	4.1	46
Zinc Lode	Probable	175	7.8	4.2	48
Main Lode Pillars	Probable	344	8.9	8.7	207
Total Ore Reserve	**Probable**	**3,170**	**6.0**	**4.6**	**64**

Source: ASX Announcement 1 July 2009 – Significant Resource Increase for the Rasp Mine.

Table 2-2 Mineral resources as at 30 June 2009

	Category	'000 t	Zn%	Pb%	Ag g/t
Western Mineralisation	Indicated	5,400	5.2	3.9	47
	Inferred	4,500	4.5	3.0	37
Zinc Lode	Indicated	151	11.6	6.6	73
	Inferred	141	9.4	5.1	76
Main Lode Pillars	Indicated	1,294	10.0	9.6	243
	Inferred	2,317	12.2	11.1	251
Centenary Mineralisation	Inferred	2,700	6.1	3.9	49
Total Mineral Resource	**Indicated**	**6,845**	**6.2**	**5.0**	**85**
	Inferred	**9,658**	**6.9**	**5.2**	**92**
	Total	**16,503**	**6.6**	**5.1**	**89**

Source: ASX Announcement 1 July 2009 – Significant Resource Increase for the Rasp Mine.

With a potential resource of 10 Mt in the Western Mineralisation and 2.7 Mt in the underlying Centenary Mineralisation, together with an estimated 3.6 Mt of Main Lode ore blocks, the Rasp Mine life has the potential to exceed 20 years. This application seeks approval for 15 years of mining incorporating construction and operation of a processing plant, underground mining operations and closure activities within the resource as described below.

Western Mineralisation

The Western Mineralisation lies down dip of the main Line of Lode and within the same stratigraphic rock package. A plan showing the extent of identified resources for the Western Mineralisation is shown in Figure 2-1. A typical cross section through the Western Mineralisation and enclosing stratigraphic setting is shown in *Figure 2-2*.

The Western Mineralisation is hosted within metamorphosed sands, silts and muds bounded to the east and west by a quartz – feldspar – garnet rock, Potosi Gneiss and gradations between these two rock types.

The Western Mineralisation is located to the west of the historical mining areas on CML7 at Broken Hill. It is a 10 m to 80 m wide sheet of mineralisation dipping at around 60 degrees to the west and plunging at around 25 degrees to the south. It consists of continuous bands of garnet quartzite and blue quartz, together with zones of veins, stringers and massive sulphides.

The main economic minerals of interest are galena (lead sulphide), sphalerite (zinc sulphide) and the copper-silver mineral tetrahedrite. The Western Mineralisation ore is a facies equivalent of the Zinc Lodes of the main Line of Lode and is characterised by gangue quartz, garnet, gahnite and pyroxenoid.

Centenary Mineralisation

The Centenary Mineralisation is located down dip from the Western Mineralisation and is separated from it by the Globe Vauxhall Shear Zone. The Centenary is similar in style to the Western Mineralisation.

The Centenary Mineralisation is a continuation of the Western Mineralisation down dip and is separated by the Globe Vauxhall Shear Zone. The Centenary is similar in style to the Western Mineralisation but contains mineralisation in both the 4.5 and the 4.7 units of the stratigraphy.

Main Lode Pillars

The Main Lode mineralisation on CML7 comprises 2 and 3 lens material. The orebody is thin and sub-vertical at the top and passes with depth to an area of complex fold interference where the ore dramatically increases in thickness and grade. Below this the ore becomes sub-vertical and thin again. The Main Lode was the primary focus of mining operations on CML7 between 1884 and 1991, and BHOP will be focusing on the remaining material.

The targeted ore is situated in the main Line of Lode in the vicinity of Kintore Pit, Blocks 8 to 12. The Main Lode Pillars are originally uneconomic blocks that modern bulk mining methods are able to economically recover. These Pillars are dispersed throughout old timber stoping areas and provide a platform to explore the highly prospective footwall which to date is essentially unmined.

Zinc Lodes

The Zinc Lodes on CML7 are along a strike extension of the B and C Lodes that are mined on the Perilya Broken Hill Pty Ltd lease to the west. The geology of the B and C lodes has been well documented in Broken Hill over a long period. On CML7 the B lode material above is concentrated in an area of fold interference and the C lode material is concentrated in “dropper” structures which are axial planar to the B lode folds. This is typical of B and C lodes throughout the field.

2.1.3 Saleable minerals from the ore

The coarse grain size and silicate gangue mineralogy of Broken Hill ores allows good recoveries and production of coarse grained concentrates with a low level of penalty elements.

The mineralogy for Broken Hill ores is well known and is extremely easy to liberate (relative to other ore bodies) using differential froth flotation methods, with grind size of 80% passing 200 microns producing a very coarse concentrate, with the following approximate grades and recoveries:

- Zinc concentrate: 90% recovery, 50% zinc (Zn), 12% iron (Fe), 9% moisture; and
- Lead Concentrate: 90% recovery, 68% lead (Pb), 600 g/t silver (Ag), 9% moisture.

2.2 OVERVIEW OF THE PROJECT

BHOP proposes to mine the Western Mineralisation, Centenary Mineralisation and Main Lode Pillars zinc-lead-silver masses within the Project Area using underground mining methods. Mining will take place over 15 years including one year to construct the processing plant an estimated 13 years for extraction of ore and one year for closure.

In summary the ore excavated during mining operations will be processed by an on-site crushing and flotation plant designed to produce high quality lead and zinc concentrates, which will be dispatched by rail for smelting and/or shipping to market. Silver will be extracted from the lead concentrate during smelting and is therefore considered as a component of lead throughout this proposal.

For a short period during construction of the processing plant any ore mined will be crushed, stockpiled and transported off site for mineral processing.

Key components of the Project are (refer to *Figure 2-3)*:

- expanded underground mine;

- surface ventilation fan;
- explosives magazine;
- ROM pad;
- processing plant;
- concentrate loading and transport system;
- mine back fill plant;
- tailings storage facilities (TSF1 and TSF2);
- evaporation and collection ponds;
- haul roads and access corridors; and
- offices, workshops and other supporting facilities (changehouse, control rooms, stores, vehicle wash facility, power distribution system and core yard).

The key Project information is summarised in *Table 2-3*.

Table 2-3 Key Project information

Component	Proposed
Mine life	15 years (includes construction and closure)
Tenement status	CML7 – Incorporates the Rasp Mine.
Approval period	15 years comprising construction, underground mining, processing operations and closure.
Mining methodology	Underground mining using various methods including long hole, benching, modified Avoca, room and pillar or uphole retreat.
Mining rate and total production	750 000 tpa ore. Total production over life of Project: Approximately 8,450,000 t
Waste rock disposal	Underground: Backfill Surface: Inert material to be used for road repair and bunding and rehabilitation at closure
Processing methodology	Crushing, grinding, flotation, thickening and filtration at on-site processing facilities.
Processing rates	250 tph in crushing plant and 93.8 tph in grinding plant.
Concentrate production	Lead: 44,000 tpa (concentrate 73% Pb and 985 g/t Ag) Zinc: 87,000 tpa (concentrate 50% Zn)
Tailings disposal	Fine tailings disposal (approximately 320,000 tpa):- - TSF1 existing on-site TSF (10 m raise), and - TSF2 Blackwood Pit Coarse tailings disposal (approximately 320,000 tpa) as underground stope back fill.
Services	Extensions to existing substations, water lines and phone lines. New 22kV overhead powerlines to be constructed.

Component	Proposed
External roads	No changes to external road network.
Water supply	Potable / treated water 9 ML/pa Raw untreated water 139 ML/pa Reclaimed / recycled water 300 ML/pa
Employment numbers	Construction and commissioning: 107 Full Production: 143
Hours of operation	Construction: 7 days per week, 7am to 7pm. Underground Operations: 7 days per week, 24 hours per day Processing Plant: Crushing and screening - 7 days per week, 7am to 7pm. Shunting 7 days per week, 7am to 6pm. Activities not listed above – 7 days per week, 24 hours per day.

2.2.1 Timing

After gaining the necessary approvals, construction will begin on the processing plant and associated surface infrastructure, and the underground mining will increase to a mining production phase of 750,00 tpa.

The construction phase of the works will last for up to twelve months. During the construction phase production from the underground operations will continue and will be crushed and removed from site for mineral processing until the processing plant is completed. It is predicted to commence full underground operations during the first quarter of 2012 and continue for 13 years. The planned schedule is provided in *Table 2-4*.

Table 2-4 Project Schedule

Activity	Estimated Start Date	Duration
Underground mining, mineral processing off-site	July 2010	18 months
Detailed engineering design	April 2010	6 months
Project Construction	January 2011	12 months
Underground mining, mineral processing on-site	January 2012	13 years
Concentrate production	January 2012	13 years
Decommissioning and closure	January 2025	12 months

2.2.2 BHOP management systems

BHOP contracted Macmahon Underground (Macmahon) for the development of the exploration decline (Rasp Decline). As the operating company Macmahon implemented its safety and environmental systems at the site. In addition BHOP developed a Noise Blasting Vibration and Overpressure Protocol and an Air Quality Management Plan that were also implemented during this period. BHOP has continued to use these systems where appropriate and while operations were in suspension. BHOP is in the process of compiling its safety and environment management systems.

BHOP places the highest priority on the safety and health of employees, contractors and visitors, and the protection of the natural environment. BHOP is committed to achieving a high level of performance in these areas and will conduct its operations responsibly and in a manner that promotes safe work habits, provides adequate safety precautions and limits the effect of its activities on the natural environment to the maximum practical extent.

The BHOP has a number of policies developed which will form the basis of the Safety and Environmental Management System:

- Health and Safety Policy;
- Environment Policy;
- Risk Management Policy; and
- Community Partnerships Policy.

These policies together with their associated standards and guidelines will provide management, employees and contractors with a clear understanding of the requirements for managing safety, health and environment performance at the Rasp Mine.

The Safety, Health and Environment Management System wil broadly follow the structure of a risk based, continuous improvement management model outlined in Australian and international standards:

- International Standards Organisation: 14000 series for Environmental Management
- Australian / New Zealand Standard: 4801 Occupational Health and Safety Management Systems
- Australian / New Zealand Standard: 4360 Risk Management

BHOP requires its managers, employees and contractors to:

- Comply with legal requirements as a minimum and go beyond those requirements where necessary to meet CBH policy commitments and identified industry standards;
- Continuously assess the potential effects of its activities and integrate safety and environmental considerations into all phases of the operations, including design, construction, operations, closure and relinquishment;
- Minimise its effects on the natural environment and in particular provide efficient use of energy, water and other resources, limit waste generation and dispose of wastes in a responsible manner;
- Progressively rehabilitate areas no longer required using practical and cost-effective methods in agreement with the local communities;
- Advise, train and supervise employees and contractors in safe job procedures, hazards and precautions as well as in environmental protection measures;
- Establish accountability of employees and management, and contractors for their safety and environmental performance; and
- Establish and maintain management systems to support and implement the CBH corporate policies and standards.

To achieve these requirements and to implement its safety and environment policies BHOP will compile a number of standards, procedures and working instructions around the following key areas:

- leadership and accountability;
- legal requirements;
- risk and change management;
- planning, goals and targets;
- awareness, competency and behaviour
- communication and consultation;
- operations and maintenance;
- design, construction and commissioning;
- suppliers and contractors;
- hazard incident reporting and investigation;
- crisis and emergency management;
- injury management and rehabilitation
- environment rehabilitation
- monitoring audit and review

The implementation process by BHOP consists of establishing policies and standards and incorporating their key requirements in procedures and work instructions. Identifying responsibilities and delegating to trained people who are tested in what is required. Monitoring performance, workplace conditions and environmental impacts are key elements for successful implementation. Employee involvement and consultation are also seen as critical and occur throughout the process as appropriate. In addition BHOP plans to achieve continuous improvement through management reviews of performance together with consideration of new information, legislation and new industry initiatives.

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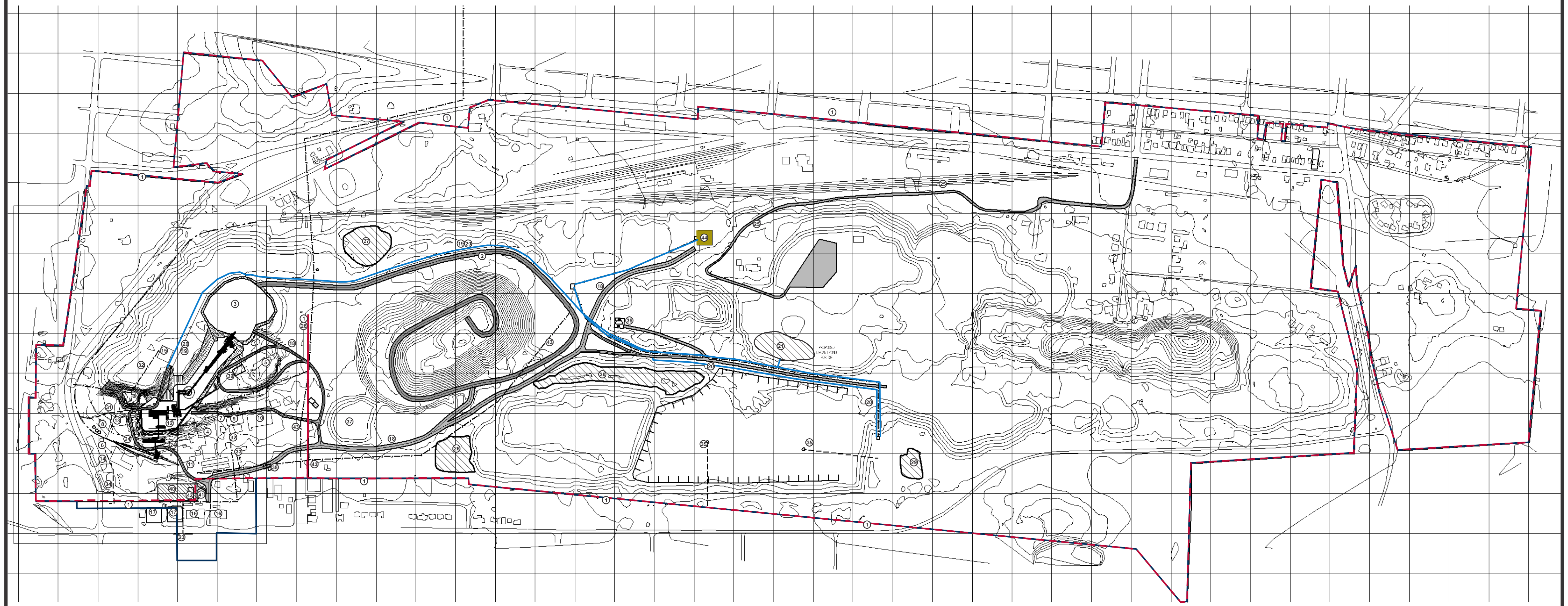
Figure 2-3 Proposed site layout - Project Area



Legend

CML 7 Lease Boundary

Project Application Area

1. CML7 BOUNDARY
2. HAUL ROAD
3. ROM PAD
4. OLD CONCENTRATOR BUILDING
5. OLD SANDFILL PLANT
6. OLD SHAFT No7
7. OLD SHAFT No1
8. OLD SHAFT No4
9. OLD ELECTRICAL SHOP
10. MACMAHONS WORKSHOP
11. OLD THICKENER TANKS
12. OLD LOADOUT
13. OLD CHANGEHOUSE (EMERGENCY CONCENTRATE STORAGE)
14. OLD SHAFT No7 OFFICES
15. TELECOMMUNICATION COMPOUND
16. CBH MAIN OFFICE
17. BOWLING GREEN
18. ACCESS ROADS
19. PIPE CORRIDOR (PLANT TO MINE BACKFILL)
20. PIPE CORRIDOR (MINE BACKFILL TO TSF)
21. PROPOSED DECANT POND
22. GOSSAN STREET 22kV SUPPLY (PROPOSED)
23. EYRE STREET 22kV SUPPLY (PROPOSED)
24. ACCESS ROAD TO COMMUNICATIONS TOWER
25. ACCESS ROAD TO BROKEN EARTH CAFE
26. EASEMENT
27. EVAPORATION POND
28. EVAPORATION POND
29. HORWOOD DAM
30. CATCHMENT
31. FIBRE OPTIC CABLE BURIED (SURVEYED)
32. WASH BAY SETTLEMENT DAMS
33. EXISTING BURIED SERVICES (SURVEYED)
34. EXISTING BURIED WATER LINE TO PERILYA (SURVEYED)
35. EXISTING DECANT PIPING (ASSUMED)
36. MAGAZINE (SURVEYED)
37. NEW VENT RISE (PROPOSED)
38. NEW VEHICLE WHEEL WASH
39. NEW REAGENT STORAGE SHED (PROPOSED)
40. CAR PARK
41. TEMPORARY CHANGE ROOMS
42. NEW CHANGE ROOMS (PROPOSED)
43. MINING 22kV SUPPLY
44. BACKFILL PLANT

Broken Hill Operations Pty Ltd

Source: Abseque Engineering & Construction Ltd

Scale: Not to scale

2.3 CONSTRUCTION

Equipment used during construction will include 50 t truck mounted cranes, mobile cranes, light vehicles, delivery trucks (semis and rigid), concrete agitators (as required), elevating work platforms, earth moving equipment and a variety of smaller hand held tooling (e.g. welders, grinders, saws, etc). Construction of infrastructure will be short term in duration with an expected construction period of up to twelve months. Potential impacts associated with construction have been addressed in this EAR.

2.3.1 Construction phases

The Project will require the construction of civil type infrastructure and will be conducted in the following stages:

- Stage 1 – Preconstruction;
- Stage 2 – Construction; and
- Stage 3 – Commissioning.

Stage 1 – Preconstruction

The preconstruction stage finalises engineering designs, establishes critical services and prepares the land site for construction purposes. This will involve:

- refinement of designs from pre-feasibility stage taking into account mitigation of core business risks such as environmental impacts and safety standards;
- the establishment of essential services such as power (22 kV line to the eastern boundary of the Project Area off Eyre Street) and water (pipelines for “raw” and potable water);
- the creation of emergency response infrastructure such as emergency plans, muster areas and a medical centre;
- land reprofiling (e.g. laydown yards, etc) and reinstatement of haul roads and railway lines;
- removal of superficial concrete structures (e.g. stacking conveyor track); and
- construction of a changehouse.

Stage 2 – General construction

The general construction stage involves the excavation of foundations and footings, placement of reinforced concrete, the erection of various structures (many prefabricated off-site) and the refurbishment of some existing buildings. The key activities include:

- excavation of free digging waste rock materials for major footings, foundations (e.g. ore bin) and permanent service lines (e.g. trenches);
- placement of reinforced concrete such as raft foundations for ball mills, crushers, conveyors, etc;
- installation of processing plant including crushers, storage bins, conveyors, grinding mills, flotation cells and thickening tanks;

- installation of pumps, pipe work and wiring throughout the processing facility;
- installation of an additional 22 kV line, substations and associated supply lines and water header and containment tanks;
- laying of new rail lines to concentrate filtration plant and installation of an indexing system to move wagons through the concentrate loading area;
- refurbishment and internal upgrade of existing buildings (no demolition) for offices, workshops, stores/warehouse and similar;
- decommissioning of temporary buildings (portables);
- construction of the enclosed concentrate filtration plant, reagent store and associated containment structures;
- works for surface water management; and
- installation of primary ventilation fans, fan evasee (diffuser) and associated noise reduction infrastructure.

Stage 3 – Commissioning

The commissioning stage involves testing equipment and plant, training operations personnel, debugging and gradually ramping up production. This will involve:

- erection of fencing;
- testing sirens and alarms;
- pre-commissioning - involving alignment and clearance checks on the mechanical equipment, electrical testing and instrumentation checks;
- service commissioning - testing of the plant using either water or air as appropriate;
- process commissioning - testing the plant using slurry to check tanks, pumps, piping, control systems and equipment; and
- production ramp-up to name plate (or design) capacity.

2.3.2 Heritage listed buildings

The design of the proposed mine and plant layout has been sensitive to the importance of existing heritage items. The strategy applied was an adaptive re-use of the buildings to preserve their heritage values (refer *Section 11.4.1* for additional details of heritage items).

The following facilities will be housed within existing buildings and only minor modifications to existing structures will be required for:

- security, office and administration building;
- crib room, training room, first aid centre and underground offices;
- core yard;

- maintenance offices, fixed plant workshop, electrical workshop, mobile plant workshop and maintenance store;
- concentrate storage; and
- store/warehouse buildings.

Due to age of the existing buildings on-site, the potential exists for asbestos to have been used in their construction (either as cladding for pipework or as asbestos sheeting). BHOP will develop an Asbestos Management Plan which will cover the assessment of buildings for asbestos and the safe containment and/or removal of the asbestos from affected buildings.

2.3.3 Access for construction

The existing access to the Project is from the current Eyre Street entrance. This will be used as the primary access throughout construction and operations, as discussed in *Chapter 14*.

During construction the access from South Road will be required for transit of heavy and/or wide deliveries of material and equipment for the processing plant. This will require the use of a safe entry procedure which will form part of the traffic management plan include spotters and may require the temporary stoppage of traffic to allow trucks to safely enter and exit the site.

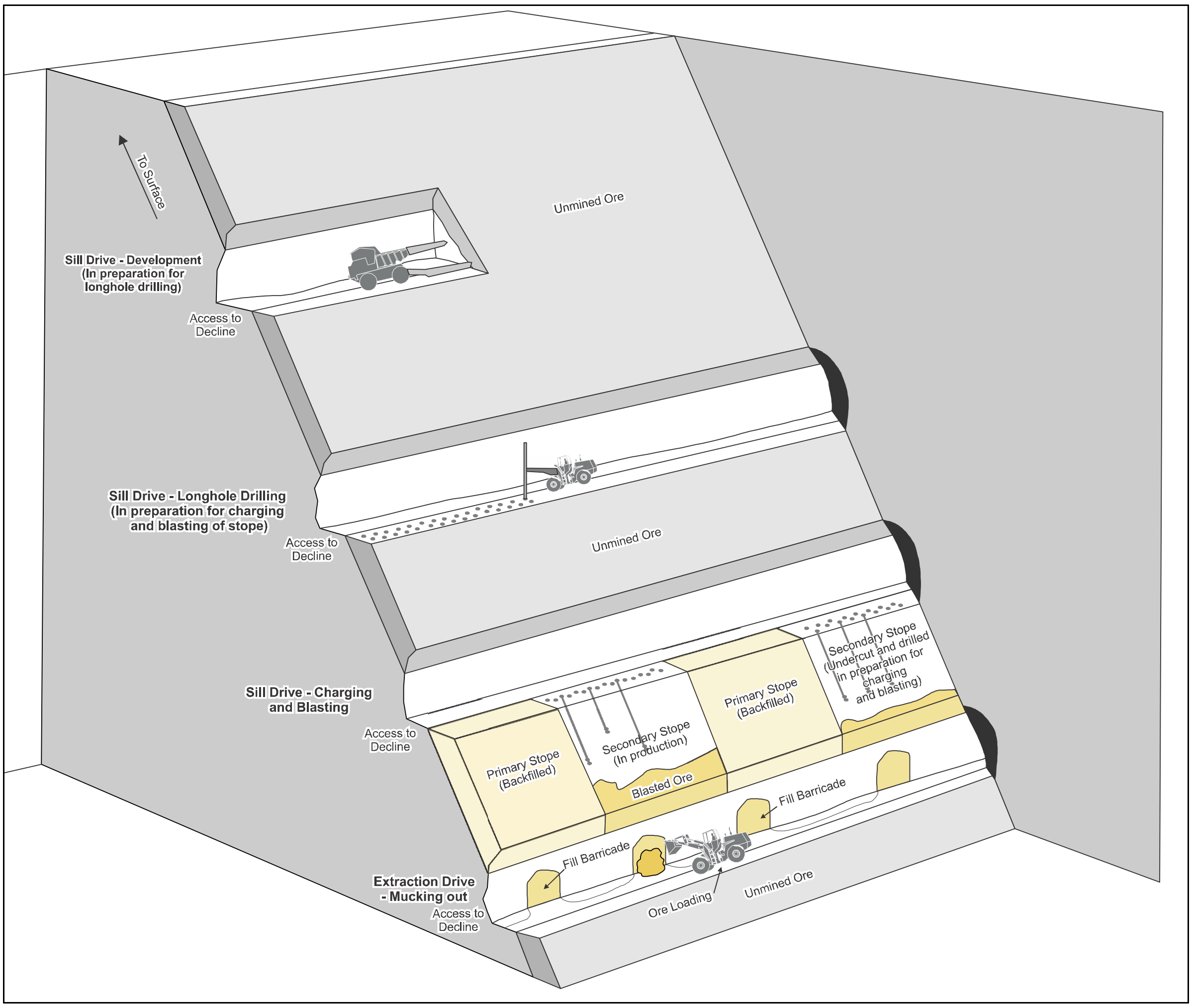
2.4 UNDERGROUND MINING

The underground operations will involve the mining of the Centenary and Western Mineralisation, and Main Lode Pillars. A variety of production methods will be utilised including; long hole open stoping (LHOS), benching, modified Avoca, room and pillar and uphole retreat. LHOS will be the most prevalent method used in the Western Mineralisation and Centenary Mineralisation (Figure 2-4) and uphole retreat will predominantly be used in the Main Lode Pillars.

All excavations will be of a stable design with no block cave operations and with back fill being placed in subsequent voids as a key control of subsidence and caving. Drill and blast will be the primary method used to break the ore into a size range which is less than 800 mm.

Underground mining will be accessed by the existing portal located in the northern end of the Kintore Pit. Mining of the Western and Centenary Mineralisation will predominately occur at depths 200 m below surface while some mining of the Main Lode Pillars may occur at depths of less than 100 m below surface (*Figure 2-5*). Drives will be developed from the decline and lead to production areas where stopes will be developed using conventional drill and blast methods. Ore and waste will be excavated using load haul dump (LHD) equipment and transported to loading points where mine trucks will transport ore to the ROM pad via the northwest haul road. Waste will predominately be used in underground back fill operations with some waste rock being retained and stored in the Kintore Pit for closure activities or temporary storage.

Figure 2-4 Indicative long hole stoping methodology



Development headings (declines, levels, tunnels, etc) will be constructed for modern mining equipment operation (provisionally 5.0 m wide x 5.5 m high) and will be reinforced with various combinations of rock bolts, cable dowels, mesh and shotcrete to provide for the safety of personnel.

Stope voids will be back filled with a combination of back fill materials including waste rock and deslimed tailings from the back fill plant. This will minimise rock stress build-up, stabilise the void and maximise ore recovery.

The process of placement of deslimed tailings (hydraulic backfill) will involve construction of purpose built bulkheads or barricades (containment walls) which are capable of withstanding the loads imposed by the fill material. The fill will be delivered, either via a fill hole or fill line, in short bursts – the duration of which is stipulated by the size of the void and its drainage characteristics. Water drainage pipes or matting will be placed into the stope and water decant holes will be drilled into the void to assess dewatering. Waste rock may also be tipped into the stope from the top of the sill drive.

Over the first 80 years of mining at Broken Hill, back fill placed into mining voids has occasional breached containment structures causing significant damage underground. BHOP proposes to manage this risk by:

- constructing purpose built containment structures that meet new design standards which take into account the need for drainage and loadings imposed by blasting, earthquakes and the material itself (sand and water);

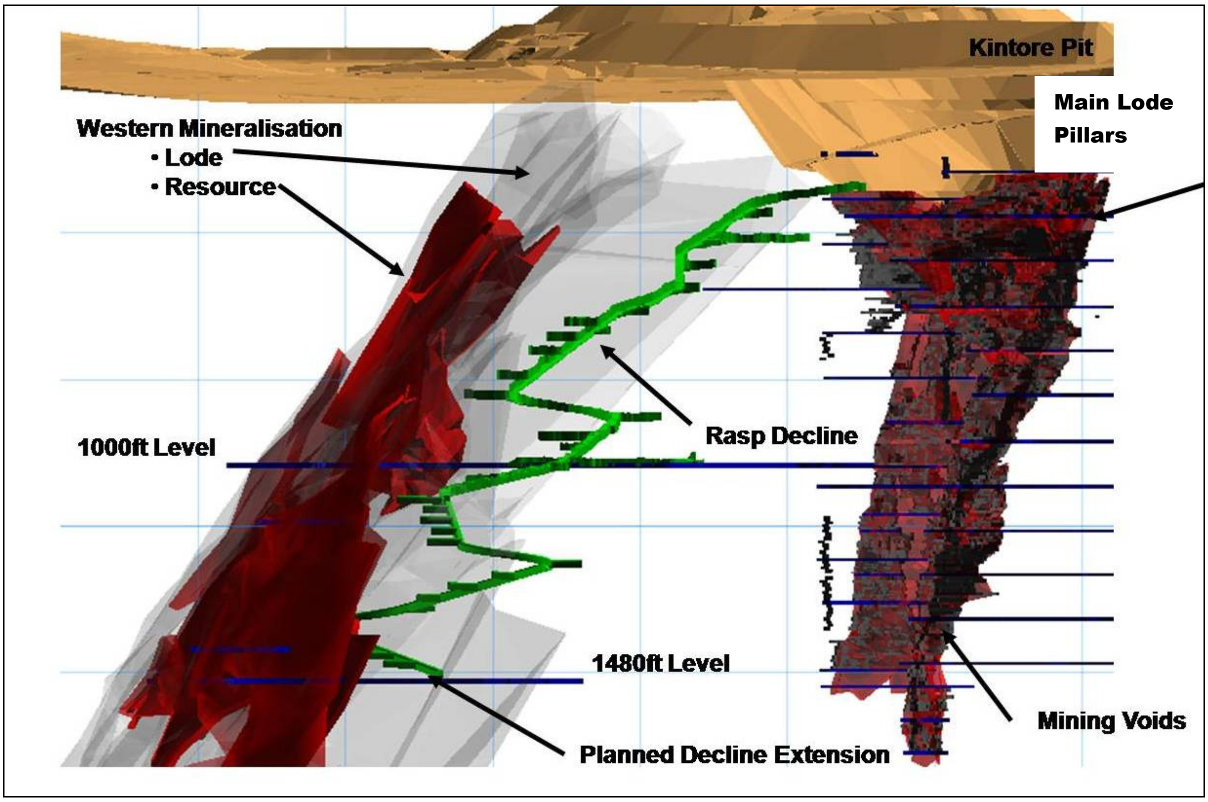
- ensuring that the containment structures and filling processes are routinely inspected and monitored;
- placing where possible fill in advance of mining activities – for example voids from old mining operations are filled before mining moves into the area;
- restricting blasting in close proximity to the structures during back fill placement; and
- development and implementation of procedures for inrush management.

The anticipated production schedule throughout underground operations is presented in *Table 2-5.*

Table 2-5 Preliminary production schedule

Year	Planned production	Zinc concentrate		Lead concentrate		
		Production	Zn content (approx)	Production	Pb content (approx)	Ag content (approx)
1	450,000 t	55,000 t	49.3%	30,000 t	73.5%	1000 g/t
2	475,000 t	56,000 t	49.3%	31,000 t	73.5%	1000 g/t
3	475,000 t	56,000 t	49.3%	31,000 t	73.5%	1000 g/t
4	525,000 t	62,000 t	49.2%	33,000 t	73.5%	950 g/t
5	600,000 t	70,000 t	49.1%	36,500 t	73.4%	950 g/t
6	675,000 t	78,500 t	49.1%	40,000 t	73.3%	925 g/t
7 onwards	750,000 t	87,000 t	49.1%	43,500 t	73.3%	925 g/t

Figure 2-5 View of proposed workings (looking north)



Source: BHOP

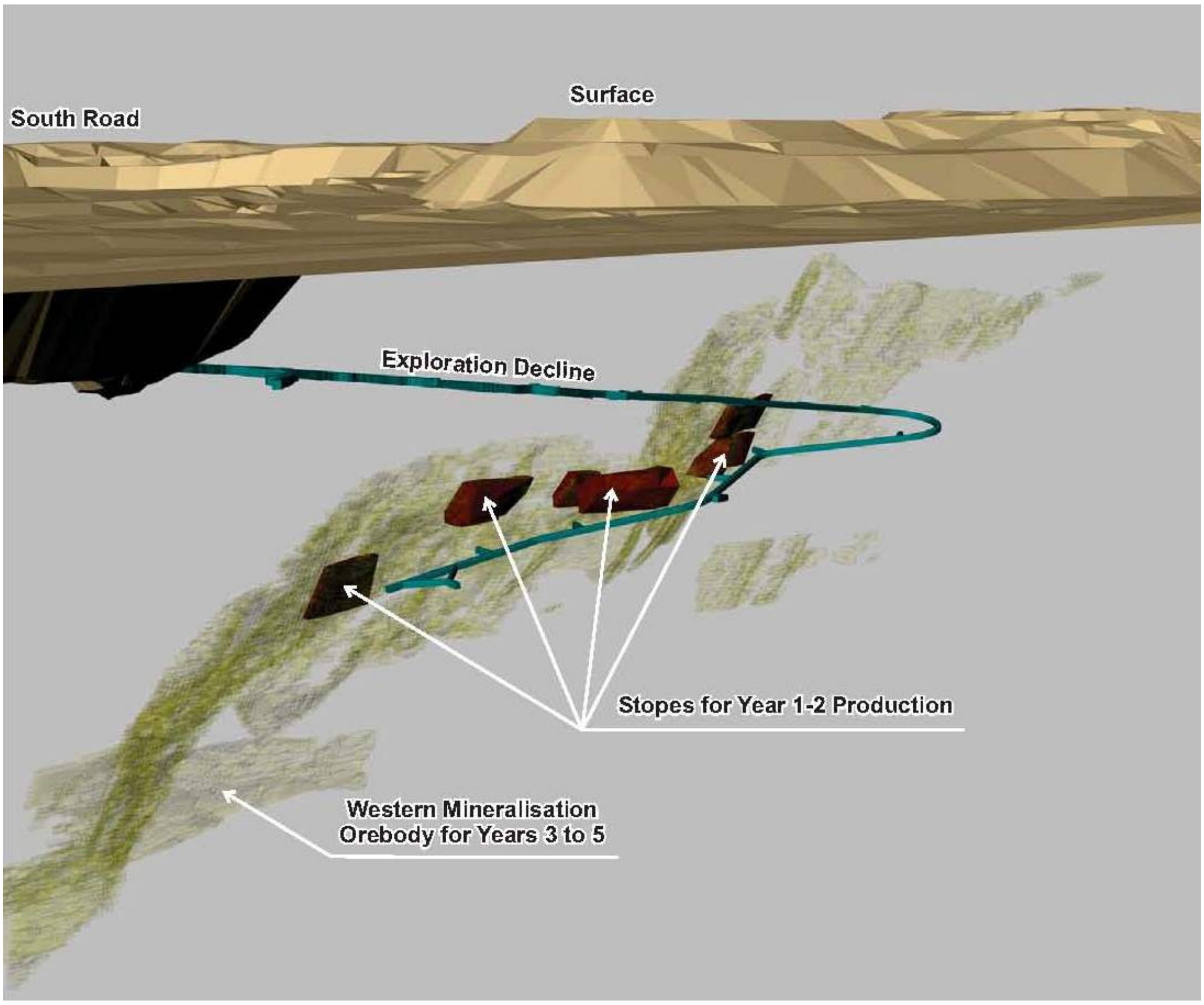
Stoping overview – Western and Centenary Mineralisation

The Western Mineralisation and Centenary Mineralisation are some of the last remaining unmined orebodies in Broken Hill; they were not previously mined due to the lower grade and nature of the deposit. The orebodies will be mined using predominantly LHOS method, however benching or modified Avoca methods may also be utilised depending on the height and width of the orebody.

Long hole open stoping requires the development of drives at the top and bottom of the stope, with the development being approximately 40 m apart. The development at the top of the stope (drill drive) is where the stope is drilled out in preparation for blasting. The lower development (mucking horizon) is where the blasted ore is mined. The development is generally 5 x 5 m and requires additional ground support; the drill drive is typically cable bolted and the draw points on the mucking horizon are cable bolted and shotcreted. The blast holes are typically between 89 - 102 mm diameter and are drilled on a ring spacing 2.5 – 3.0 m apart.

Figure 2-6 provides an overview of the general (idealised) stopes planned for production during the first two years of underground operations. A summary of stope geometry is presented in *Table 2-6*.

Figure 2-6 Indicative location of first five years of production (looking west)



Source: BHOP

Table 2-6 Summary of stope geometry for the Western and Centenary Mineralisation stopes

Parameter	Western Mineralisation	Centenary Mineralisation
Level interval	Fixed at 40 m (sill to sill)	Fixed at 40 m (sill to sill)
Strike length	Average 72 m (60 m to 80 m range)	Average 60 m (50 m to 70 m range)
Cross strike width	Average 14 m (12 m to 26 m range)	Average 10 m (6 m to 20 m range)
Depth below surface	Typically 250 m or more (but locally at 150 m below surface)	Typically 800 m or more
Blast hole size	Typically 89 mm – 102 mm	Typically 89 mm – 102 mm

Stoping overview – Pillars

The Main Lode Pillar resource has a large tonnage of high value ore remaining. This ore has generally been left behind in either vertical or crown pillars. Vertical pillars are generally narrow blocks of ore between 5 to 10 metres in width and approximately 30-35 metres to their full level in height. Crown pillars are horizontal pillars which are generally 5 to 10 metres in height, up to 100 metres in width and between 100 and 400 metres in length.

The method of recovering vertical pillars involves the development of a drive in the base of the pillar from which the uphole blast holes can be drilled and the blasted ore recovered. The development is generally 5 x 5 m and requires additional ground support in particular all development within a vertical pillar is shotcreted. The blast holes are typically between 64 – 76mm diameter and are drilled on a ring spacing of 1.5 m. Generally firings are kept quite small in the pillars with only 2 -3 rings of blast holes being fired at any time.

With crown pillars, due to the flat nature of the pillar, recovery is usually carried out via uphole retreat panels or room and pillar method. The development is generally 5 x 5 m with drives being spaced approximately 10 metres apart across the pillar. Extraction of the ore is usually by a combination of vertical blastholes (64 – 76 mm diameter) and jumbo strip (45 mm diameter) holes. As with vertical pillars the size of firings are kept small. A summary of slope geometry is present in *Table 2-7*.

Table 2-7 Summary of stope geometry for the Main Lode Pillars

Parameter	Vertical Pillars	Crown Pillars
Level interval	Variable – ranges from 15 m to 25 m (sill to sill)	Not applicable (usually located a level apart depending on the historic mining)
Strike length	Typically 17.5 m to 25 m.	Between 100m and 400m
Cross strike width	Typically 3 m to 5 m but locally 15 m wide.	Average 60 m (50 to 100 m range)
Depth below surface	Typically 100 m or more but some in closer proximity to surface	Typically 100 m or more but some in closer proximity to surface
Blast hole size	Typically 64 - 76 mm	Typically 45mm and 64 - 76 mm

Mining ventilation

A primary ventilation circuit will be constructed within the underground mine to draw air through the mine clearing exhaust fumes, dust and heat resulting from the mining operations and promoting fresh air intake.

Fresh air will enter the mine via the decline and the existing Delprat Shaft and travel through the mine, getting pushed and pulled by various fans underground until finally connecting with the 1480' haulage drive.

Exhaust or return air will leave the 1480' level via the existing Kintore Shaft. This process will be assured by twin 450 kW centrifugal fans (fitted with soft start) located at the top of the Kintore Shaft (refer to *Figure 2-3*). This site was selected as it is approximately central to the Project Area and away from the mining lease boundaries and surrounding neighbours. This type of fan was chosen because of its low noise level characteristics.

As described in *Chapters 7* and *8*, all ventilation outlets including fans are to be suitably orientated with appropriate noise attenuation mechanisms and air quality control measures installed to minimise impacts to the local community.

Supporting infrastructure

i. Power

The underground power will be delivered via a dedicated borehole (drilled from surface) located near the 11 kV transformer at the proposed back fill plant. A heavily armoured suspended cable will pass through the borehole to a purpose build underground excavation to an 11 kV to 1 kV transformer. The 1 kV feed will be distributed via armoured cables located in both development headings and dedicated bore holes to operational areas where power is required (e.g. for pumps, fans, mining equipment, etc).

ii. Communications

Fixed, mounted and portable two-way radio systems form the backbone of communications underground and at surface. Aside from the radio sets themselves, the radio infrastructure comprises three main components:

- battery backup systems – to ensure the system remains operational in a power outage;
- surface radio systems – surface radio operates via surface mounted antennas and interfaces with the "head-end" equipment used for underground communications; and
- leaky feeder and associated systems – a leaky feeder system will serve as the backbone of the underground radio system. The main components will be the leaky coaxial cable, amplifiers and the head-end equipment which powers the network.

Telephone communications will also be provided at strategic locations underground, for example, refuge chambers.

iii. Refuge chambers

Safety of underground personnel, in the event of a fire or similar emergency event in which the atmosphere underground is potentially rendered unsafe, will be assured by way of a refuge chamber network distributed throughout the mine in accordance with industry good practice (*"Guideline for Underground Emergency Escape Systems And The Provision of Self Rescuers",* Mine Safety Operations Division NSW Department of Primary Industry, Document Number MDG 1020, December 2001).

Refuge chambers will provide breathable air, first aid kit, water, seating, communications and toilet facilities in a safe environment for a period of up to 36 hours.

The placement of such chambers is dynamic and as such is not detailed here. They will be placed proximate to the areas in which mining activities are concentrated (for example; active stopes, decline, etc) based on the ongoing assessment of the requirements under the mine's emergency response and mine evacuation procedures.

iv. Underground water management

Process water will be required underground for drilling, dust suppression, housekeeping, gland water and emergency response purposes (e.g. fire control).

The process water is stored in header tanks (storage tanks) located in the Kintore Pit. The process water will be delivered into the underground workings via polythene pipe suspended from the backs (roof) of the decline and adjoining level development. The underground mine process water demand will be approximately 110,000 kL per annum and will be a mixture of reclaimed and raw water.

Mine water will be collected in underground sumps located in close proximity to the current workings. The sumps will provide surge capacity and enable the settling of suspended particulates. Water from the sumps will be transferred by way of a series of electrically driven pumps through interconnected pipes and boreholes to the proposed back fill plant location on the surface.

The underground mine water will be passed through an oil / water separator and settling process to further remove suspended particulates. The water will be stored in an appropriate tank at the proposed back fill plant, to be used as flushing water for the back fill process, or mixed back into the process water for use underground.

2.4.2 Mining induced subsidence

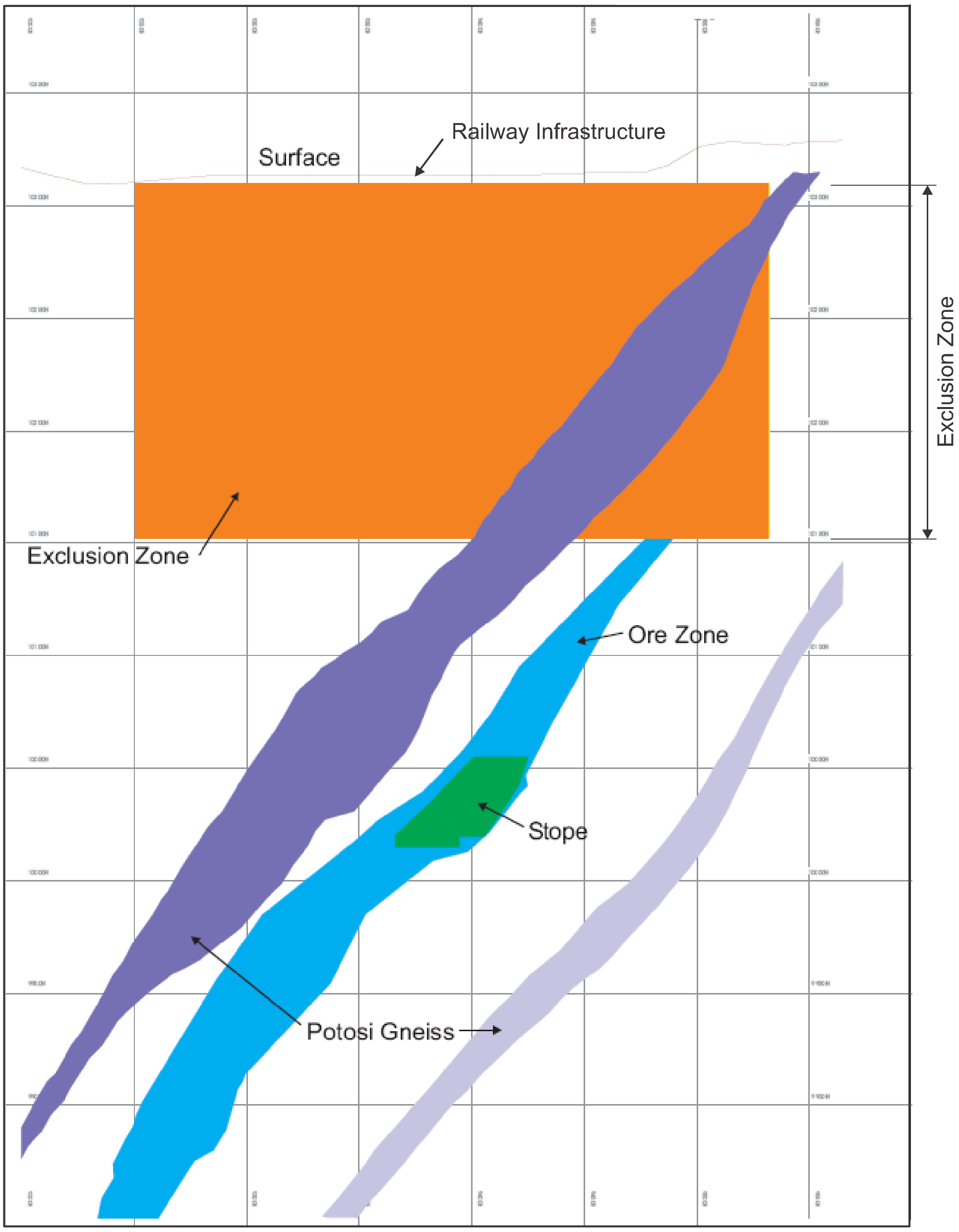
Mining induced subsidence is a term which describes the phenomena in which large scale earth vertical movements occur as a direct result of mining activities below surface. It is commonly associated with long-wall coal mining operations and rarely with hard rock operations. In hard rock, subsidence can occur either deliberately (e.g. block caving) or as an unplanned event (e.g. stope collapse).

Individual primary stopes will be back-filled with deslimed processing plant tailings and development waste to eliminate mining voids (no void = no place for the rock to fall) as well as facilitate the recovery of pillars between the primary stopes.

In addition, most mining will occur from approximately 200 m below surface downwards. There is not expected to be any surface subsidence as a result of the mining activities.

Coffey Mining was engaged to assess the potential for subsidence at surface and the effect, if any, on the railway operations from the underground operations. The assessment looked at the stope geometry, geology and the railway infrastructure. *Figure 2-7* shows a representative cross section through the Western Mineralisation demonstrating the significant separation between the mining operations and the surface facilities.

Figure 2-7 Surface exclusion zone for railway infrastructure - cross section (looking north)



Source: Coffey 2007

After extensive analysis Coffey Mining concluded that any stope failure (no matter how unlikely) would not propagate through to the surface and therefore significant surface subsidence is not predicted above the stopes. The Coffey Mining Subsidence Study is included in Volume 2 as *Annexure E.*

It is important to note that the analysis indicated that there exists some potential for hanging wall failures, however these failures are expected to be localised in extent. The presence of the more competent Potosi Gneiss above the stope hanging walls limits potential of a failure from propagating upward. Furthermore, if there was a failure, rock expansion would fill the void and prevent failure propagation to the surface.

Subsidence represents an unacceptable operational event for both economic and health and safety reasons, thus BHOP will utilise a number of management tools to mitigate the risk to a level which is as low as reasonably practicable. These interventions include:

- risk assessment process targeting excavation stability generally;

- a culture of continuous improvement which is captured as part of the mine design processes which use risk based approaches to evaluate mining strategies (see below);
- regular void monitoring using modern survey equipment;
- use of empirical stope design charts in conjunction with detailed geotechnical modelling of extraction sequences to ensure ground stresses do not exceed the capabilities of the rock mass;
- regular stope inspections used to ascertain if predicted behaviour matches the actual performance of the void;
- installation of modern ground support / reinforcement systems which capitalise on the inherent strength of the rock mass;
- placement of mine back fill (eliminating the void) in a timely manner after production has ceased; and
- use of trained and competent people in critical functional roles such as mine technical services and mining operations.

As part of the mine design process, each stope will undergo an individual risk assessment. The assessment will address the following:

- stope size and shape;
- ground support requirements, including additional support into the hanging wall if required;
- ring design and stope firing sequence; and
- back fill requirements.

This process will mitigate the potential for localised failures within the stoping blocks. Additional diamond drilling and geological mapping of the orebody, footwall and hanging-wall will occur once the underground development has progressed sufficiently. This additional geological and geotechnical information will be used for the individual stope assessments and in the larger mine planning process to further mitigate the risk of localised failures.

2.4.3 Ore transportation

Ore extracted during underground operations will be transported by haul trucks to the ROM pad via the haul road located to the west of the Kintore Pit.

This haul road is being reinstated around the northwest side of the pit to aid in the management of potential noise and dust issues. The haul road will be sealed (from about 50 m from the exit of the Pit) to reduce dust emissions and to address potential noise impacts bunding at a height of 4 m will be installed.

In addition a street sweeper will be utilised to minimise dust build up on sealed roads. For unsealed roads a combination of chemical dust suppressants and water will be utilised, with the water being delivered through the installation of water sprays or the use of a water truck.

The proposed locations of the haul road and ROM pad are provided in *Figure 2-3*.

2.4.4 Waste rock

Underground waste rock material will comprise the following geological units:

- Metasediments – the most abundant rock type comprising psammite (quartz – feldspar) and pelite (biotite, sillimanite, garnet, feldspar);

- Potosi Gneiss – a leucocratic quartzo-feldspathic gneiss comprising quartz + feldspar + biotite + garnet with varying occurrences of sillimanite;

- Pegmatite – coarse grained leucocratic quartzo - feldspathic rocks comprising feldspar and quartz with lesser amounts of muscovite. Locally biotite may be present; and

- Amphibolites – a rock which contains greater than 40% mafic minerals, generally comprising pyroxenes, amphibole, plagioclase, garnet. Grades into garnet, amphibolite and foliated, quartz – feldspar – biotite – garnet rock.

These rock types do not generate acidic water, feldspar and sillimanite decomposition consumes acid.

The Potosi Gneiss unit is quarried as “blue metal” for the local Broken Hill market and surrounding areas in the adjacent quarry owned and operated by E B Mawsons & Sons Pty Ltd. It is predominantly used for road base.

The volume of waste rock to be extracted during mining is estimated at 250,000 tpa from underground development.

Waste rock from underground mining will be deposited in underground voids as they become available. Where there are no voids available the waste rock will be:

- placed in underground drives waiting for a void to become available; or

- stored in Kintore Pit awaiting back-loading into underground voids upon availability.

Towards the end of the mine life inert waste rock will be retained and stored in the Kintore Pit to be available for closure and rehabilitation activities. Testing of the waste rock from the pit and underground will identify inert material suitable for civil works and rehabilitation.

2.4.5 Explosives magazines

Explosives magazines are located in the BHP Pit. The magazines are earth grounded ventilated containers with an outer cover to prevent direct exposure to sunlight.

Bulk explosives will be water resistant slurries and ammonium nitrate (ANFO). There will be no mixing of explosives on-site. Detonators and primers will be stored in separate bunded magazines with an inventory maintained by the registered magazine keeper.

Explosive accessories, primers and blasting agents will be stored in approved magazines constructed in accordance with the requirements of *Australian Standard 2187.1 Explosives—Storage, transport and use Part 1: Storage* and will be licensed under the *Explosives Act 2003*.

2.4.6 Core yard

A core yard will be used by exploration and mining personnel for sample preparation, logging and storage of core, storage of equipment, drilling consumables and exploration supplies. The facility will be located in an existing building to the east of the truck wash facility.

2.5 MINERAL PROCESSING

2.5.1 General description

During construction any ore mined will be crushed prior to transporting off-site for mineral processing. The crushed ore will be loaded into trucks which will be covered and washed prior to leaving site and transported to the CBH Endeavor Mine near Cobar.

Once the processing plant is commissioned the ore will be processed on-site to produce zinc (87,000 tpa) and lead (44,000 tpa) concentrates which will be transported from site in lidded containers. The plant design capacity is 750,000 tpa based on a throughput of 93 tph. The processing method is representative of commercial practices at existing zinc / lead ore processing plants and is considered to be industry standard (*Figure 2-8*).

It is interesting to note that the flotation method was originally developed in Broken Hill in the early 1900s and has since become a mainstream method of ore processing throughout the world.

Processing of ore excavated during underground operations will include:

- ore crushing and screening;
- wet grinding;
- zinc and lead flotation;
- zinc and lead concentrate thickening and filtration;
- reagent mixing, storage and distribution; and
- concentrate loading.

The layout of the processing plant is provided in *Figure 2-9*.

Tailings disposal is discussed in *Section 2.6*.

2.5.2 Crushing

The crushing plant will operate on day shift (7am to 7pm) only.

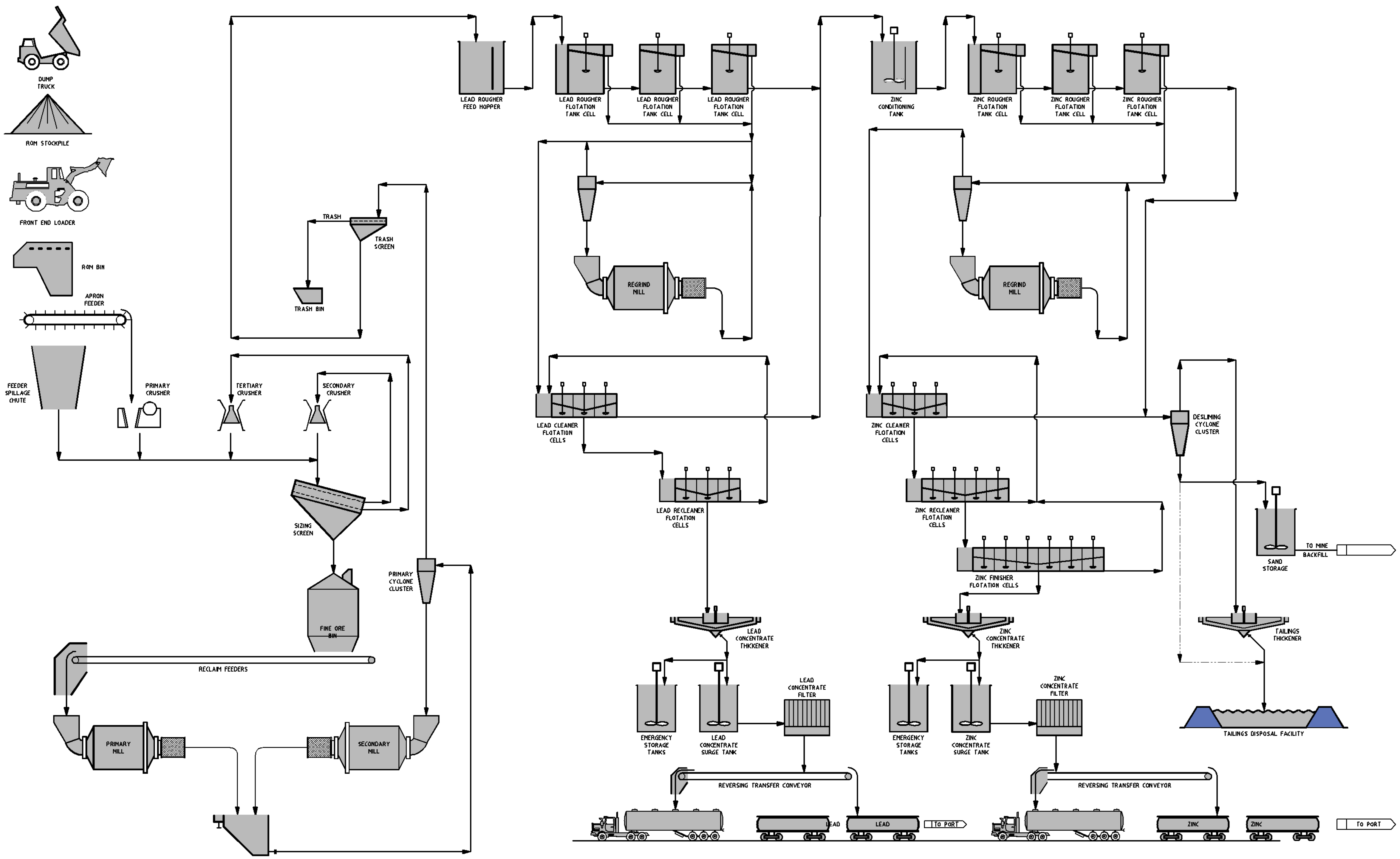
A three stage primary, secondary and tertiary, crushing and screening process will reduce the ore from rocks as large as 800 mm to a size suitable for grinding, roughly comparable to that of gravel (less than 15 mm).

Crushed ore will be loaded from the ore stockpile into the 150 t capacity ore bin using a front end loader (FEL) before being stored in a 2,250 t capacity enclosed fine ore bin prior to transfer to the grinding mills.

Crushing and screening facilities will be enclosed within in a purpose built building, under negative pressure with baghouse type dust collectors installed and operated at all times whilst the crushing and screening plants are operating. In addition, all conveyor transfer points not serviced by a dust collector will be fully enclosed.

All processes from grinding onwards require the ore to be mixed with water in slurry and do not require any dust collection or suppression measures.

Figure 2-8 Process flow chart

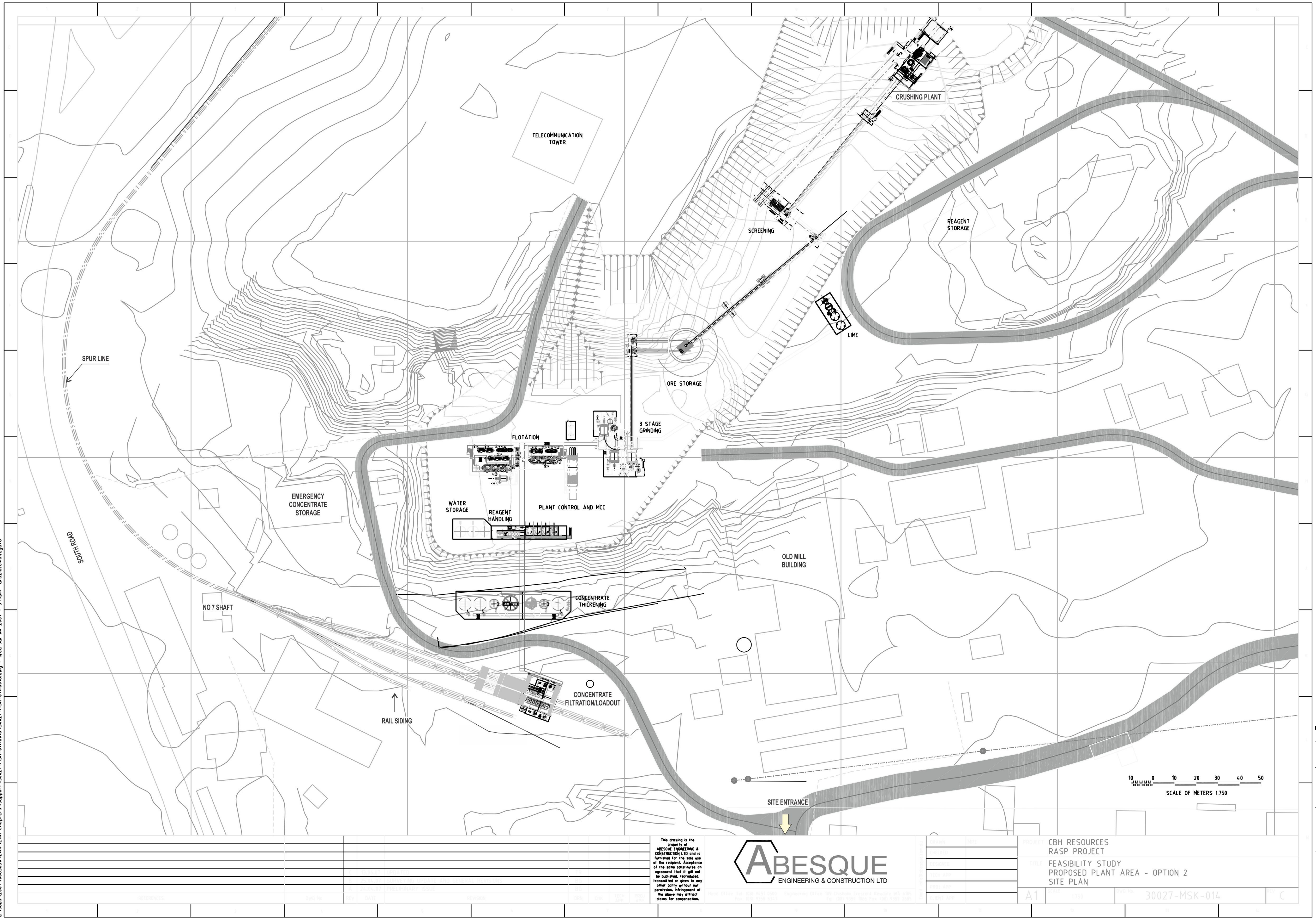


Broken Hill Operations Pty Ltd

Source: Abseque Engineering & Construction Ltd

Scale: Not to scale
Size: A3

Figure 2-9 Processing plant and rail loadout layout



Broken Hill Operations Pty Ltd

Source: Abseque Engineering & Construction Ltd

Scale: Not to scale
Size: A3

2.5.3 Grinding

The grinding circuit will consist of primary and secondary ball mills.

The grinding and classification circuit will operate 24 hours per day, 7 days per week. The proposal involves a circuit of two rubber lined ball mills, which will grind the wet ore to a particle size suitable for flotation recovery (fine sand size – P80 less than 300 microns). The ore feed for the grinding circuit will be reclaimed from the fine ore bin via conveyor.

2.5.4 Flotation

Flotation collection relies on a molecule that is both hydrophobic and hydrophilic. Heavy economic sulphides attach to the molecule and upon aeration the molecule attaches itself to an air bubble and rises to the surface. The bubbles are skimmed from the surface and the economic minerals are then floated sequentially.

Lead flotation

The ground ore will be mixed with collector in the conditioning hopper and fed to the conditioning tank in the lead flotation circuit for processing to lead concentrate. The pulp from the conditioning tank will flow to the lead rougher flotation tank feed box, where frother is added. It will then flow through a series of lead rougher flotation tank cells and be discharged to the zinc flotation feed conditioning tank for processing within the zinc flotation circuit.

The lead rougher concentrate will undergo regrinding to obtain a sizing of 80% passing 45 micron which will be feed to the lead cleaner flotation cells. Collector will be added to the cleaning circuit as required and a centrifugal fan complete with a sound enclosure will provide low pressure air to the flotation cells. Concentrate from the flotation circuit will be pumped via the on-stream analysis system to the lead concentrate thickener.

Zinc flotation

At the zinc rougher concentrate tank the slurry from lead flotation will be conditioned by adding lime to adjust the pH to approximately 10.5 and copper sulphate (zinc activator). Following conditioning, the slurry gravitates to the zinc rougher flotation feed box, where collector is added before overflowing through a series of zinc rougher flotation tank cells.

The zinc rougher concentrate will then be pumped to the zinc concentrate regrind mill discharge hopper prior to pumping to a cyclone cluster. Underflow (coarser particles) from the cyclones will feed by gravity to the rubber lined regrind ball mill with the grinding product pumped back to the cyclones. Overflow from the cyclones at 80% passing 60 microns will overflow the cyclones and feed by gravity to a series of zinc cleaner flotation cells, zinc recleaner flotation cells and zinc finisher flotation cells.

The tailings from cleaner flotation cells joins rougher cells tailings as final residue from the circuit and is sent to the underground backfill plant. Tailings from the zinc recleaner and finisher flotation cells will be sent back to the zinc cleaner cells for reflotation. Collector and lime will be added to the cleaning circuit as required and a low pressure centrifugal fan complete with a sound enclosure will provide air to the flotation cells. The zinc final concentrate from the flotation circuit will be pumped via the on-stream analysis system to the zinc concentrate thickener

2.5.5 Concentrate thickening, filtration, storage and dispatch

Zinc and lead slurry will be dewatered in a process of thickening and filtration prior to transport. The slurry will be pumped to high rate thickeners where it will be diluted with clarified overflow solution to 15 percent solids by means of a self-diluting feedwell fitted to the thickeners. Diluted flocculant will also be added to the feedwells, to increase particle settling rates.

Thickener overflow will be reused as process water.

Thickened zinc and lead concentrates will then undergo filtration. Zinc and lead concentrates will be filtered to reduce the concentrate moisture content to around 9 percent moisture and zinc concentrate to around 9 percent moisture (filter cake). After filtering, the filter cake will be discharged directly to the rail wagons, located below the filter presses.

These activities will be conducted in an enclosed building. Filtrate and filter wash down water will be pumped to the respective concentrate thickener for reuse as process water.

The process is designed as a continuous process from slurry - to concentrate feed - to rail wagons. A storage area has been designated, as a contingency, in the event of breakdowns or if rail wagons are not available. Concentrate will be stored in sealed containers and located in the existing No 4 Shaft change-house (Building 13, *Figure 2-3*). This eliminates double handling which could cause additional dust generation.

2.5.6 Concentrate loading

The rail infrastructure runs parallel to the lease on the western side of the Project Area. A spur line runs into the lease and stops at No. 7 Shaft. It is proposed to refurbish and re-establish the rail siding between No.7 Shaft and the old mill building to allow rail access onto the lease to transport concentrate from the facility.

Concentrates (131,000 tpa) will be loaded into rail wagons / containers which will be covered to prevent dispersal of the concentrate in the form of dust during transport to a smelter or export port facility located at Port Pirie, Newcastle, Port of Adelaide or another port and / or smelter.

All wagons / containers will pass through a wash facility prior to leaving site to remove any potential concentrate spillage and will meet the requirements for dangerous goods where applicable.

2.5.7 Reagent storage, mixing and distribution

Reagents used in processing are detailed in *Table 2-8*, which also includes a summary of on-site storage and handling.

The reagents will be delivered to, segregated and stored in a dedicated reagents store located to the north east of the flotation circuit (refer *Figure 2-3*).

The reagents store will comprise a shed with a concrete floor designed in a manner which permits reagents to be stored as solids or liquids in individually bunded areas compatible with the containers used for their transportation to site.

Transfer of the reagents (as required) will occur in a dedicated mixing area suited to using a forklift. The reagent mixing area is to be located between the concentrate thickeners and the flotation cells. It will also be a concrete bunded area consisting of respective mixing tanks for each individual reagent. From these mixing tanks, the reagents will be piped to the relevant process tanks.

Table 2-8 Summary of reagent storage, mixing and distribution volumes

Reagent	Storage	Mixing	Solution storage	Distribution to process	Process supply (approx)
Sodium ethyl xanthate (collector)	200 L containers	Mix 15% solution	1 m^3 header tank	Reagent metering pumps to grinding and lead flotation circuits	2 days (per container)
Sodium iso propyl xanthate (collector)	200 L containers	Mix 15% solution	1 m^3 header tank	Reagent metering pumps to zinc flotation circuit	2 days (per container)
Copper sulphate	1 t bulk bags of powder	Mix 15% solution	1 m^3 header tank	Reagent metering pumps to zinc flotation circuit	25 hours (per bag)
MIBC	1 m^3 bulk liquid containers	n/a	500 L header tank (undiluted frother)	Reagent metering pumps to flotation circuit	8 days (per container)
Hydrated lime	17 t bulk tankers with transfer to a 100 t storage silo with rotary valve for transfer to mixing tank	Mix 20% slurry in a 25 m^3 live capacity mixing tank	50 m^3 live capacity storage tank	Automatic metering to grinding and flotation circuits by control valves on a ring main supply	19 hours (per mix)
Flocculant	25 kg bags of pellets	Proprietary flocculant mixing system	-	Positive displacement pumps to the thickeners	-
Sodium metabisulphite	1 t bulk bags of powder	Mix 15% solution	1.2 m^3 header tank	Reagent metering pumps to lead flotation circuit	20 hours (per bag)

2.5.8 Processing water circuit

Process water for supply to the grinding and lead flotation circuits will be supplied by a combination of raw water and reclaimed water. The raw water will supply the fire water system, gland water system, dust suppression sprays, both concentrate filters, reagent mixing and supply make-up water to the process water tank. The process water tank will have a three hour holding capacity.

The reclaimed water from No. 7 Shaft dewatering and underground mine operations dewatering is unsuitable for use as process water without treatment. BHOP proposes to treat the water by mixing it with the processing plant tailings and precipitating the dissolved minerals out in the back fill plant thickener. Test work has demonstrated that the addition of lime solutions have a significant impact on the pH of the water and the level of dissolved metals respectively. These results confirmed the waters suitability for use in processing.

BHOP, as part of its water conservation program, will reclaim maximum water from the processing circuit for re-use. Water will be reclaimed from tailings, thickener overflows and the TSF decant pond primarily for use within the processing plant.

2.6 TAILINGS DISPOSAL

2.6.1 Overview

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 back fill mine voids and stopes. The finer stream will be pumped to the existing tailings storage facility, a conventional paddock style facility (TSF1) for containment and settling and, once this is filled to free-board capacity, tailings will be deposited in the disused Blackwood Pit (TSF2).

In the early stages of the Project, prior to the development of sufficient underground void capacity, the total tailings stream will report to TSF1. When capacity is available underground plant tailings will be deslimed by cyclones and treated before being pumped underground as hydraulic backfill. The slimes will be thickened and transferred initially to TSF1 and later to the Blackwood Pit (TSF2). The tailings disposal system will be designed to operate with a variable split between underground backfill operations and surface tailings disposal.

Photograph 2-1 shows TSF1 (darkened area on CML7 in mid-ground of photograph) and TSF2 (pit in foreground).

A tailings storage scoping study and preliminary design has been undertaken for the Project by Golder Associates, 2009 and is presented in *Annexure F*.

Photograph 2-1 Aerial photograph over CML7 looking south west towards TSF1 and TSF2

2.6.2 Tailings properties

Tailings properties have been defined through test work and from historic mining operations on the site.

The tailings properties are:

- water/solids ratio - 50% solids (after thickening);
- water/solids ratio - 55% to 60% solids (at point of discharge from back fill plant);
- 80 tph (average solids only), 40 tph to TSF, 40 tph to underground;
- 80 tph (liquid only);
- 62 m^3/h volumetric flow;
- 80% passing 200 micro-metres (after desliming);
- dry settled density varies from 1.3 t/m^3 (shallow) to 1.5 t/m^3 (bottom of Blackwood Pit) depending upon depth of placement. 1.3 t/m^3 was adopted as a conservative value for design purposes;
- friction angle – 20 degrees;
- cohesion – 4 kPa; and

Preliminary testwork and mass balance calculations indicate that the tailings will contain the following elements; zinc (0.4%), lead (0.4%), silver (8ppm), iron (3.3%), sulphur (1.2%), arsenic (460ppm), bismuth (70ppm), cadmium (trace) and antimony (45ppm). Further analyses and testing of these and other minerals likely to be contained within the tailings will be carried out as part of the detailed design and test work for the processing plant.

An estimated 6.97 Mt of tailings (average of 620,000 tpa) will be generated from the Project.

2.6.3 Tailings disposal methodology and production schedule

When in full production fifty percent of tailings will be directed underground via boreholes and fill lines to mined voids for use as back fill and fifty percent will be deposited in the two separate surface storage facilities; TSF1 and SF2 (*Figure 2-10*):

- TSF1 - existing two-cell TSF; and
- TSF2 - disused Blackwood Pit.

Section 2-13 Describes the alternatives considered for tailings disposal and the justification for the strategy selected.

The storage characteristics for each TSF are outlined in *Table 2-9.*

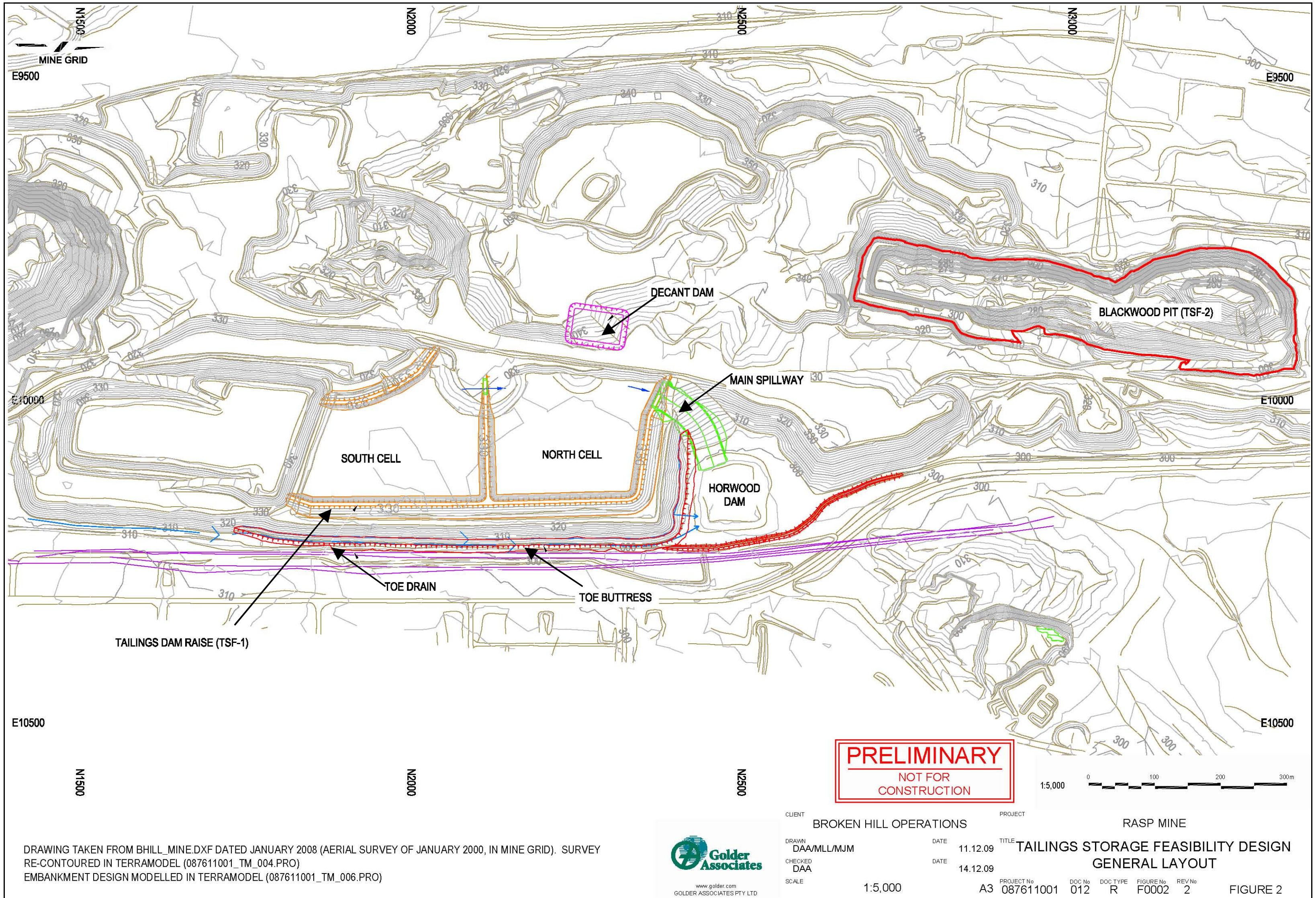
Table 2-9 Tailings storage characteristics

Characteristic	TSF1	TSF2
Crest Height	322 mRL to 332 mRL.	295.5 mRL.
Rate of rise	Varies, approximately 2.5 m per year 1 x 6m and 1 x 4m wall lift.	Varies, approximately 3 m per year No walls – subsurface void.
Tailings storage area	4.97 ha south cell 5.28 ha north cell	Varies such that it increases with depth of tailings – approx 10 ha.
Total freeboard required	Operation freeboard 1 m.	Minimum of 1 m freeboard.
Capacity	970,000 t	3,120,000 t
Life	4.25 years	8.75 years

During the first 18 months of operations, while production in the underground operations ramps up, more than fifty percent of the tailings will be sent to the surface storage facilities. Production forecast for tailings disposal during this ramp up is summarised below:

- during the initial four months of processing, all tailings will be stored on the surface in TSF1; equating to approximately 144,000 t;
- during the following eight month period of processing, 63% of tailings will be stored on the surface (161,906 t) and the remaining 37% used as underground back fill (97,969 t); and
- during the second and subsequent years of production the processing tailings will be split equally between surface storage and underground.

Figure 2-10 Location of tailing storage facilities



Broken Hill Operations Pty

Source: Golder Associates

Scale: Not to scale

The schedule for filling of the TSFs for the life of the Project is provided in *Table 2-10*.

Table 2-10 Proposed schedule for tailings storage

Year (to 30 June)	Underground Back fill per year (tonnes)	Surface Tailings storage per year (tonnes)	Cumulative surface tailings storage (tonnes)	Cumulative tailings in TSF1 (tonnes)	Cumulative tailings in TSF2 (tonnes)
1	97,969	273,281	273,281	273,281	0
2	195,938	195,138	469,219	469,219	0
3	195,938	195,138	665,156	665,156	0
4	216,563	216,563	881,719	881,719	0
5	247,500	247,500	1,129,219	970,000	159,219
6	278,438	278,438	1,407,656		437,656
7	309,375	309,375	1,717,031		747,031
8	309,375	309,375	2,026,406		1,056,406
9	309,375	309,375	2,335,781		1,365,781
10	309,375	309,375	2,645,165		1,675,156
11	309,375	309,375	2,954,531		1,984,531
12	309,375	309,375	3,263,906		2,293,906
13	309,375	309,375	3,573,281		2,603,281
TOTALS	3,397,969	3,573,281			
TOTAL	6,971,250				

2.6.4 TSF1 raise to exiting tailings facility

Background

TSF1 is located centrally within CML7 and is adjacent to Eyre Street. The nearest residences are about 100 m to the south of the proposed facility, separated by a road and powerline corridor. There are also a number of active industrial premises in the area; a sand supply yard, wood cutters yard, unoccupied land and a land quarry approximately 500 m south-east of the facility. The other three sides of TSF1 are surrounded by mining disturbed land with Horwood Dam to the north east, an old waste rock covered tailings storage to the southwest and a plant/mine access road to the north. At TSF1 tailings will be deposited over a historic tailings dam which was constructed in the early 1980s and was closed in 1991.

The historic tailings dam was constructed using remnant tailings with a starter embankment of approximately 2 m to 3 m in height and progressively raised using the upstream construction method in raises of 2 m to 3 m. Decants were used to remove excess tailings process water and stormwater discharging to Horwood Dam. The existing upper surface of the tailings has been covered with a nominal 0.5 m thick layer of slag and waste rock has been placed over the sides of the tailings embankment.

The crest of the existing TSF walls is 324 mRL with the top of tailings varying between 322 and 323.5 mRL.

Proposed storage facility

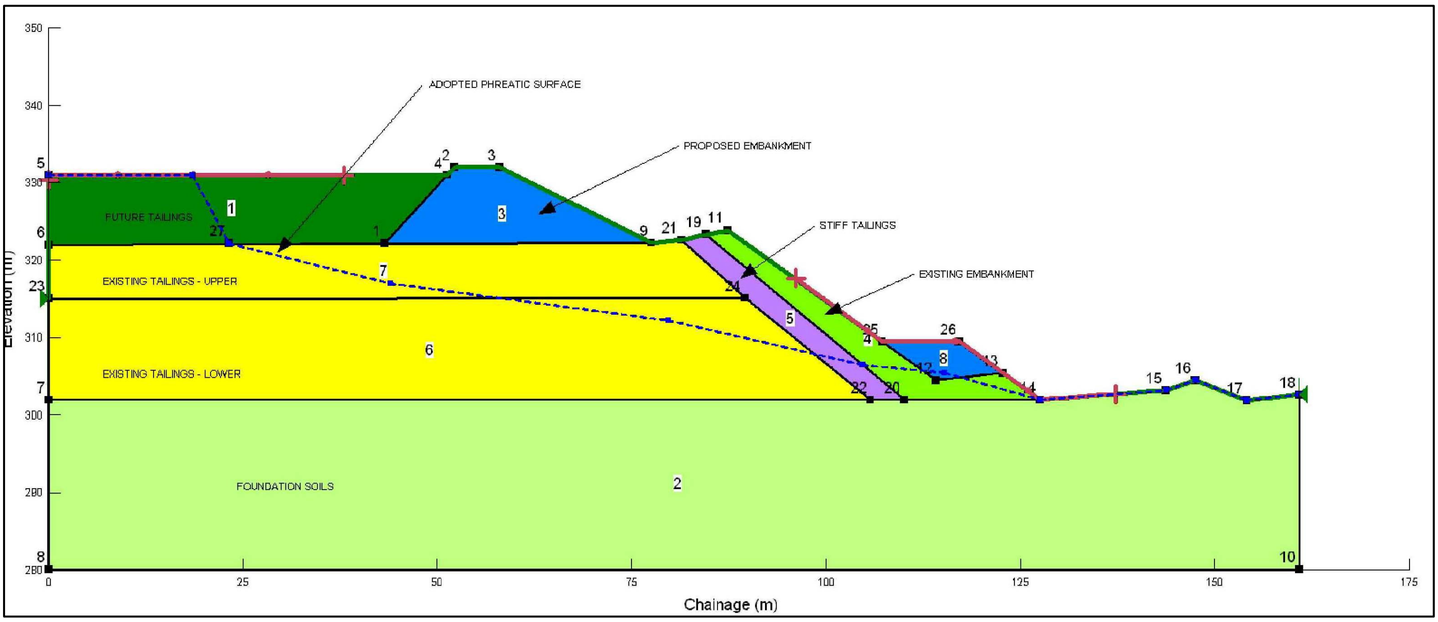
It is proposed to raise the existing TSF from 322 mRL to 332 mRL with waste rock as the embankment material using the centreline raise method. This method is recommended by Golder as it avoids placing new raises over freshly deposited tailings which is likely to present construction and stability risks. A geochemical analysis of waste rock (Golder Associates, April 2008) stockpiles adjacent to the existing tailings facility, indicate sufficient quantities of material suitable for embankment construction. It is not proposed to remove the current layer of slag on the surface of the TSF.

The embankment will have a minimum offset of 10 m from the inside crest edge of the current embankment wall to the south, with the construction of a 6 m high starter embankment followed by a subsequent 4 m high raise. The embankment will be constructed to the full footprint of the proposed final embankment, avoiding the need to construct the raise on freshly deposited tailings. The design allows for a 1 m freeboard.

The starter embankment will be keyed into the existing tailings and perimeter embankment along the eastern and southern crest of the facility. Along the western side, the starter embankment will be keyed into Mt Hebbard a previous tailings storage facility now covered with waste rock. This will minimise the potential for preferential flow paths for seepage water from the TSF at the south west corner. Along the northern and western boundary of the TSF, drains will be installed to minimise seepage into the existing tailings facility and waste dumps.

The eastern starter embankment of the north cell and southern starter embankments of both the south and north cells will be constructed on the existing tailings, the second and final raise will not exceed the footprint of the starter embankments. The dividing wall between the two cells will also be raised using the centreline method. The western embankment of the south cell will be raised by constructing against the Mt Hebbard tailings dam. Along the northern flank, a small bund wall will be constructed on the waste dump for each stage of the works. A section through the proposed embankment is presented on *Figure 2-11*.

Figure 2-11 Cross section of TSF1



Source: Golder Associates

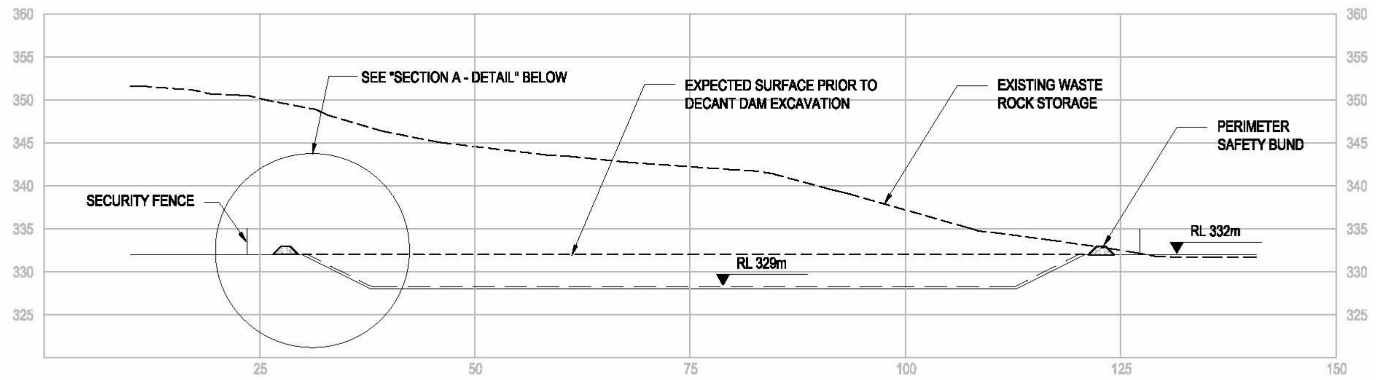
Tailings will be deposited in TSF1 as a slurry with a moisture content of around fifty percent, deposition will occur through a ring main with spigots located at approximately 25 m (adjusted for actual tailings size distribution) intervals around the perimeter of the embankment. Spigots will be positioned so that tailings beach toward the northern side of the cells creating a supernatant pond close to the northern side of the cells Discharge from each spigot would be rotated to ensure deposition is evenly distributed around the facility and deposition would be switched between the two cells to maximise drainage and consolidation of the tailings. It is expected that tailings will be cycled between the two cells over a one to two week period. This allows for tailings to be deposited in thin layers and release supernatant water, resulting in increased tailings strength.

Guidelines will be outlined in the Tailings Construction and Operations Manual for managing the supernatant ponds on the surface of the cells by pumping the water (supernatant and stormwater) to the external decant dam. Routine pumping of water from the facility will help increase the tailings density in the storage, reduce seepage form the tailings and improve the safety of the storage.

Decant dam

The decant dam is located over waste rock storages to the north of TSF1 in an area of proposed borrow for the embankment rockfill. The preliminary design requires a 3 m excavation and has been sized to contain approximately 4 weeks of TSF1 pond off-take under normal winter operating conditions. The decant dam will be lined and a sump will be formed to facilitate pumping of water from the dam for the dust management spray system and also potentially for the process plant. An emergency spillway will direct water back into TSF1 during its operation and subsequently to the gully beside Mt Hebbard or to Horwood Dam. A preliminary design of the decant dam is shown in *Figure 2-12*.

Figure 2-12 Decant dam cross section



Source: Golder Associates

Embankment

To protect the embankment a geomembrane will be installed on the upstream face of the embankment and will extend 20 m over the floor of each cell. The cell floor will be prepared by placing sand over the area which will act as an intercepting filter. The geomembrane will extend through the dividing wall and embankment wall, and at the junction of the two walls, with a cushion geotextile and select fill placed over the geomembrane to protect against damage from the rock fill. The filter will control potential development of a hydraulic gradient through the embankment and will also act as cushioning for the geomembrane liner.

A seepage collection drain will be installed in the intercepting filter along the upstream toe of the embankment raise. This drain will collect water that is intercepted by the filter layer and will direct flow to the Horwood Dam.

Emergency spillways

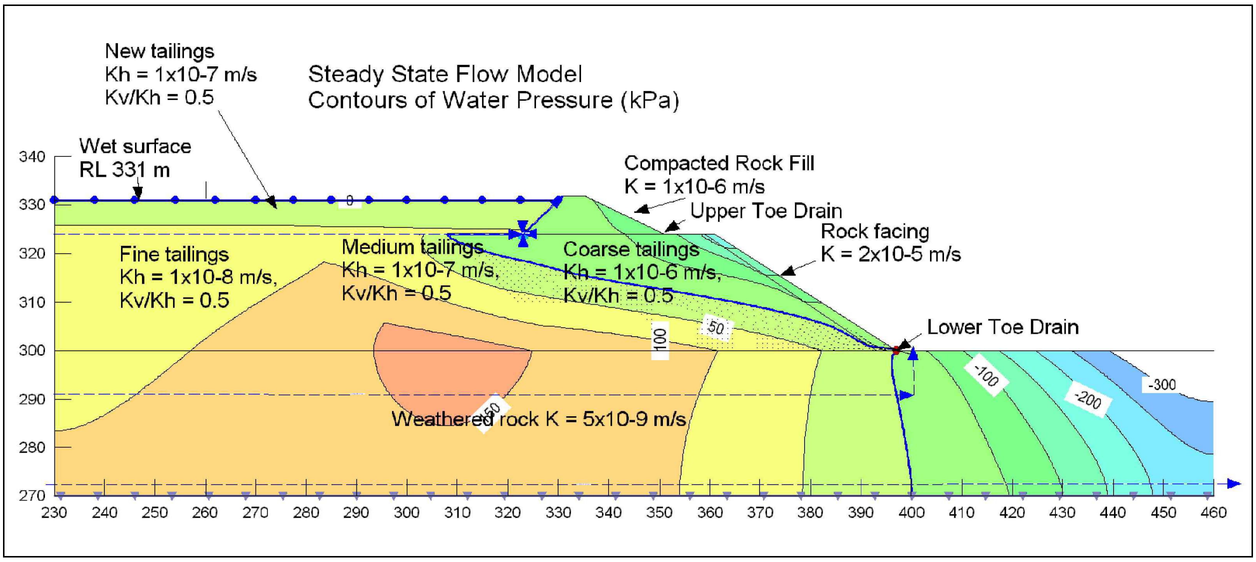
Emergency spillways will be constructed in each cell to allow for discharge of water in a controlled manner in the event of a probable maximum precipitation (PMP) storm event. The spillways would only become operational if a PMP storm event occurred just prior to raising of the cell embankments and near the end of life of the facility. During Stage 1 lift the south cell spillway will discharge to Mt Hebbard gully and the north cell will discharge into the south cell. During Stage 2 lift the south cell will discharge to the north cell which in turn will discharge to Horwood Dam.

Seepage modelling

Seepage modelling was conducted by Golder Associates and the results are included in their Report at *Annexure F*. The existing tailings dam is underlain by relatively low permeability bedrock (assumed at a hydraulic conductivity of 5×10^{-9}), identified as weathered gneiss in the geotechnical investigation (Golder, 2008). The old tailings deposited above this bedrock varies in permeability from the centre to the perimeter due to variations in the old tailings properties. Old tailings were characterised by laboratory testing as silty sand, sandy silt and clayey silt (1×10^{-8} to 1×10^{-6}). The geomembrane liner was modelled conservatively assuming a number of defects in the liner. Other seepage modelling assumptions are listed in Section 10.5 of the Tailings Storage Facility Feasibility Design Report, Golder 2009, *Annexure F*.

Results of the Golder seepage modelling indicate that the upstream toe drain of the embankment raise was estimated to be 0.003 m3/d/m and seepage to the lower toe drain was estimated to be 0.16 m3/d/m. The water pressure contours (*Figure 2-13*) become negative moving south past the lower toe drain indicating that little or no water will progress beyond this point. The seepage analysis shows that under the TSF, seepage is predominantly downwards and as a consequence there is a low probability of the seepage water reaching houses on the southern side of Eyre Street.

Figure 2-13 Seepage Analysis Output



Source: Golder Associates

Risk assessment and Hazard Rating

A risk assessment for TSF1 was undertaken by Golder Associates (2009) in accordance with the *Guidelines on Assessment of the Consequences of Dam Failure* (ANCOLD, 2000) concluded that the rating was considered to be a 'High B'.

Embankment stability was also analysed by Golder using the SLOPE/W modelling software. Based on the geotechnical investigations which indicate that the old tailings storage is predominantly drained, a low phreatic surface close to the interface of the tailings and underlying ground, has been assumed. The stability of the facility was modelled under both static and dymanic (earthquake load) conditions. The results indicate factors of safety which are greater than the recommended minimum levels.

Table 2-11 outlines the recommended minimum Factors of Safety required for tailings storages of this type and the predicted Factors of Safety (as determined by Golder Associates).

Table 2-11 Recommended and predicted factors of safety

		Factor of Safety	
	Static Loading	**OBE Loading (0.013g)**	**MDE Loading (0.2g)**
Recommended Minimum FoS	1.5	1.2	1.0
	Static Loading	**OBE Loading (0.013g)**	**MDE Loading (0.2g)**
Predicted Minimum FoS			
Starter embankment, no tailings, upstream failure	1.9	1.8	1.3
Final height, global downstream failure with a conservative phreatic surface	2.0	1.9	1.2

Based on geotechnical work and the TSF design, preliminary embankment stability modelling results indicate that the design satisfies safety requirements. The structural integrity of the proposed raises to the TSF has been confirmed (Golder Associates, 2009).

Waste rock and embankment construction

Waste rock has been chosen as the construction material for the embankments as it has fewer fines and is readily available adjacent to the facility. During construction there is the potential to generate dust by the excavation of the waste rock material, the transport of this material to TSF1, and the dumping and spreading of this material.

Prior to embankment construction, approximately 45,000 m3 of waste rock will be required to construct a buttress at the toe of the slope. This will ensure the integrity of the wall and will involve approximately 2,200 truck movements and take less than one month. Approximately 190,000 m3 of waste rock will then be required for construction of the embankments. Stage 1 starter embankment will take approximately three months to construct and require around 9,500 truck movements. Stage 2, a 4 m lift, will take approximately two months to construct with an estimated 2,500 truck movements.

The excavation area will be hosed down prior to removal of material via a dedicated water cart and / or water sprays. Water sprays will be temporarily installed along the waste rock transport route to minimise dust generation by trucking movements. Water sprays will also be utilised during the placement of rockfill layers at the embankment after spreading and again during compaction.

The construction contractor will be required to monitor and report on dust conditions taking additional action as required and as outlined in the Tailings Construction and Operations Manual. Wind speed and direction will be noted in the morning meetings and provided to the construction contractor. The Manual will form part of the construction contractor's contract, it will outline dust management measures, monitoring, inspection and reporting requirements.

TSF operation

The tailings surface is likely to initially be a slurry, changing slowly over a few days to wet then moist tailings. The length of wet beach is expected to extend from the active spigot to the opposite side of the cell. *Figure 2-14* shows the planned operational layout for TSF1 – Stage 1 development.

During the period in which a cell or part of a cell is inactive, there is a potential for dust to be generated from the tailings surface - if the tailings dries out sufficiently to release dust. A spray system comprising the following components is proposed to manage this risk:

- sprinklers and reticulation pipe;
- water supply, pump and control system; and
- dust suppressant (crusting) agent.

The spray system will apply a coating of a chemical dust suppressant over the surface of the wet to moist tailings, using water as a medium to place the material. The material coating forms a crust with the tailings, resulting in a surface that does not release fine particles of dust. The crusting agent is resistant to wind and water erosion and the durability of the crusting agent is related to the severity of surface disturbance. Golder noted that information provided by one of the suppliers of a chemical dust suppressant product that wind tunnel testing was based on testing of samples placed at an angle of 37 degrees to the direction of a wind blowing at a speed of 10 m/s (or 36 km/hour). Golder considered this to be a conservative testing scenario in relation to the relatively flat surface of the proposed tailings beach. Golder recommended that field trials be undertaken prior to commencement of operation for wind speeds of 50 km/hour to establish the optimum concentration of crusting agent required to provide no dust lift off. These trials would be carried out over a period of weeks to assess degradation of the chemical dust suppressant crust with time.

As there is no surface disturbance proposed on the tailings maximum efficiency of the chemical dust suppressant product is expected.

Water sprays

The spray system is to be installed as part of the initial works for TSF1. The piping and sprays, with the associated control and mixing system could be activated at any time during operations. Six sprinklers are proposed around the perimeter of each cell as indicated in *Figure 2-15.* Each sprinkler has a maximum throw distance of 95 m and a maximum spacing of 75 m is proposed between sprinkler units. The 48 mm diameter spray nozzle has a capacity to spray 4500 L/min.

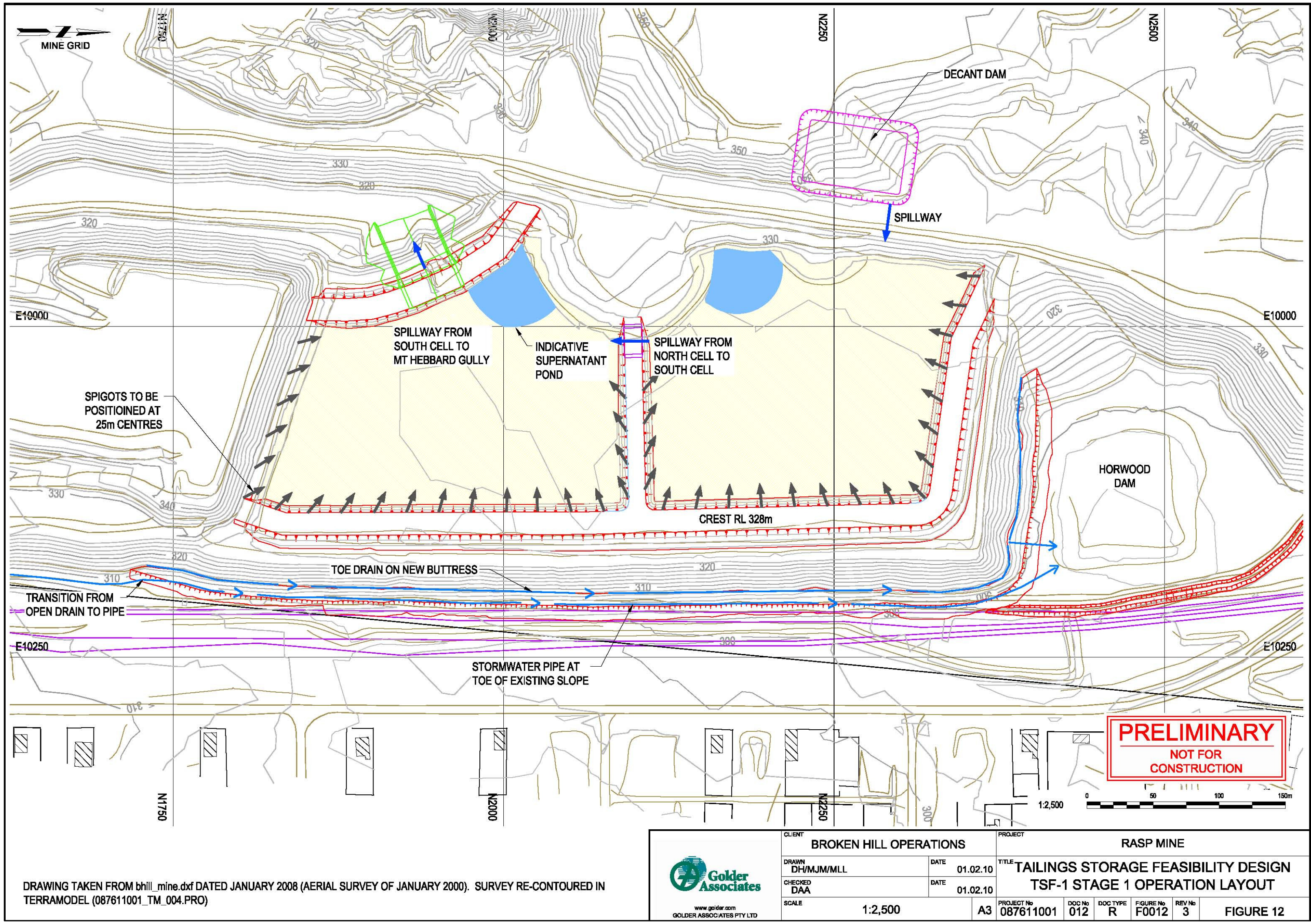
The control system would include an agent flow rate meter to ensure sufficient agent is delivered. If the agent source is depleted, an alarm would be activated and the system paused. A mainline flow meter would also be used to monitor the overall flow through the system.

The decant dam is the nominated source of water for the proposed spray system. Water would be pumped from the dam and the pump will be sized to supply at least 4500 litres/minute at a pressure of 8.5 bar. The water balance estimates presented in *Table 2-12.* Indicate that the decant dam has sufficient capacity to meet the demands of the sprinklers.

Table 2-12 Summary of annual water balance results

Inflows		**Outflows**			**Net annual water reporting to decant Pond (m^3)**
Rainfall runoff from tailings (m^3)	**Bleed water from tailings (m^3)**	**Evaporation from Pond and tailings (m^3)**	**Seepage from tailings (m^3)**	**Water for dust management spray (m^3)**	
13,300	208,500	81,700	30,300	4,500	105,300

Figure 2-14 TSF 1 operational layout

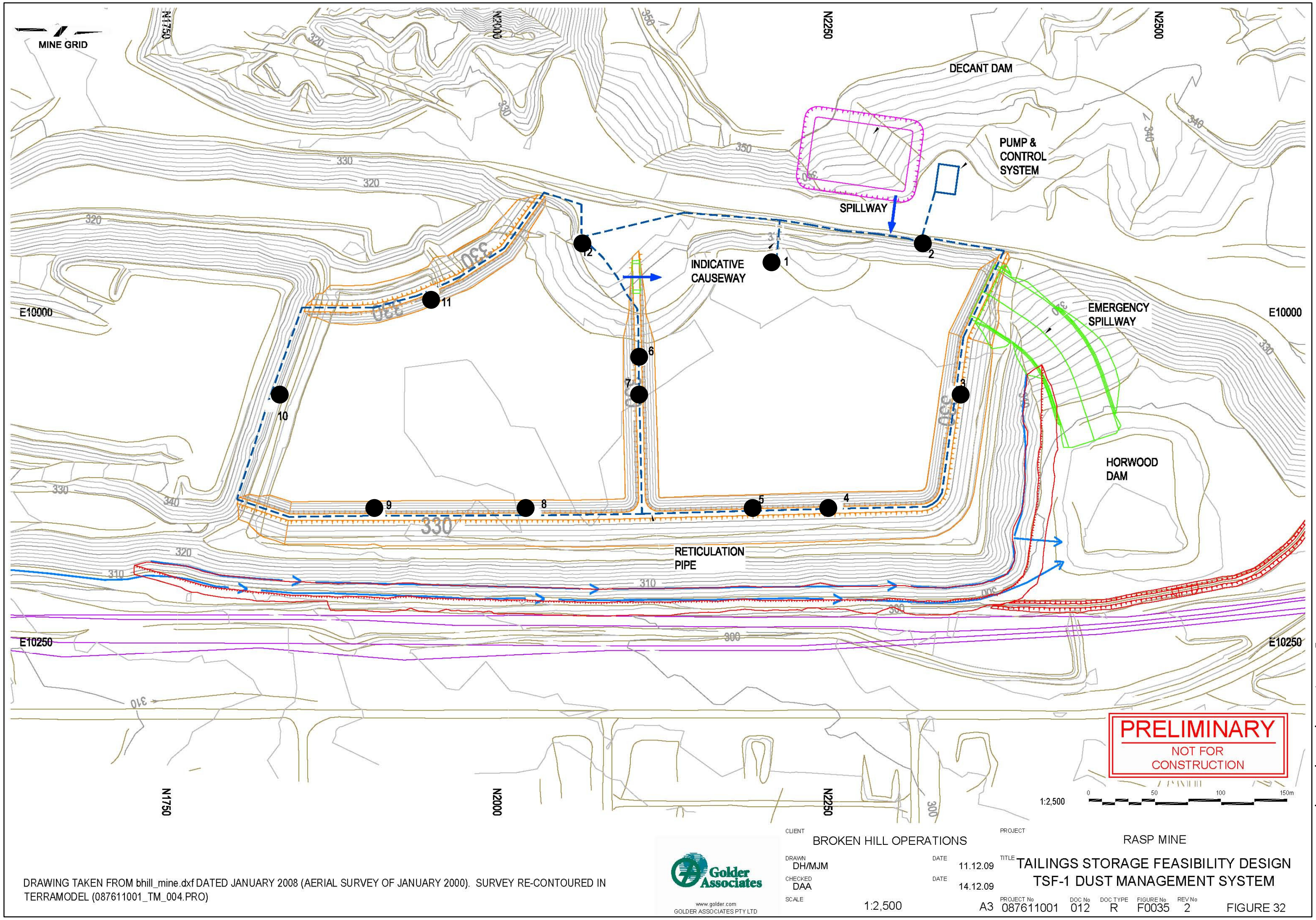


Broken Hill Operations Pty Ltd

Source: Golder Associates

Scale: Not to scale

Figure 2-15 TSF1 dust management system



Broken Hill Operations Pty Ltd

Source: Golder Associates

Scale: Not to scale

Crusting Agent

The crusting agent would be added to water at an indicative rate of approximately 9 L per 4500 L of spray (ie 500:1 ratio). Supplier information has indicated that approximately 0.005 L of crusting agent is required per square metre and that an application of the crusting agent would provide dust control for a number of months. The actual concentration of crusting agent to be adopted for the site will be subject to field trials prior to the commencement of operation. Trial criteria will include resistance wind speeds of up to 50 km/hour.

The estimated volume of agent required to cover the entire surface of TSF1 is between 500 and 750 L. It is proposed to operate each cell for a period of two weeks before switching to the other cell resulting in one spray cycle per cell every 4 weeks. Generally only one application of the crusting agent is expected to be required after tailings deposition is switched to the adjacent cell. Additional applications of either crushing agent or water may be activated if the surface of the tailings appears to be at risk of generating dust.

The crusting agent takes up to ten minutes to apply, at the recommended rate, per sprinkler. The recommended dosing rate for the mixing of the crusting agent, and hence the application rate on the tailings surface, may be varied over the weather seasons at the site. A higher concentration or more frequent application of crusting agent can occur prior to a period of high wind, following intense rainfall events, or if disturbance of the tailings surface has occurred.

The sprinkler system also applies a significant amount of water onto the surface of the tailings, as part of the crusting agent application process. In addition the application of the crusting agent water could be sprayed on a specific section of the tailings surface if a localised issue developed with potential for the tailings to generate dust.

Dust mitigation measures

A preliminary dust management plan for the tailings storage has been developed to suppress dust during construction, operation and closure of the facilities. The dust prevention strategy comprises the use of waste rock as embankment material, the use of temporary water sprays during construction, the installation of a spray system around the perimeter of each TSF1 cell and the application of dust suppressant after a cycle of tailings deposition ceases.

Furthermore, significant contingency and redundancy has been built into the design of the TSF to ensure that adequate dust mitigation is available both during normal operations and under ‘upset’ conditions.

The proposed operation of the TSF will include:

- Tailings will be delivered to the active TSF cell as a slurry of 55% to 60% solids at a rate of ~137 000 litres per day;
- After tailings has stopped being applied to the active cell, it will take ~1 to 2 weeks for the surface to go from ‘wet’ to ‘spade-able’;
- The binding chemical suppressant will be applied to the TSF sometime between when the surface is wet until it dries out enough to become spadeable;
- The chemical suppressant will be applied via sprinkler systems that have overlapping arcs.
- The chemical suppressant will not be applied during high wind due to the potential for uneven distribution;

- Sufficient moisture will be retained in the tailings prior to the chemical suppressant being applied, such that during high wind conditions, emissions can be adequately controlled prior to the suppressant being applied;

- It is conservatively estimated that there will be a period of 1 week between when the material becomes spadeable and when further drying presents a high risk of wind blown dust emissions. On this basis there will be time allowance to ensure that the chemical suppressant is applied under favourable meteorological conditions;

- Extra water can be supplied from the decant dam by the sprinklers surrounding the TSF cells at a maximum expected rate of 4,500 litres/minute (subject to the detailed design process);

- The tailings slurry can be directed to the inactive cell as a backup emission control, and it is estimated it would take approximately a 6 hour to flood the inactive cell. The time taken to cover the tailings surface with fresh tailings is an estimate based on the design tailings deposition rate. The areas most likely to dry first are the same areas that would be covered the quickest as these areas are near the spigot outlets;

- Tailings will only be directed to one cell at a time;

- The spigots that deliver the tailing slurry to the TSF cells have not currently been designed to enable the delivery of water from the decant dam to the inactive cell when tailings are being directed to the active cell. The technical feasibility of this additional control option is being investigated.

- Sprinklers can apply water to the surface of the inactive cell by switching on the pump without adding the chemical dust suppressant. This will not interfere with the tailings deposition on the active cell.

A summary of potential upset conditions, a qualitative assessment of their likelihood, and details of the contingency measures in place with regard to dust control are provided in *Table 2-13*.

Table 2-13 Dust Mitigation Contingencies Under Potential 'Upset' Conditions at the TSF

Scenario	Effect	Likelihood	Level 1 Control	Level 2 Control	Alternative Control
Sprinkler pump blows at active cell	Anticipated to take between 7 days and two weeks for the material within active cell to dry out to a condition where it is spadeable. .	Possible	Replacement pumps kept on site as essential spares – estimated 2 hour period to replace.	Wet tailings may be applied through spigot closest to the inactive sprinkler. Spigots may be selected individually to target the area with potential to dry out.	Spigots designed to enable the delivery of water from the decant dam to inactive cell (subject to technical feasibility investigation).
Weather conditions (high winds) cause delay in application of chemical dust suppressant to inactive cell	Minimum one week window within which chemical dust suppressant may be applied once cell becomes inactive.	Possible	Application of water with sprinklers.	Whole cell may be covered with tailings layer using spigots within 6 hours	Spigots designed to enable the delivery of water from the decant dam to inactive cell (subject to technical feasibility investigation).
All sprinklers are rendered inactive as	Minimum one week window before material	Unlikely	Whole cell may be covered with a layer of	Spigots designed to enable the delivery of water from the	

Scenario	Effect	Likelihood	Level 1 Control	Level 2 Control	Alternative Control
sprinkler water supply is cut by a site upset.	dries out to a condition where it is spadeable.		tailings using spigots within 6 hours.	decant dam to the inactive cell when tailings are being directed to the active cell. (subject to technical feasibility investigation).	
Inactive cell seen to be raising visible dust	Dust raising detected by visual inspection or via feedback from real-time PM_{10} monitoring equipment fitted with telemetry.	Possible	Sprinkler spray arcs overlap. Whole cell may be covered with additional chemical dust suppressant within 10 minutes	Water may be applied through sprinklers. Sprinklers to be used for water application may be selected individually to target the area raising dust.	Whole cell may be covered with tailings layer using spigots within 6 hours
Production upset leads to cessation of tailings deposition. Active cell seen to be raising visible dust	Dust raising detected by visual inspection or via feedback from real-time PM_{10} monitoring fitted with telemetry.	Unlikely	Sprinkler spray arcs overlap. Whole cell may be covered with additional water within 10 minutes	Whole cell may be covered with chemical dust suppressant using sprinklers	Spigots designed to enable the delivery of water from the decant dam to inactive cell (subject to technical feasibility investigation).
Note: As an alternative control measure, manual water spraying using vehicle or mobile equipment may be applied in any of the above scenarios.					

Tailings Construction and Operations Manual

A Tailings Construction and Operations Manual will be prepared for the deposition of tailings into the 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 crusting agent and use of water sprays; and
- monitoring and inspection requirements.

Summary of dust mitigation measures

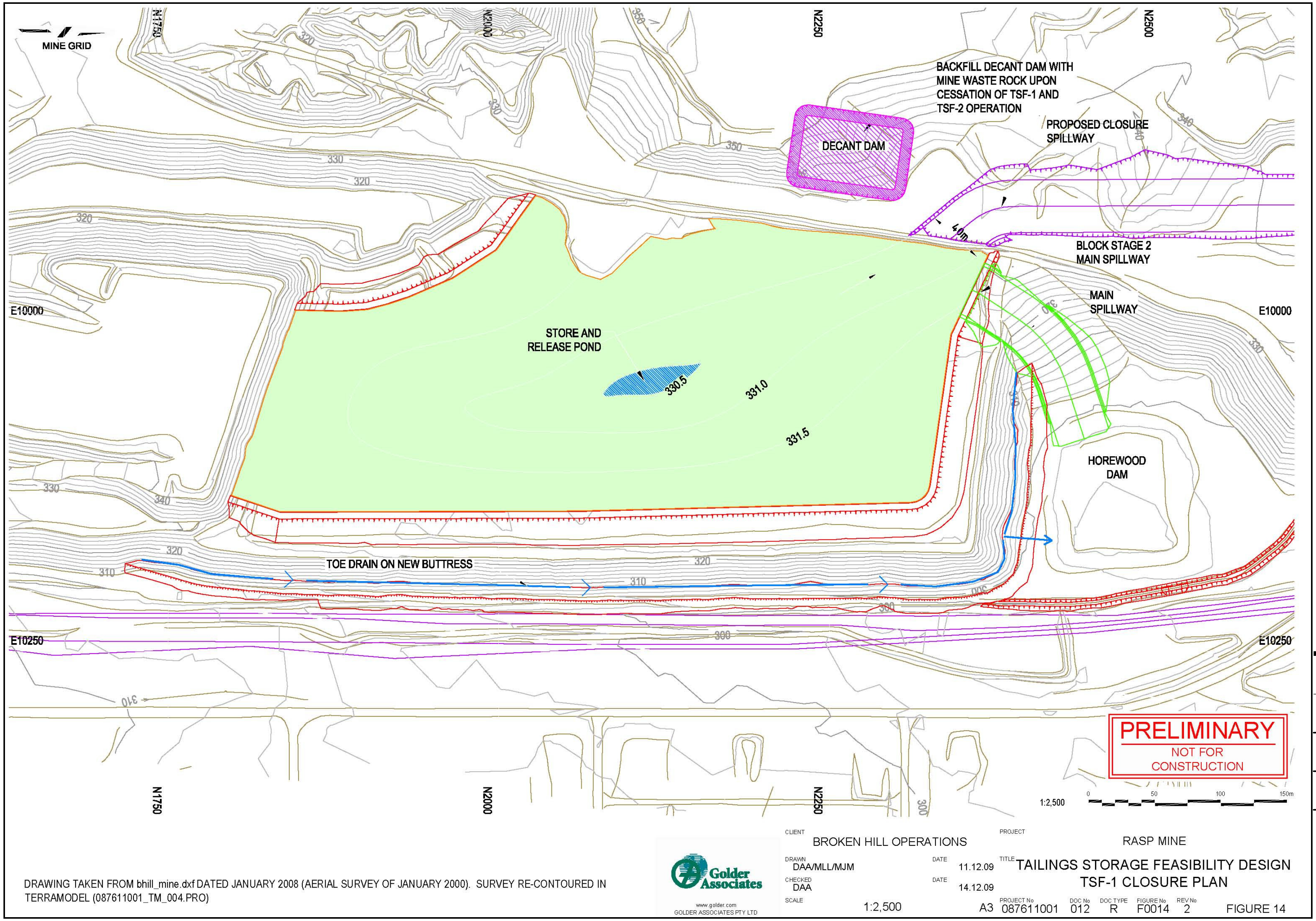
The following summarises the measures that have been considered in the conceptual design of TSF1 to minimise dust generation:

Decommissioning and closure

Following completion of tailings disposal to the cells, a final covering of chemical dust suppressant shall be placed over each cell. Irrigation sprays will remain in situ to allow additional application of the chemical dust suppressant or water as required to prevent dust generation whilst the tailings dry sufficiently to allow inert waste rock to be placed over the top of the cells.

On completion of TSF1 tailings will be deposited in TSF2.

Figure 2-16 TSF-1 Closure Plan



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Source: Golder Associates

Scale: Not to scale

2.6.5 TSF2 Blackwoods Pit

Background

Blackwood Pit is located to the north east of the existing tailings facility and will form TSF2 as part of the tailings storage strategy (see *Photograph 2-2 and Figure 2-17*). The depth of the pit varies from about 40 m at the western end to about 70 m at the eastern end. In the past, portions of the eastern end of the Pit have been back filled with mine waste. Old underground workings intersect the bottom of Blackwood Pit particularly at the western end. Before discharging tailings into Blackwood Pit, these old workings will have to be sealed to ensure that no inrush of tailings into the underground operations can occur.

Review of geological data covering the eastern end of the mining lease indicate there is potentially 630,000 tonnes of minable remnant ore remaining in the Blackwood Pit area. BHOP proposes to use TSF1 for tailings disposal initially to allow detailed investigation into the potential remnant ore located beneath the Pit (recovery of remnant ore does not form part of this application).

Photograph 2-2 Blackwood Pit – TSF2

Proposed Facility

The proposal is to deposit tailings into Blackwood Pit from the 260 mRL to 295.5 mRL by pumping tailings into the bottom of the Pit. Preliminary estimates indicate there is 1,290,000 m^3 of storage capacity, at a density of 1.3 t/m^3. This will allow for disposal of 1,680,000 t of tailings resulting in an operational life of 5.75 years. Should there be an increase in surface tailings production, there is scope to fill TSF2 above the 295.5 mRL. If storage is required above 308.5 mRL, an engineered bund wall would be required near the eastern end of the Pit on the northern side. The depth of the pit of the tailings may consolidate to a higher density (than 1.3 t/m^3) resulting increased storage capacity. There is insufficient capacity in TSF2 for all mine tailings.

At the cessation of tailings disposition in TSF2, a final covering of inert wast rock will be placed over the top of the tailings to avoid the potential for dust generation as they stabilise and consolidate.

The Blackwood Pit is considered inherently stable as there is no outer embankment to erode (Golder Associates, 2009). As the storage does not required embankment construction, the risk of a dam break is not considered an issue, the severity of damage resulting form a potential release through the emergency spillway is considered minor to medium. Golder has assigned TSF2 as a "Low" consequence category.

The existing perimeter bunds around Blackwood Pit would be extended where required to maintain a nominal 1 m height and to divert stormwater runoff. Tailings deposition would initially commence at the eastern end of the Pit. During the filling of the deeper eastern end of the Pit, deposition would occur from different deposition spigots to facilitate decant water off-take and evaporative drying. Once the eastern end of the Pit has been filled deposition would be switched to the western end to form a downward sloping beach to the east, facilitating efficient water extraction during operation. The pond water will be pumped to the decant dam by submersible pumps mounted on a floating pontoon.

Pond water from TSF2 would also be pumped to the decant dam used for TSF1. The decant dam would also serve as a secondary settlement pond, allowing for clarification of water prior to returning to eh processing plant, and will be the primary source of water for dust management for the tailings storages.

The preliminary design of TSF2 includes an emergency spillway located at the eastern end of the Pit and will be designed for a 1:1000 year storm event to satisfy flood discharge criteria for a "Low" consequence category facility. A spillway release is considered unlikely during operation of the facility, as there is approximately 13 m of freeboard above the final predicted tailings beach for flood containment.

Supernatant water is expected to cover the entire tailings surface at certain times during the initial operation of the facility, however it is envisaged that once tailings deposition form the west is established, the water pond will mainly be located at the eastern end.

At the commencement of tailings deposition into TSF2 it is not expected that dust generation will be an issue. The same dust management measures as outlined in the section above for TSF1 will apply.

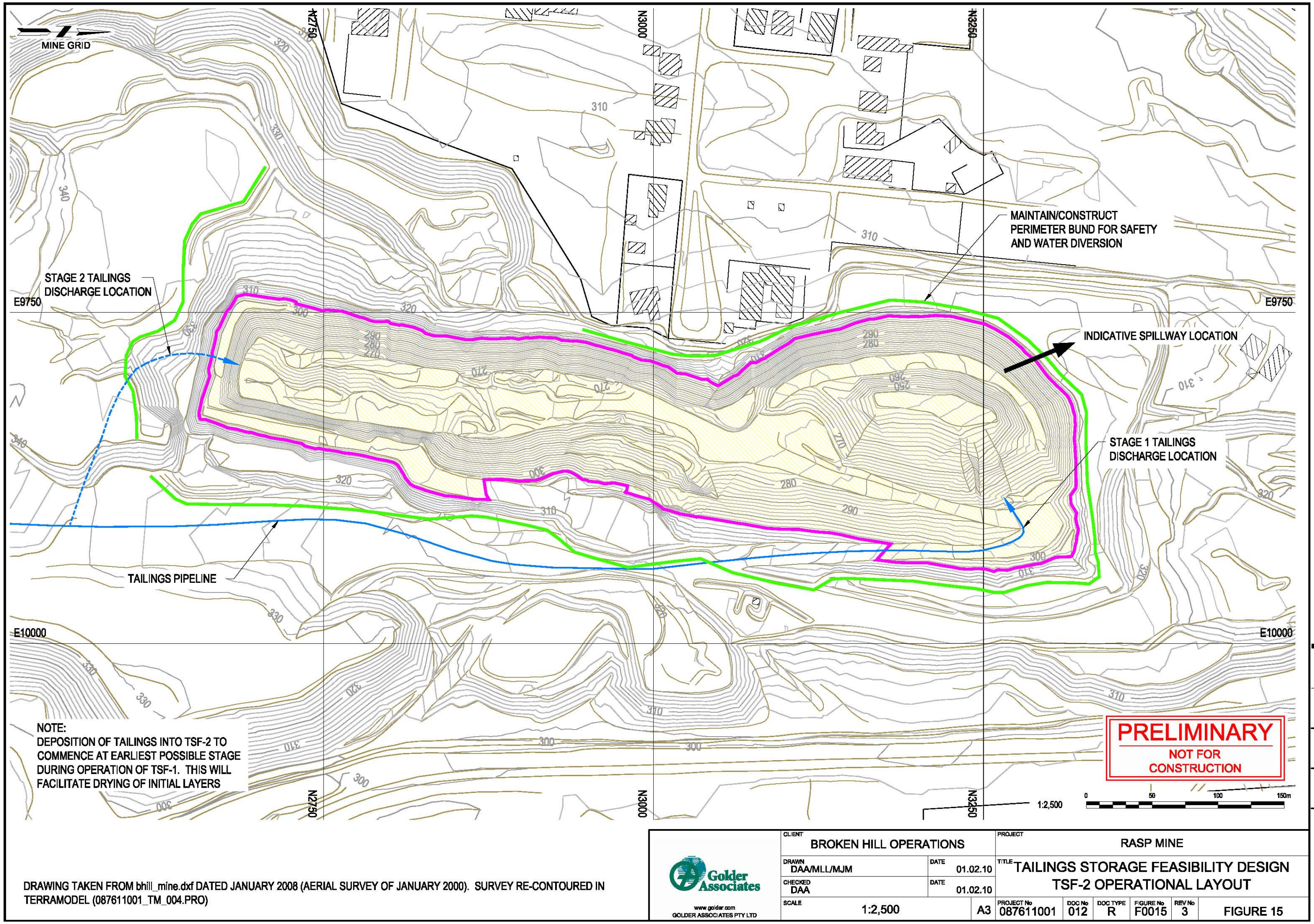
Tailings Construction and Operations Manual

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

- 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 the TSF2 from surrounding landforms.

Dust suppression measures will be utilised consistent with TSF1, as appropriate.

Figure 2-17 TSF 2 operational layout



Broken Hill Operations Pty Ltd

Source: Golder Associates

Scale: Not to scale

2.7 *BACK FILL PLANT*

The tailings from the processing plant will be pumped from the plant to the back fill plant located near the Delprat Shaft. The tailings will be transported to the back fill plant by way of pipes on surface placed within a purpose built containment structure (trench or bund) which will protect the line from damage and contain the tailings in the event of a rupture (refer to *Figure 2-3*).

The back fill plant will consist of cyclones to split the tailings feed. The coarser underflow stream from the cyclones will be mixed with suitable materials and redirected underground to use as stope fill. The finer overflow (slimes) will be directed to a high rate thickener, allowing thickened slimes to be sent to the TSF1 or TSF2.

In the first year of the Project all tailings will be directed to TSF1, once voids become available underground the tailings will be distributed between the backfill operation and TSF1 / TSF2 (*Table 2-10*). As a contingency measure against breakdowns or maintenance at the back fill plant, the ability to direct tailings from the plant directly to a TSF, bypassing the back fill plant, will be maintained. This will enable tailings to be kept as moist as possible on the TSF surface minimising potential dust generation.

The reclaimed water from No. 7 Shaft dewatering and underground mine operations dewatering is unsuitable for use as process water without treatment. BHOP proposes to treat the water by mixing it with the processing plant tailings and precipitating the dissolved minerals out in the back fill plant thickener. Test work has demonstrated that the addition of lime solutions have a significant impact on the pH of the water and the level of dissolved metals respectively. These results confirmed the waters suitability for use in processing. The treated water will be directly returned to the processing plant for reuse (process water tank will have a three hour holding capacity) or will be held in the Silver Tank which has a capacity of 9 ML.

2.8 *STORMWATER MANAGEMENT*

As part of the post-mining rehabilitation works undertaken by Normandy Mining Investments, CML7 was graded and a number of areas bunded to form water storage basins so that runoff water evaporated or was directed to underground workings.

Since 1991 when this work was undertaken, the mine site has experienced a 100 year storm event in 1992 and a 50 year storm event in January 1998. The existing measures on site including stormwater retention ponds have performed well during these events. No adverse impacts on the surrounding environment from these two events have been reported. Given the success of the previous stormwater management measures BHOP has continued with this philosophy.

In 2007 in preparation for the development of the exploration decline (now known as the Rasp Decline) bunding was installed to minimise water runoff into Kintore Pit and direct flows to Little Kintore Pit.

Golder Associates were engaged by BHOP to identify stormwater management measures that are required on the mine site to facilitate Project operational and environmental objectives. The main surface water management objectives for Project activities are to:

- prevent discharge of potentially contaminated surface waters from active mine areas off-site;
- minimise disruption to the mining activities and provide a safe working environment; and
- identify erosion and sediment control measures for the surface areas of CML7 which fall under the responsibility of BHOP.

The updated Stormwater Management Plan is provided at *Annexure J*.

The primary feature of the SWMP is the provision of small ponds/storages, spread throughout the mine site, that temporarily hold surface water runoff. Due to high evaporation rates, this runoff would be expected to evaporate in a relatively short period following storm events. This arrangement prevents runoff from active mine areas leaving site and allows the suspended particles to settle in the ponds/storages, better managing contaminated sediment on site. BHP and Blackwood Pits are also utilised where water flows are directed underground.

Based on this management criteria, the mine site was subdivided into small catchments (refer *Figure 2-18*) enabling where possible for the runoff from each catchment to be retained within the catchment by providing bunding along its boundary.

The catchment layout generally conforms to the existing landform. Where practical the catchment area has been reduced to minimise the requirement for storage within the catchment. For large catchments or catchments where significant mining activities are to be undertaken, dedicated water storages have been designed. A review of current facilities will be undertaken prior to final design, in the case of current water storage basins to ensure design capacity and in the case of pipes and bunding, to ensure their integrity. De-silting and repairs will be undertaken where required.

Potential impacts of the Project on surface waters will be mitigated by implementation of the SWMP. As well as fully retaining all runoff from active mine areas for storms up to a 100-year ARI event (and in some cases 1:200 Horwood Dam and 1:500 Catchment 1A events), the cascade arrangement of storages will enable settlement of most sediment and suspended contaminants before they can reach Horwood Dam. Storage dams will have markers that indicate when sediment is to be removed so that minimum storage requirements can be maintained. During maintenance, sediment will be removed from the dams and disposed of to the BHP Pit, TSF1 and / or TSF2. Sediment will not be removed off-site.

All runoff from the haul roads and hardstands will be directed to storage basins and retained until disposed of by evaporation or returned for use as process water or for other operational uses.

The closed water circuit for the mining operations will result in complete management of process water with no off-site wastewater discharges from the Project operations other than the conventional sewage discharge. Sediment collection ponds are proposed in the vicinity of the processing activities and again between catchments 14 and 17 to capture and return potentially mineralised sediment to the processing circuit.

Additional details are provided in *Section 10.6* with further details for each catchment, including required water management structures, outlined in the SWMP Report at *Annexure J*.

Figure 2-18 Water Catchment Areas

Rehabilitated areas

Mine lease surface exclusion areas

CML7 Bounday

Catchment Boundaries

Broken Hill Operations Pty Ltd | Source: Golder Associates | Scale: Not to scale

2.9 VEHICLE WASH FACILITIES

The following describes the vehicle washing facilities that form part of the Project infrastructure.

Two wash bays will be located adjacent to the mechanical workshop to enable vehicles and equipment to be clean prior to regular maintenance. An existing small wash bay will continue to be used for light vehicles. A separate dedicated wash bay will be required for larger vehicles and heavy equipment. Raw water will be used for washing in both bays. The water drains from the wash bays to an existing oil / water separator and into a series of existing settlement / evaporation dams. The settlement from the dams will be regularly collected for disposal on-site in the BHP and / or Blackwood Pits.

All vehicles that have entered passed the boom gate access point will be required to be washed down prior to leaving site. This is to remove any potential lead contamination that may be on the vehicle. For this purpose a vehicle wash facility has been installed as part of the exploration decline development. It is located on the main exit road prior to the boom gate access point. The main features of this facility are:

- fully automated wash system;
- deluge designed to wash wheels and undercarriage of cars and trucks;
- waste water treatment and recycling systems; and
- sediment collection and removal system.

Raw water will be used for the initial system fill and top up water. All water used in the washing process will be collected and recycled through a treatment system; including oil/water separator and sediment collector. The sediment will be collected on a regular basis for disposal in the BHP and / or Blackwood Pits.

The capacity of the facility is in excess of 1000 vehicle movements per day.

A small wash pad and hose is provided near this facility for manual washing of delivery vehicles that cannot pass through the vehicle wash facility.

2.10 DIESEL, OIL AND LUBRICANT MANAGEMENT

Storage arrangements for diesel, oil and lubricants have been allocated as part of the Rasp Decline development. The Rasp Mine maintains two Material Safety Data Sheet (MSDS) registers, one is located in the main administration building and the other in the workshop where most of the chemicals are used and stored.

Diesel will be stored in a 68,800 L Transtank T68 self bunded fuel storage container. The facility has been designed and manufactured in accordance with Australian Standards AS1940 – 2004: The storage and handling of flammable and combustible liquids and AS1692 – 206: Steel tanks for flammable and combustible liquids. BHOP currently has provision for diesel storage on its Dangerous Goods Licence: UN 00C1 Diesel to 70,000 L.

Lubricants and oils will continue to be stored in appropriate containers (1000 L pods) in a bunded area on the western side of the main workshop. This facility will be maintained to provide oils and lubricants to the workshop facility for servicing of equipment. A permanent refuelling location is planned to the west of the old No.6 Ventilation Shaft.

The permanent refuelling facility will include provisions for the storage of oils and lubricants in either self bunded storage containers or a bunded area capable of holding 110% of the oils and lubricants. The permanent refuelling location will be bunded so that any spills will be contained and passed through an oil / water separator.

Fuel and lubricants which have to be transferred to remote equipment will be transported via a purpose built fuel trailer.

Waste oil from fixed and mobile equipment will be stored on-site in drums or 1000 L pods in a bunded area and collected by a licensed contractor.

2.11 UTILITIES AND SERVICES

The Project has existing connections to the Broken Hill electricity supply network, telecommunications network and reticulated sewerage and water supply networks. These utilities have been upgraded to ensure they have sufficient capacity to service construction and mining / processing operations.

Electrical Supply

The electricity supply with a connection of a 22 kV line to the Eyre Street boundary has been upgraded under current approval (DA 101/2007), and will enable BHOP to supply and distribute high voltage (22kV) power via overhead transmission lines to the operations, ventilation fans, processing plant, back fill plant, workshops, the TSFs and some existing buildings on the lease.

An additional 22kV connection to the Broken Hill power grid will be required for the processing plant, backfill plant and both TSF1 and TSF2. A connection to the power grid on the western side of the Project Area will be required to supply sufficient capacity for the mine during full operations. This upgrade to the electricity supply will be carried out during construction of the processing plant.

The Eyre Street connection will provide a temporary electricity source until such time that an additional 22 kV line can be constructed. This further upgrade to the electricity supply will be carried out during construction of the processing plant.

Water Supply

The total water supply for the Project is estimated at 448 MLpa. The Project has existing connections to both Broken Hill's potable and raw water supply networks. Broken Hill water supply comes from the Stephen's Creek Reservoir, Umberumberka Reservoir, Imperial Lake (emergency supply only) and Menindee Lakes Scheme on the Darling River. The following water supplies will be utilised over the life of the Project:

1. Potable water (9 ML/annum): water from the town supply is treated at the Mica Street treatment plant and supplied to the Project via existing connections;

2. Raw water (288 ML/annum): water from the town supply is supplied untreated to the project via existing connections;

3. Reclaimed water (300 ML/annum): water reclaimed onsite from various sources to be recycled for the Project. If necessary, the reclaimed water will be treated onsite to ensure that it is suitable for use as process water in both the processing plant and underground operations. The sources for the reclaimed water include:

    - No. 7 Shaft dewatering (95 ML);

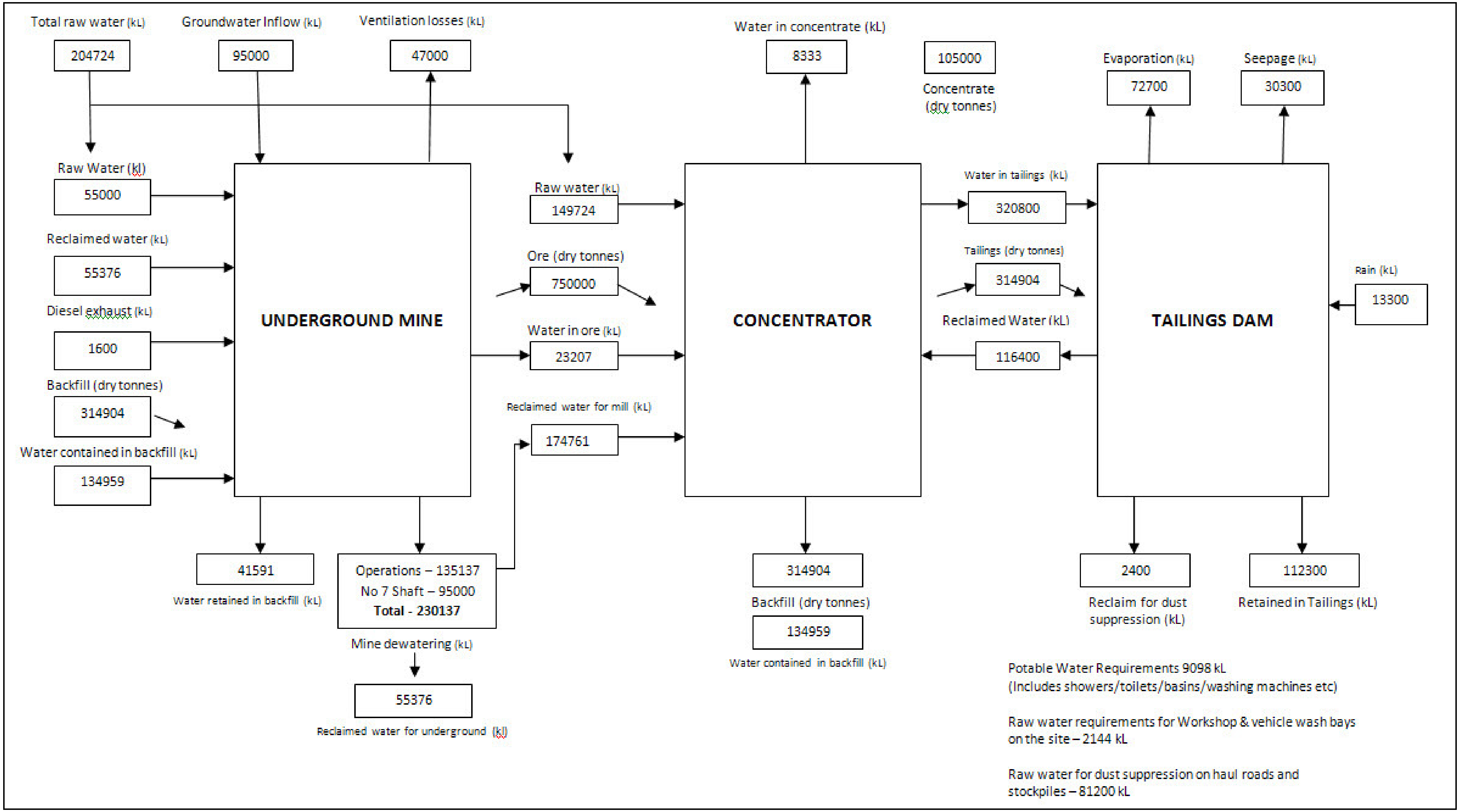
- mine underground operations dewatering (135 ML);
- processing plant tailings and thickener overflows (included in TSF decant pond reclaim water);
- TSF decant pond (116 ML); and
- stormwater containment dams (amount dependent on extreme rain events as insufficient runoff is collected for pumping during normal rainfall events, therefore no allocation has been made).

Reclaimed water will be returned after treatment at the back fill plant to the process water tank which has a three hour holding capacity or to the Silver Tank which has a capacity of 9 ML.

Water extraction licenses for dewatering from No 7 Shaft and for mine operations dewatering are required. These will be obtained prior to BHOP taking over the dewatering of No 7 Shaft from Perilya and prior to dewatering from underground operations. A water transfer agreement will be negotiated if required.

An indicative water balance for the Project is presented in *Figure 2-19.*

Figure 2-19 Mine water balance model



2.12 WORKFORCE AND HOURS OF OPERATION

Table 2-13 provides a list of underground activities that will occur during day shift and those that will take place 24 hours per day.

Table 2-13 Operation of key mining activities

Day shift	24 hours per day
• Crushing and screening • Shunting of rail wagons between the siding's four rail spurs and to and from the off-site marshalling yard	• Mineral processing – grinding, flotation, thickening, filtration • Loading of concentrate to rail wagons (including movement of wagons along the two loading rail spurs, to enable loading of subsequent wagons) • Truck haulage of ore from underground • Ventilation fans • Underground Operations

It is anticipated that during the construction phase the on-site workforce will be approximately 107 employees and contractors. *Table 2-14* shows the work rosters during for the Project phases.

Table 2-14 Summary of operational hours for major functional groups

Task	Roster	Hours of work
Processing Plant	7 days per week	24 hours per day
Underground	7 days per week	24 hours per day
Construction	7 days per week	7am to 7pm
Administration	Monday to Friday	7am to 5pm

Underground operations will occur 24 hours per day, seven days a week with the following exceptions:

- Crushing and screening will only occur during dayshift (7am to 7pm).
- Shunting of concentrate wagons will only occur between 7am and 6pm.

It is anticipated that the on-site workforce will include 143 employees. There will be two shifts, 7am to 7pm and 7pm to 7am.

2.13 ENVIRONMENTAL MANAGEMENT AND MONITORING

BHOP contracted Macmahon for the development of the exploration decline (Rasp Decline). As Macmahon was the managing agent its safety and environmental systems were implemented at the site. In addition BHOP developed a Noise Blasting Vibration and Overpressure Protocol and an Air Quality Management Plan that were also implemented during this period. BHOP has continued to use these systems where appropriate while operations were in suspension and is in the processing of compiling its safety and environment management systems.

BHOP has continued to undertake monitoring activities; the following provides details of these activities.

Air Quality

BHOP maintains an air quality monitoring program in accordance with its EP Licence 12559. One high volume and 4 dust deposition gauges have been installed in accordance with the EP Licence. A fifth dust deposition gauge was installed in December 2009 to meet the new licencing requirements subsequent to the approval of Development Application 264/2009. The parameters to be monitored are detailed in *Table 2-15*.

Table 2-15 EP Licence - Dust Monitoring

Location	Parameter	Unit	Frequency	Equipment	Sampling Method
HVAS1	Total Lead	µg/m^3	Every 6 days	HVAS	AS2800-1985
D1, D2, D3, D4	Total Lead Lead (dissolved) Particulates – deposited matter	g/m^2/m	Monthly	Dust deposition gauge	AM-19

Monitoring locations are include:

- Location HVS 1 Silver Tank area
- Location D1 RSPCA – St Johns
- Location D2 Block 10 Hill
- Location D3 Thompson Shaft area
- Location D4 Browne's No. 1 Residence

Weather Station

BHOP has installed a weather station in accordance with its EP Licence and monitors the following weather parameters:

- Air temperature
- Relative humidity
- Wind speed
- Rain fall
- Wind direction

These weather parameters are up dated every minute and reporting is available as averages over intervals of 10 minutes, one hour and / or one day.

Noise and Vibration / Overpressure

A noise monitoring program was implemented with the commencement of the crushing activities in May 2007. Monitoring was conducted in accordance with the requirements of the EP Licence at the following locations where criteria, as presented in *Table 2-16,* was applied.

Table 2-16 EP Licence – Noise monitoring crushing operations

Location	Day LAeq, 15 min dB(A)	Evening LAeq, 15 min dB(A)
Residences in Eyre Street (and cross streets with similar setbacks from the premises)	43	40
Residences in Piper Street (and cross streets with similar setbacks from the premises)	42	39
Residences in Hebbard Street (and cross streets with similar setbacks from the premises) and any other residence.	38	35

1. Day is defined as 7.00am to 6.00pm Monday to Saturday and 8.00am to 6.00pm Sundays and Public Holidays.
2. Evening is defined as 6.00pm to 10.00pm

The noise readings were taken at:

- Location N2 Eyre Street
- Location N5 Piper Street
- Location N6 Hebbard Street

In October 2008 it was determined to obtain background noise levels for other locations adjacent to the Rasp Mine. During the development of the Reference to Environmental Factors for the Project in 2006 the noise consultant recommended several sampling locations for noise monitoring. The monitoring program was altered from the above locations to the recommended locations, so that these locations could be monitored. These locations included an additional location along Eyre Street, and locations at South Road and Crystal Street (Keenan Lookout) (Locations N1 to N4) This monitoring continues each month.

A Noise Blasting Vibration and Overpressure Protocol has been developed to provide employees with an understanding of their responsibilities for noise control on site.

Blasting was conducted in the base of the Kintore Pit to establish the portal and underground to develop the decline. Blast management was optimised by:

- The use of blast noise and overpressure absorption barriers to minimize noise and blast overpressure at lease boundaries.
- Stemming of development blast holes to minimize noise and blast overpressure.

A Blasting Vibration and Overpressure Log was maintained when blasting activities occurred. The EP Licence provides the following limits for vibration and overpressure when blasting:

Table 2-17 EP Licence Limits for Vibration

MEASURE	LIMIT	FREQUENCY
Ground vibration peak particle velocity	5mm/sec	5% of total blasts over 12 months reporting period
Ground vibration peak particle velocity	10mm/sec	Not at any time

Table 2-18 EP Licence Limits for Overpressure

LIMIT	FREQUENCY	TIME PERIOD
115dB (Lin Peak)	5% of total blasts over 12 months reporting period	7am to 7pm
120dB (Lin Peak)	Not at any time	7am to 7pm

The EP Licence also provides the following monitoring locations for vibration and overpressure**:**

- Location V1 543546 easting and 6462242 northing - (Eyre Street)
- Location V2 542875 easting and 6463294 northing - (Gossan Street)
- Location V3 543573 easting and 6463629 northing - (Crystal Street)

Monitoring was undertaken at least 15 minutes prior and subsequent to each blast using instrumentation in accordance with *Australian Standard 2187.2 Explosives—Storage, transport and use Part 2: Use of Explosives* and will be licensed under the *Explosives Act 2003*.

Electronic records are filed in the Blasting Vibration and Overpressure Log and summarised on the Development Blasting Vibration and Overpressure Record Sheet. Monitoring will include the time, date, charge mass, location and blasting technique used.

The Monitoring Officer reports the monitoring results to the BHOP Mine Manager and the Contracts Manager (when they are responsible for the blasting activity).

The vibration and overpressure monitoring program was conducted during blasting operations and was suspended when operations were suspended in June 2008.

2.13 PROJECT ALTERNATIVES

2.13.1 Key Project Components

Multiple options for key Project components have been canvassed over the Project's development phase. Workshops have been held at the Rasp Mine and attended by BHOP representatives, process plant feasibility consultants and environmental specialists. These workshops were fundamental in modifying the Project plans to meet economic, social and environmental objectives will be met.

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

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

Consideration was given to designing Project components to minimise impacts arising from these key environmental issues. *Table 2-19* details key Project components and the advantages and disadvantages of each option.

Table 2-19 Summary of options assessed for major project components

Component	Description	Advantages	Disadvantages
Underground mining	Primarily long hole and bench stoping **This option is preferred given the form and location of the Western Mineralisation orebody. It is also considered a 'lower risk' approach to operations.**	• Suited to narrower ore bodies of variable width; • Allows for greater flexibility when selecting ore zones to mine (better grade control and overall recovery); • Enables more control of charge density minimising potential impacts due to vibration; • Increases number of stopes reducing operational risks relating to stope unavailability. • Excavations are designed as stable (e.g. not caving or similar) and thus present less threat to surface infrastructure.	• Higher number of stopes required for operation increases development requirements, and costs.
	Exclusively long hole open stoping	• Larger stopes reducing the amount of development required; • Lower cost per tonne of ore extracted.	• High dilution of ore resulting in lower grade material; • Greater potential for localised geotechnical instability (confined to the immediate production area); • Higher risk of significant ground vibration from individual blasts; • Greater potential of disruption to production resulting from stope unavailability.
Ventilation fan location	Ventilation fan located within the Little Kintore Pit connecting to Kintore Shaft. **This option is preferred as the location will allow for adequate fan function whilst providing the maximum reduction in potential air and noise impacts.**	• Minimised acoustic impacts as fan will be located within the bunded pit; • Minimised air quality impacts as the fan will be some distance from the lease boundary; • Dust emissions will be further minimised due to the distance underground between the fan and the active mining areas; • Dust emissions will be reduced as the shaft has a high humidity content; • The ventilation fan will not be visible to receptors off-site; negating visual impacts.	• Due to the distance from the active mining areas to the fan, special underground ventilation design features will be required for it to function effectively; • Inefficient underground ventilation circuit which would increase costs and create difficulties in controlling ventilation underground; • Potential requirement for booster fans in underground workings; • Use of a existing timbered shaft of uncertain condition; • Requirement to strip out existing underground workings.
	Ventilation fan located in the western section of the Project Area towards Crystal Street and adjacent to	• Closer to active mining areas, thus providing better air through flows with the minimum of	• Significant potential for adverse noise impacts; • Fan clearly visible from off-site without

Component	Description	Advantages	Disadvantages
	town centre.	underground development; • Allows the overall ventilation design to be simpler and more effective (hence improved greenhouse performance).	considerable earth works; • Condensation on cold dry winter days may create alarm as some viewers may conclude that there is an underground fire; • Increased potential for dust emissions.
	Ventilation fan located on the eastern side of the decline on top of the rock waste dumps.	• Fan location significant distance from Project Area boundaries reducing potential for air and noise impacts.	• Shaft to be installed through 50 – 60 m of unconsolidated fill requiring slow and costly construction techniques to be used; • Inefficient underground ventilation circuit which would increase costs and create difficulties in controlling ventilation underground; • Fan would be clearly visible from receptors located off-site.
Primary ventilation fan design	Centrifugal fans **This option is preferred as centrifugal fans have a smaller footprint, emit lower noise levels and use less energy.**	• Capable of higher operating pressures than axial fans of the same size; • Capable of operating very efficiently at the design operating point; • Generates less noise than an axial flow fan operating at the same pressure.	• Noise generated from expansion of exhaust air, electrical motors, and gear boxes; • Visual impact due to requirement for more substantial surface infrastructure.
	Axial fans	• Suited to operating in series to provide necessary pressure; • Blade pitch control allows for wide operating range covering the life of the project.	• Higher levels of noise generated for a given operating pressure; • Noise generated from expansion of exhaust air, electric motors and gear boxes; • Visual impact due to collar bend, fan housing and evasee; • Larger fan installation required for a given operating pressure.
	Underground primary fan installation	• Reduced noise levels at surface exhaust; • Minimal visual impact from the ventilation installation.	• Possible recirculation of exhaust air in the underground; • Inaccessibility in the event of underground fire; • Difficulties in accessing and servicing the fan installation; • Noise generated due to expansion of exhaust air.
Ore haulage method	Truck Haulage from underground production and development areas to ROM pad.	• Suited to shallow ore bodies (less than 500m); • Suited to low production rates (less than 2,500	• Higher operating costs; • Higher levels of noise generated for a given

Component	Description	Advantages	Disadvantages
	This option is preferred as there is insufficient room in the Kintore Pit for the crushing and conveyor infrastructure and recommissioning of No 7 shaft would result in the project being uneconomic.	tonnes per day); • Lower capital costs; and • Most flexible haulage option.	production rate; and • Potential for higher levels of dust generation for a given production rate.
	Conveyor haulage from a crushing plant installed in the Kintore pit.	• Crushing operation contained within Kintore Pit minimising potential noise and dust generation issues; • Lower operating costs for a given production rate; • If conveyor fitted with wind deflectors or fully enclosed the potential for dust generation is negligible; and • Crushing could be carried out 24 hours per day.	• Significantly higher capital costs; • Truck haulage still required to transport ore from underground production and development areas; • No capacity for stockpiling ore prior to crushing; • Insufficient room within the Kintore pit for installation of crusher and conveyor infrastructure • Potential safety issues arise due to close proximity of underground portal and crushing infrastructure. • Suited to high production rates (greater than 5,000 tonnes per day).
	Recommissioning of No 7 shaft to allow haulage from a crushing plant installed in the underground workings.	• Crushing operation contained in the underground workings removing the potential for noise and dust generation issues; • Lower operating costs; • Crushing and haulage could be carried out 24 hours per day; • Method used extensively in Broken Hill and by previous mining companies on CML7.	• Very high capital costs for recommissioning of shaft and installation of underground crushing station; • Truck haulage still required to transport ore from underground production and development areas to shaft; • Recommissioning of No. 7 shaft would require replacement / upgrade of winders, replacement / upgrade / repair of steel work within shaft, replacement of shaft conveyances and upgrade / repairs to head frame. Additionally modification to heritage headframe would be required to allow for transportation of ore from No. 7 to the processing plant; • Suited to deep ore bodies (greater than 800 m); • Suited to high production rates (greater than 5,000 t per day).
Haul road location	Haul road located on the north and west sides of the Kintore Pit with a four metre earth bund to be constructed between the haul road and the western	• Significant reduction in noise and dust impacts due to increased distance from major receptors and earth bunding;	• Increased distance of truck haulage to ROM pad; • Additional construction costs associated with development of new road;

Component	Description	Advantages	Disadvantages
	lease boundary. **This option is preferred as it results in significant reduction in mine noise emissions from haulage whilst allowing for efficient traffic operations.**	• Allows improved management and control of internal traffic.	• Increased use of diesel fuels (increased greenhouse gas emissions).
	Existing haul road to be utilised located on the south and west sides of the Kintore Pit.	• No construction of haul road required; • Shorter distance to ROM pad. • Improved greenhouse performance.	• Proximity of haul road to external receptors resulting in increased potential for noise and air quality impacts; • Internal traffic management more difficult when full scale operations.
Processing plant location	Plant located in the southern corner of Project Area in a 10 m depression. **This option is preferred as it maximises operational efficiency whilst not resulting in significant environmental impacts or costs.**	• Allows for open plan design, which increases efficiency of operations; • Location in a 10 m depression aids noise amélioration; • Easy access for maintenance and better control of environmental monitoring structures including dust gauges.	• Components of the processing plant visible from off-site; • Processing plant not fully enclosed providing potential for noise and air impacts.
	Locating the plant inside old mill building	• Negate any visual impacts; • Minimises potential for noise and air impacts.	• Confined working area; • Heritage building, may restrict functionality; • Inefficiencies as plant design required to fit with old structure creating cost and safety risks; • Remedial costs to get building up to safe standard; • Difficulty in meeting modern regulatory requirements and design standards.
	Locating the crushing components of the processing plant in the base of Kintore Pit.	• Minimise potential for noise and air quality impacts; • No visual impacts.	• Sterilisation of ore; • Functionality of underground operations would be unacceptably impacted due to limited space on the pit floor.
	Locating the mill and TSF off-site. This option includes processing post crushing, ore would be crushed on site and trucked to new facility.	• Minor reduction in dust emissions from 93 tpa TSP to 86.6 tpa and 36.3 tpa PM_{10} to 33.4 tpa. • Reduction in noise emissions. • Less light vehicles from employees entering / leaving site. • Less truck deliveries for processing materials.	• Increased footprint for Project environmental impacts. • Requirement for trucking ore through the town to an offsite location with wider spread of impacts to additional residents, eg noise and dust from truck movements.

Component	Description	Advantages	Disadvantages
			• Potential difficulty in purchasing and securing a suitable plant site (much of the land around Broken Hill already governed by exploration licences). • Distance to truck ore may be cost prohibitive (much of the land around Broken Hill already governed by exploration licences). • Major Project time delays and uncertainty in obtaining mining licence over new land. • Cost of acquiring new land may be prohibitive and make the Project uneconomic.
Processing plant design	Open processing plant design (crusher and screens to be located in a purpose built building, venting under negative pressure, to a baghouse) **This option is preferred as it maximises operation efficiency whilst not resulting in significant environmental impacts.**	• Minimises visual impact; • Allows for easy housecleaning and provision of a safe working environment; • Allows for ease of maintenance; • Majority of process is carried out as a slurry therefore minimising the potential for dust generation; • Requires minimal changes to the current landform to allow for its construction.	• Requires installation of noise reducing equipment (rubber lined mills, noise attenuation on motors etc); • Limits crushing operations to day shift only; • Requires installation of dust control measures within the crushing circuit (bag house on crushers, enclosed transfer points and conveyors).
	Enclosed processing plant	• Traditional design utilised in Broken Hill; • All processing operations contained within the building; • Negates potential for noise and dust impacts.	• Increased visual impact; • Construction requires either significant changes to the current landform or the removal of an existing heritage building to accommodate the processing plant; • Higher capital cost to construct; • Restricted work spaces pose potential difficulties for housekeeping and provision of safe working environment.
Tailings management	Fine tailings disposal; constructing additional raises at existing on-site TSF (TSF1) followed by disposal in Blackwood Pit (TSF2). Coarse tailings disposal as underground stope back fill. **This option is preferred as it provides sufficient capacity for the proposed operations, to manage tailings on-site and allow for underground**	• Provides sufficient capacity for the Project life; • Prevents sterilisation of a substantial economic resource by enabling remnants beneath Blackwood Pit to be assessed and mined prior to tailings placement in the pit; • Increased stability of old pit workings; • Minimises visual impacts from TSF; • Tailings are managed on-site;	• Limited capacity; • Limited geotechnical information regarding previous construction; • Due to location of TSF1, the facility will be a prescribed dam under the Dam Safety Act; • Cost of chemical dust suppressant.

Component	Description	Advantages	Disadvantages
	disposal as stope fill. Refer detailed discussion of TSF options at section 2.1.2 below.	• Requires no additional environmental footprint.	
	All tailings directed to new TSF located off-site. Coarse tailings disposal as underground stope back fill.	• Optimise design to maximise tailings storage.	• Increased footprint of Project environmental impacts; • Potential difficulty in securing TSF site; • Increased costs to tailings transfer infrastructure; • Potential for off-site spillage/leakage from tailings transfer pipe work; • Higher potential for dust generation; • Significant increase in capital costs associated with acquiring land, pipe work, pumping and establishment of facility.
Other infrastructure	Maximising reuse of heritage buildings. **This option is preferred as it utilises existing infrastructure whilst not adversely impacting on the heritage value of these items.**	• Use of existing buildings would minimise capital expenditure; • Provide ongoing maintenance of heritage buildings; • Provides structurally sound buildings for post mining uses.	• Design limitations associated with use of existing buildings to maintain heritage values; • Potential up keep costs of buildings; • Difficulty in meeting modern regulatory requirements and design standards.
	Construction of new buildings for the project.	• Enable purpose built designs potentially increasing functionality; • Optimise location on-site to maximise operational efficiencies.	• Difficulty in finding suitable locations to build new buildings; • Increased visual impacts; • Potential for demolition of heritage buildings to allow space for construction of new buildings; • Location of historical mining voids.
Water management	Use of underground water in operation. **This option is preferred as it aids in water conservation, reduces costs and has operational benefits.**	• Aids in the conservation of water resources; • Minimises reliance and impact on town water supply; • Enables zero off-site release policy to be maintained; • Provide long term access to deeper ore sources and underground workings - no inundation; • Decreases operation costs (not required to pay for large volume of town water); • Provides an additional level of safety for the Perilya southern operations.	• Processing plant requirements to deal with impurities of underground water; • Water pre-treatment prior to use; • Need for a water extraction licence.

Component	Description	Advantages	Disadvantages
	Utilising predominately town water supply to support operations.	• Reduced setup costs; • No metallic impurities in water.	• Increased operating costs; • Reliance and impact on town water supply; • May result in off-site discharge of mine water as water from underground workings is not used in processing.
Hours of operation	Restricted operating hours for ore handling front end loader, crushing plant and train load out facility. **This option is preferred despite increased costs and reduced productivity as modelling indicated a significant reduction in potential noise impacts at night.**	• Significantly reduces the potential of adverse noise impacts during night time hours.	• Reduced productivity; • Increased capital costs in equipment sizing.
	24 hour operation.	• Increased productivity; • Decreased capital costs in equipment sizing.	• Greater potential for adverse noise impacts during night time hours.
Product concentrate transportation	Rail transport of all product concentrate. **This is the preferred option as it negates potential off-site environmental impacts relating to haulage of product concentrate on public roads.**	• No off-site road haulage reduces the noise, visual and traffic impacts; • Reduction in the generation of greenhouse gases; • Decreased transport costs.	• Reduces operational flexibility in terms of timing of haulage and destination for product concentrate; • Creates need for more control systems in the load-out operation, increasing cost and maintenance requirements .
	Off-site road haulage.	• Minimises impact of rail disruptions between the mine and the port; • Simpler and cheaper to operate; • Increased flexibility in transport operations in terms of timing and ability to send concentrate to other smelters or distribution centres.	• Increased transportation costs; • Traffic and transport impacts associated with haulage on public roads; • Increased noise and greenhouse gas emissions.

2.13.2 Discussion of TSF Surface Management Options 1 and 2

A key Project consideration is the storage of tailings. The preferred strategy is detailed in *Section 2.6* and *Annexure F*. Surface storage options considered included off-site storage, storage in Blackwood Pit (TSF2) only and storage in the existing TSF (TSF1) supported by the TSF2. The storage of tailings off-site was not considered viable for the reasons presented in *Table 2-19.*

The preferred Option 1 initially utilises TSF1 (existing surface storage facility) supported by TSF2 (disused Blackwood Pit).

This option allows for the full recovery of available ore as proposed by the Project application. The Project proposes to mine 8,450,000 t of ore with an estimated value of $334,000,000. This requires the disposal of 6.97 Mt of tailings; 3.4 Mt to be used as underground hydraulic backfill and 3.6 Mt to be stored in surface facilities: 970,000 t in TSF1 and 2.6 Mt in TSF2.

This option allows the maximum potential for future resource recovery from the Blackwood Pit. There is approximately 630,000 t of minable high grade remnant ore located within / under the Blackwood Pit with an estimated value of $93,000,000.

As part of the tailings management investigations, consideration was given to using the Blackwood Pit as the primary disposal site from the beginning of production. This has the advantage of avoiding the use of the existing facility and the resultant need to manage its proximity to local residences.

However, a concurrent review of historical mining activity by an experienced Broken Hill geologist indicated there is a strong possibility that significant quantities of remnant ore remain in the vicinity of Blackwood Pit. This ore was left behind by the early miners for a number of reasons; including the provision of regional ground support, its grade may have been below that considered economic at the time, or it may have been zinc rich when lead and silver were the primary targets.

The historical data review indicated that there could be as much as 2.1 Mt of remnant ore remaining in this area. As further drilling and detailed design work will be required to enable the value of these remnants to be established with any certainty, a first pass evaluation was conducted to see if there was sufficient incentive to use the existing TSF while this was study is undertaken. Golder Associates, 2009 concluded that TSF1 could provide an operational life of 4.25 years.

Given that a portion of the remnants may not be recoverable due to size, location or ground conditions, a conservative minable figure of 30% was adopted – yielding approximately 630,000 t of ore. At long term forecast prices and exchange rates this would be worth over $100 million to the project (before tax and royalties), a benefit that cannot be overlooked.

Early placement of tailings into the Blackwood Pit would render the surrounding area unsafe for mining due to the possibility of uncontrolled flows of material through the bottom of the Pit via old workings. This would effectively sterilise the remnant ore around and below the pit. Therefore, it is considered essential that sufficient time be allowed to fully evaluate the amount and recoverability of these remnants before any filling occurs in this Pit. This dictates the need to use the existing tailings settling facility (TSF1) for as long as possible.

Prior to the commencement of tailings to Blackwood Pit a drilling program is required to be completed and the results reviewed and a decision to proceed determined based on the identified recoverable ore and the economics of mining method to be employed. Prior to mining proceeding all required approvals would need to be obtained.

Table 2-20 Summary of Benefits and Liabilities for the Tailings Storage Options

	Option 1	Option 2
Project life	15 Years	12 Years
Ore recovery		
Western Mineralisation	8,480,000 t	7,350,000 t
Potential Blackwood Remnants	630,000 t	300,000 t
Total potential ore recovery	9,110,000 t	7,650,000 t
Economic value		
Western Mineralisation	$ 334 M	$ 250 M
Potential Blackwood Remnants	$ 93 M	$ 41 M
Blackwood Remedial Works		$ (5) M
Total potential value	$ 427 M	$ 286 M
Ore sterilisation	Nil	330,000
Closest residence	120 m	20 m
Period for construction	1 x 4 months	Nil
	1 x 2 months	
Visual impact	Minimal	Nil
Wind erosion / dust generation	Construction – Minimal	Construction – Nil
	Operations - Minimal	Operations – Minimal

The overall intent is to prevent sterilisation of valuable ore reserves. This will ensure that the NSW Government will continue to receive royalties. The placement of tailings in the TSF1 will allow time for the resource in Blackwood Pit to be fully assessed and for a resource extraction strategy to be developed and for seeking relevant approvals.

Dust generation during the construction and operation of both TSF1 and TSF 2 can be managed through the design and operation as detailed in *Section 2.6*. and *Section 8.1*.5. A high priority in designing the TSF1 has been to minimise dust generation and this has been achieved with a robust design containing with several layers of redundancy. These were the result of reviewing scenarios for a number of potential upset conditions, conducting a qualitative assessment of their likelihood, and determining contingency measures with regard to dust control.

In terms of economic impacts, Option 2 would have the potential to adversely impact on the economic viability of the project by reducing the tailings storage capacity and consequently the quantity of material that could be mined. In addition this option would reduce the potential resource that may be recovered through future approvals from the Blackwood Pit.

On balance, Option 1 is therefore the preferred option for tailings disposal.

The management of environmental issues was an important consideration during the Project development phase. Representatives from BHOP together with process plant feasibility consultants and environmental specialists liaised frequently during the development process with preliminary noise and air quality modelling results directly influencing Project design elements.

The preferred options 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 provide positive multiplier effects for the region in an area where mining is the only substantial primary industry.