Rasp Mine

Zinc – Lead – Silver Project

Project Approval No. 07-0018

January 2011

Site Water Management Plan

BHO-PLN-ENV-004

June 2019

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Contents

1. Introduction

1.1 Overview

Broken Hill Operations Pty Ltd (BHOP), a wholly owned subsidiary of CBH Resources Limited (CBH), owns and operates the Rasp Mine (the Mine), is located centrally within the City of Broken Hill on Consolidated Mine Lease 7 (CML7). The Mine produces zinc and lead concentrates which it dispatches via rail to Port Pirie in South Australia and Newcastle in New South Wales.

Project Approval (PA) was granted in January 2011 (07_0018) and mining commenced in April 2012. Modifications to the PA have been granted on a number of occasions and details can be found on the CBH web site. The existing operations include underground mining operations, a processing plants, a rail siding for concentrate dispatch and other associated infrastructure.

Mining has been undertaken within CML7 since 1885 and the entire site has been disturbed with little or no remnant native vegetation.

The mine is located at a high point in the regional topography and is a prominent feature in the City of Broken Hill. Most of the site is raised from the adjoining area in the form of an extensive mound, formed from waste rock and tailing. Site elevations vary from 356 m AHD at the parking bay for the Miners Memorial to approximately 216 m AHD at the base of Kintore Pit.

The total area of CML7 is approximately 342 ha. There are several surface exclusion zones within CML7, these include rehabilitation areas and areas with no or limited surface rights. These exclusion zones comprise approximately 123.7 ha. BHOP is not responsible for the surface water management in these exclusion zones.

1.2 Purpose

The purpose of this Site Water Management Plan (SWMP) is to outline the responsibilities and actions for monitoring and managing water in relation to the operations of the Rasp Mine.

The SWMP has been developed in accordance with the:

- Project Approval 07-0018 Conditions (as modified);
- Rasp Mine Environment Protection Licence 12559;
- CML7 and Mining Purpose Leases (MPLs) 183, 184, 185 and 186, and
- Commitments made by Broken Hill Operations Pty Ltd to monitor and manage water related activities.

The SWMP satisfies the requirements for a *Water Management Plan* as outlined in Schedule 3, Condition 23 of the PA.

1.3 Objectives

The primary objectives for this SWMP are to:

- To comply with section 120 of the Environment Operations Act 1997, which prohibits the pollution of waters.
- Prevent discharge of potentially contaminated surface waters from active mine areas off-site.

- Separate runoff from the mine processing plant area and groundwater collection ponds from areas of general runoff.
- Limit disruption to the mining activities and provide a safe working environment.
- Identify erosion and sediment control measures for the site and outline control measures and a monitoring plan for areas considered susceptible to erosion
- Outline a water monitoring program for the site to include both surface and ground waters; Provide a site representative water balance.
- Provide reporting requirements based on statutory obligations and internal processes.

1.4 Surface Water Management Goals

The topography of the site and the arid climate conditions provide opportunities to develop a SWMP that satisfies the operational requirements of the mining activity and prevents release of runoff from active areas of the mine site for rainfall events up to the design frequency event – 100 year average recurrence interval (ARI) 24 hour rainfall event. A set of goals were developed in order to guide this SWMP, these goals are:

- Retain runoff from a 100 year ARI 24 hour rainfall event from the active mine areas. The high evaporation rate would allow retained water to evaporate in a relatively short period. This goal will minimise impact on the downstream environments;
- Retain runoff locally in small ponds / storages at various locations in the mine site, utilising the existing landform where feasible to maximise evaporation. This would:
    - Eliminate the need to construct a large storage and avoid hazards associated with large storages;
    - Help in the sedimentation process that would remove suspended solids from the runoff;
    - Minimise erosion potential by eliminating the requirement to carry large discharge to a smaller number of large storages;
- Provide appropriate spillways for the local ponds to convey flows greater than the 100 year ARI runoff event. Spillways will be set at the 100 year ARI 24 hour storm event storage level;
- Use the available capacity of Horwood Dam to contain the 100 year runoff event from various sub-catchments;
- Use the available capacity of S22 to contain runoff from TSF 1, Mt Hebbard (catchment 19) and adjacent catchments to the northwest, in addition provide storage for mine water settlement ponds including underground mine dewatering and groundwater from Shaft 7;
- Divert runoff away from Kintore Pit to reduce the flooding risks in the Pit and associated potential impact on mining operations;
- Provide appropriate sediment and erosion measures on site;
- Divert stormwater surface runoff from undisturbed areas around mining affected water storage facilities;
- Monitor the groundwater bores on site;
- Summarise the results of the site water balance model;
- Address the conditions of the PA, Statement of Commitments and Environment Protection Licence conditions;
- Provision and location of spill kits and requirements for training;
- Design and installation of chemical storage to include bunds with suitable sumps, and where appropriate roofed to prevent stormwater entry;
- Bunding of the diesel refuelling station;

- Oil / water separators to be installed at vehicle wash facilities and the diesel refuelling station;
- Management of sediment and sludge from vehicle washing facilities;
- Water quality monitoring including groundwater (represented by mine dewatering) and at locations to the east of TSF1, and surface water represented by Horwood Dam;
- Monitor the quality and quantity of water captured by the toe drains on the Tailings Storage Facility (TSF); and
- Monitor the movement of seepage sourced from the TSF and to monitor the quality of the local groundwater system.

1.5 Consultation

The SWMP has been prepared in consultation with the Department of Industry – Water (DI-W), the Environment Protection Authority (EPA) and the DPE Resources Regulator (DRR) as required by PA07_0018.

1.6 Supporting Plans and Documents

Table 1-1 lists the plans, procedures and associated forms developed in accordance with this Plan.

Table 1 - Water Management Associated Documents

Document Title	BHOP Document Code	Associated Forms
Pollution Incident Response Management Plan	BHO-PLN-ENV-002	• Incidents entered into INX inControl electronic database.
Site Water Monitoring Procedure	BHO-ENV-PRO-011	• Groundwater Monitoring Form • Surface Water Monitoring Form • Mine Water Monitoring Form
The Erosion and Sediment Control Monitoring Procedure	BHO-ENV_PRO-018	• Environmental Inspection Form
Eyre Street Dam Monitoring Procedure	BHO-PRO-ENV-027	• Eyre St Trench Inspection Form

2. Statutory Requirements

Table 2-1 details the statutory requirements as prescribed in the:

- Project Approval 07_0018 (modified) pursuant to the *Environment Planning and Assessment Act 1979*;
- BHOP Environment Assessments and Statement of Commitments, and
- Environment Protection Licence 12559 pursuant to the *Protection of the Environment Operations Act 1997*.

Table 2 - BHOP Water Management Requirements and Obligations

Reference	Requirement	Relevant Section within this Plan
Project Approval 07_0018 (modified)		
Sched 3 Cond 21	Except as may be expressly provided by an Environment Protection Licence issued under the Protection of the Environment Operations Act 1997, the Proponent shall comply with section 120 of that Act, which prohibits the pollution of waters.	Section 1.3
Sched 3 Cond 22	The Proponent shall ensure that it has sufficient water for all stages of the project, and if necessary, adjust the scale of mining operations to match its water supply. *Note: The Proponent is required to obtain the necessary water licences for the project under the Water Act 1912 and/or Water Management Act 2000.*	Section 11
Sched 3 Cond 23(a)	A Site Water Balance which must include details of: • Sources and Security of water supply; • Water use of site; • Water management on site; and • Any off-site water transfers. Investigate and implement all reasonable and feasible measures to minimise water used by the project	Section 6, 11.2.3
Sched 3 Cond 23(b)	An Erosion and Sediment Control Plan, which must: • Identify activities that could cause soil erosion, generate sediment or affect flooding; • Describe measures to minimise soil erosion and the potential for transport of sediment to downstream water, and manage flood risks; • Describe the location, function and capacity of erosion and sediment control structures and flood management structures; and • Describe what measures would be implemented to maintain the structures over time.	Section 9
Sched 3 Cond (c)	A Surface Water Management Plan, which must include; • Detailed baseline data on surface water flows and quality in creeks and other waterbodies that could potentially be affected by the project; • Surface water and stream health impact assessment criteria including trigger levels for investigating any potentially adverse surface water impacts. • Program to monitor and assess: ○ Surface water flows and quality	Section 3 Section 8

Reference	Requirement	Relevant Section within this Plan
	○ Impacts on water users ○ Stream health; and ○ Channel Stability	
Sched 3 Cond (d)	A Groundwater Monitoring Program, which must: • Provide a program to monitor seepage movement within and adjacent to the tailings storage facility; • Include details of parameters and pollutants to be monitored for: ○ Water from mine dewatering ○ Groundwater locations to the east of TSF1 ○ Surface water represented by Horwood Dam ○ Water captured by the toe drains of the tailings storage facility. ○ Water seepage from the tailings storage facility; and ○ The background local groundwater system • Outline performance parameters against monitoring data will be compared to determine whether seepage is occurring, and whether an unacceptable impact on local groundwater may be occurring; and • Include details of contingency measures to be implemented in the event that an unacceptable impact is identified	Section 7
Sch4, 1	**Environmental Management Strategy** The Proponent shall prepare and implement an Environmental Management Strategy for the project to the satisfaction of the Director-General. This strategy must: (a) be submitted to the Director-General for approval by the end of June 2011; (b) provide the strategic framework for the environmental management of the project; (c) identify the statutory approvals that apply to the project; (d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project; (e) describe the procedures that would be implemented to: • keep the local community and relevant agencies informed about the operation and environmental performance of the project; • receive, handle, respond to, and record complaints; • resolve any disputes that may arise during the course of the project; • respond to any non-compliance; and • respond to emergencies; and (f) include: • copies of any strategies, plans and programs approved under the conditions of this approval; and • a clear plan depicting all the monitoring required to be carried out under the conditions of this approval. Management Plan Requirements The Proponent shall ensure that the management plans required under this approval are prepared in accordance with relevant guidelines, and include: (a) detailed baseline data;	See Environmental Management Strategy

Reference	Requirement	Relevant Section within this Plan
	(b) a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; and • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria; (d) a program to monitor and report on the: • impacts and environmental performance of the project; and • effectiveness of any management measures (see (c) above); (e) a contingency plan to manage any unpredicted impacts and their consequences; (f) a program to investigate and implement ways to improve the environmental performance of the project over time; (g) a protocol for managing and reporting any: • incidents; • complaints; • non-compliances with the conditions of this approval and statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and (h) a protocol for periodic review of the plan. Note: The Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.	
Sch4, 2	Management Plan Requirements The Proponent shall ensure that the management plans required under this approval are prepared in accordance with relevant guidelines, and include: (a) detailed baseline data; (b) a description of: • the relevant statutory requirements (including any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria; and • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures; (c) a description of the measures that would be implemented to comply	Section 3, 7 Section 2 Section 2 Sections 7, 8, 9 Sections 7, 8, 9,

Reference	Requirement	Relevant Section within this Plan
	with the relevant statutory requirements, limits, or performance measures/criteria; (d) a program to monitor and report on the: • impacts and environmental performance of the project; and • effectiveness of any management measures (see (c) above); (e) a contingency plan to manage any unpredicted impacts and their consequences; (f) a program to investigate and implement ways to improve the environmental performance of the project over time; (g) a protocol for managing and reporting any: • incidents; • complaints; • non-compliances with the conditions of this approval and statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and (h) a protocol for periodic review of the plan. Note: The Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.	10, 11 Section 11 Sections 7.3, 8.4, 10 Section 6, 11 Sections 11 Section 11.3
Sch4, 3	**Annual Review** By the end of June 2012, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Secretary. This review must: (a) describe the development (including any rehabilitation) that was carried out in the past year, and the development that is proposed to be carried out over the next year; (b) include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the: • relevant statutory requirements, limits or performance measures/criteria; • monitoring results of previous years; and • relevant predictions in the documents referred to in Conditions 2 of Schedule 2; (c) identify any non-compliance over the past year, and describe what	Section 11.2

Reference	Requirement	Relevant Section within this Plan
	actions were (or are being) taken to ensure compliance; (d) identify any trends in the monitoring data over the life of the project; (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and describe what measure will be implemented over the next year to improve the environmental performance of the project.	
Sch4, 4	**Review of Strategies, Plans and Programs** Within three months of: (a) the submission of an annual review under Condition 3 above; (b) the submission of an incident report under Condition 5 below; (c) the submission of an audit report under Condition 7 below, or (d) any modification of the conditions of this approval (unless the conditions require otherwise), the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Secretary. *Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.*	Section 11.3
Sch4, 5	**Incident Reporting** The Department must be notified in writing to compliance@planning.nsw.gov.au immediately after the Proponent becomes aware of an incident. The notification must identify the project (including the application number and the name of the project if it has one), and set out the location and nature of the incident.	Section 11.1
Sch4, 5A	**Non-compliance Notification** The Department must be notified in writing to compliance@planning.nsw.gov.au within 7 days after the Proponent becomes aware of any non-compliance with the conditions of this approval. The notification must identify the project and the application number for it, set out the condition of approval that the project is noncompliant with, the way in which it does not comply and the reasons for the non-compliance (if known) and what actions have been done, or will be, undertaken to address the non-compliance.	Section 11.1
Sch4, 6	**Regular Reporting** The Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any approved plans or programs of the conditions of this	Section 11.2

Reference	Requirement	Relevant Section within this Plan
	approval.	
Sch4, 7	**Independent Environmental Audit** By the end of December 2011, and every three years thereafter, unless the Secretary directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must: (a) be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary; (b) include consultation with the relevant agencies; (c) assess the environmental performance of the project and whether it is complying with the relevant requirements in this approval and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals); (d) review the adequacy of any approved strategies, plans or programs required under these approvals; and, if appropriate (e) recommend measures or actions to improve the environmental performance of the project, and/or any strategy, plan or program required under these approvals. *Note: This audit team must be led by a suitably qualified auditor and include experts in any fields specified by the Secretary.*	Section 11.3
Sch4, 8	**Independent Environmental Audit** Within six weeks of the completing of this audit, or as otherwise agreed by the Secretary, the Proponent shall submit a copy of the audit report to the Secretary, together with its response to any recommendations contained in the audit report.	Section 11.3
BHOP Statement of Commitments		
EA	BHOP is committed to the following water conservation measures: • Treatment of mine dewatering to enable usage in the processing plant; • Tailings water to be returned to the processing plant for reuse; • Water to be recycled from Horwood Dam to the processing plant; • The silver tank is a raw water holding tank for water to be used in the processing plant, reducing the potential for evaporation from open type storages; • Investigate the use of grey water from domestic facilities for use in ground management; and • Installation of flow metres to monitor water usage.	Section 6
EA	Measures to manage water quality that will be included in BHOP's water management program include: • Provision and location of spill kits and requirements for training; • Design and installation of chemical storage to include bunds with suitable sumps, and where appropriate roofed to prevent stormwater entry;	Section 1

Reference	Requirement	Relevant Section within this Plan
	• Bunding of the diesel refuelling station; • Oil / water separators to be installed at vehicle wash facilities and the diesel refuelling station; • Management of sediment and sludge from vehicle washing facilities; • Water quality monitoring including groundwater (represented by mine dewatering) and at locations to the east of TSF1, and surface water represented by Horwood Dam; • Monitor the quality and quantity of water captured by the toe drains on the Tailings Storage Facility (TSF); and • Monitor the movement of seepage sourced from the TSF and to monitor the quality of the local groundwater system.	
EA	In addition the recommendations from the Stormwater Management Plan as proposed by Golder Associates (Golder 2010, Annexure J) will be implemented and will address potential impacts from new Project activities prior to the commencement of those activities. This Plan includes: • Erosion and sediment control measures; • Design requirements for on-site retention evaporation basins; • Requirements for management of catchment areas, including drains, pipework, bunding and sumps; and • Quarterly inspections of the site storm water management structures to confirm that they are operational.	Section 4, 9
EA	A Groundwater Management Plan will be prepared to provide details of the monitoring of seepage movement within and adjacent to the TSF.	Section 7
EA	If sufficient water is not available, the scale of their operations will be adjusted to match the licensed water entitlements.	Section 11
EA	Finally, all necessary licences under the *Water Act 1912* will be obtained prior to the commencement of activities on site.	Section 1.2
MOD1	Divide Catchment 25 into two catchments, 25A and 25B with two smaller storm water storage basins, S25A which diverts water away from the vent shaft and flows into S25B.	Section 4
MOD4	The following mitigation measures will be implemented for water seepage: • Incorporate TSF2 seepage controls recommended by Golder and as required by the DSC. • Line each embankment of the TSF with a geomembrane liner. • Collect seepage in a filter sand layer on the upstream slope of each embankment of the TSF extension where collection drains will be installed. • Periodically monitor seepage at the TSF extension via inspection chambers installed on the drainage pipes.	Section 7
MOD4	The following mitigation measures will be implemented for stormwater: • Review and update the BHOP Site Water Management Plan to address stormwater management at the CBP and TSF2 embankments to collect and retain a 1:100 year, 72 hour rainfall event. • Construct a spillway at TSF2 to meet the NSW DSC requirements.	Section 5.3
Environment Protection Licence 12559		

Reference	Requirement	Relevant Section within this Plan
Section 3 L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	Section 1.3
Section 3 L8.1	All storm water and other surface water holding ponds identified in the Site Water Management Plan must be designed, constructed and maintained to accommodate the stormwater runoff generated in a 100 year (24 hour) Average Recurrence Interval rain event.	Section 4
Section 3 L8.2	The water storage ponds listed below must have the base and wall artificially lined with an impermeable high density polyethylene liner: 1) "Mine Settlement Ponds" and "Backfill Plant Sediment Pond" identified in Figure 3 of the Rasp Mine Site Water Management Plan. 2) "Plant Event Pond" and the "Overflow Event Pond" identified in Figure 4 of the Rasp Mine Site Water Management Plan.	Section 5
Section 4 O4.1	All surface water storage ponds must be maintained to ensure that sedimentation does not reduce their capacity by more than 10% of the design capacity.	Section 4, 9
Section 5 M1.1	The results of any monitoring required to be conducted by this licence or a load calculation protocol must be recorded and retained as set out in this condition.	Sections 7, 8, 9
Section 5 M1.2	All records required to be kept by this licence must be: a) in a legible form, or in a form that can readily be reduced to a legible form; b) kept for at least 4 years after the monitoring or event to which they relate took place; and c) produced in a legible form to any authorised officer of the EPA who asks to see them.	Section 11
Section 5 M1.3	The following records must be kept in respect of any samples required to be collected for the purposes of this licence: a) the date(s) on which the sample was taken; b) the time(s) at which the sample was collected; c) the point at which the sample was taken; and d) the name of the person who collected the sample.	Sections 11
Section 5 M2.1	For each monitoring/discharge point or utilisation area specified below (by a point number), the licensee must monitor (by sampling and obtaining results by analysis) the concentration of each pollutant specified in Column 1. The licensee must use the sampling method, units of measure, and sample at the frequency specified.	Table 7.2, 8.3
Section 5 M2.2	Lists the water monitoring requirements for nominated locations and includes – pollutant, unit of measure, frequency and sampling method. Surface Waters points 29, 31, 32, 33, 34 Receiving waters points 35 and 36 Ground waters points 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52	Table 7.1, 8.1, 8.2

Reference	Requirement	Relevant Section within this Plan
	Water from shaft 7 and mining extraction points 53 and 54	
Section 5 M5.1	The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.	Sections 11
Section 5 M5.2	The record must include details of the following: a) the date and time of the complaint; b) the method by which the complaint was made; c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect; d) the nature of the complaint; e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and f) if no action was taken by the licensee, the reasons why no action was taken.	Section 11
Section 5 M5.3	The record of a complaint must be kept for at least 4 years after the complaint was made.	Section 11
Section 5 M5.4	The record must be produced to any authorised officer of the EPA who asks to see them.	Section 11
Section 6 R1	Details requirements for reporting water monitoring results in the Annual Return to the EPA.	Section 11
Section 6 R2	Details requirements for notifying of environmental harm to the EPA.	Section 11
Section 6 R3	Details requirements for written reports that can be requested by the EPA.	Section 11

3. Site Description

The Mine is located centrally within the City of Broken Hill and is surrounded by transport infrastructure, areas of commercial and industrial development and some residential housing. The Mine is bounded by Eyre Street and Holten Drive to the south and east, Perilya's Broken Hill North Mine to the east and its South Mine to the west, and the commercial centre of Broken Hill to the north. The Mine site is dissected by two major State roads, South Road (Silver City Highway SH22) to the southwest and Menindee Road (MR66) to the northeast. The Broken Hill railway station is located directly to the north of the Mine and lies on the main Sydney – Perth railway line. Residential and commercial areas surround the Mine with pasture land to the southeast.

The far west region of NSW is characterised by rolling downs and lowlands. The Barrier Range lies to the north, west and south-west of Broken Hill. Elevations generally range from approximately 180 m AHD 30 km west of Broken Hill to 300 m AHD within Broken Hill to 472 m AHD at Mount Robe, 33 km north-west of Broken Hill (Broken Hill City Council, 2000).

CML7 lies centrally within the Line of Lode which divides the City and its surrounds into North and South Broken Hill. To the north of the City, the land consists generally of steep, rugged hills and hill slopes. The remaining area consists of low hills, foot slopes and low calcareous rises (Broken Hill City Council, 2000).

The Rasp Mine and the City of Broken Hill are located within the catchment of the Stephens Creek Reservoir. West of Broken Hill, all runoff drains to Lake Frome, in South Australia. Three main creeks run within 30 km of the City; Umberumberka Creek to the northwest, Stephens Creek to the east and southeast and Yancowinna Creek to the northeast. The closest major water course is the Darling River approximately 100 km to the south east. The Rasp Mine is not subject to flooding from external water courses.

The surface drainage patterns of the Rasp Mine have been substantially altered by previous mining and rehabilitation works. A major part of the rehabilitation works has been the construction of a number of water storage areas and diversion drains to contain site runoff. The final discharge point for the initial areas of potential impact is the Horwood Dam.

3.1 Site Facilities

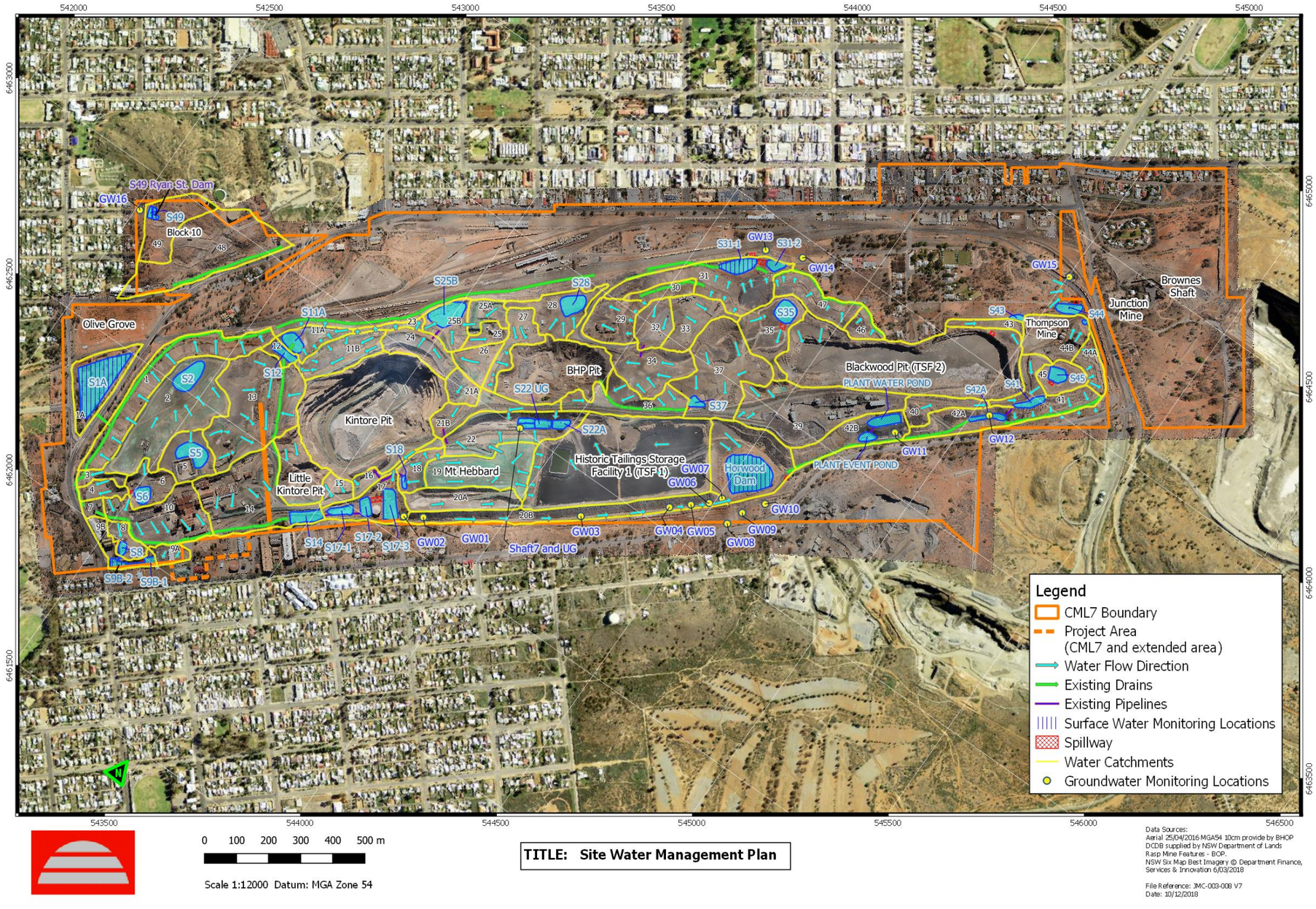
The Mine consists of the following site facilities:

- Open Pit and Waste Rock Dumps;
- Workshops;
- Processing Plant;
- Services – Primary Ventilation, Concrete Batching Plant, Backfill Plant and Sub-Stations;
- TSF1 historic tailing storage;
- TSF2 current tailing deposition;
- Sealed and unsealed roads; and
- Free Areas (non-active mining areas).

3.2 Site Catchment Areas and Water Storage Locations

The site has been subdivided into 60 catchment areas, with 39 storage locations. Figure 1 outlines catchment boundaries within the Mine as well as water flow direction and water storage locations.

Figure 1 - Site Water Management Plan

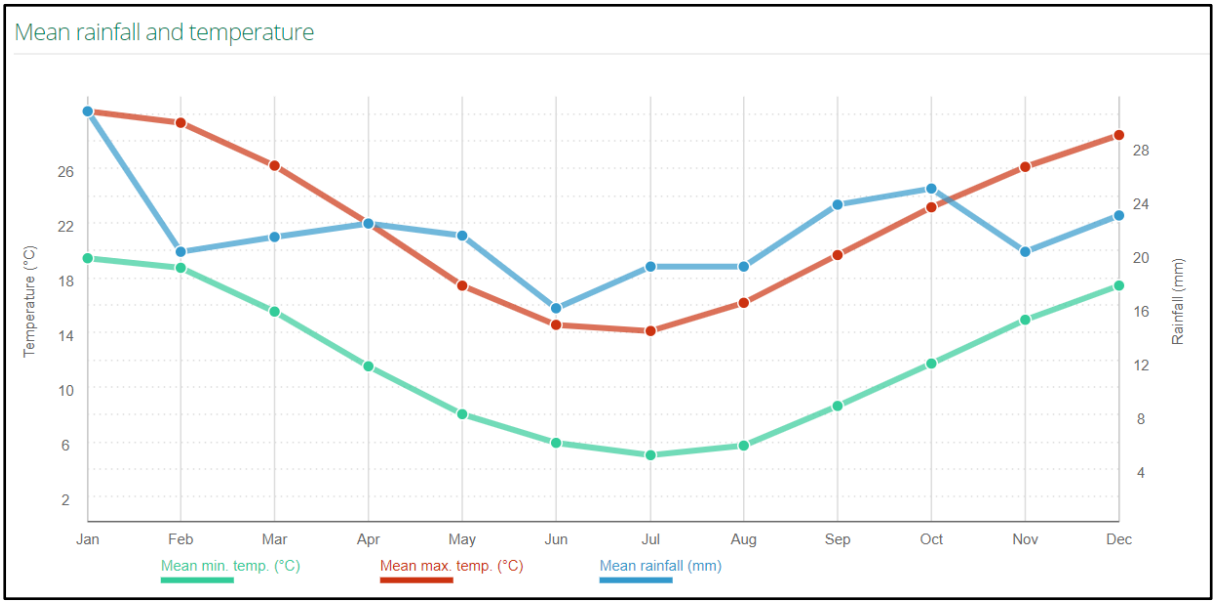


3.3 Surface Hydrology

3.3.1 Rainfall and Temperature

The local climate is arid with an average annual rainfall of approximately 250 mm. A review of the Bureau of Meteorology (BOM) data for the last 120 years indicates limited seasonal variation in average rainfall depths, with mean monthly rainfall varying within a narrow band from approximately 17 mm to 24 mm during the year. The monthly mean temperature varies from 33°C in January to 15°C in July. **Figure 2** shows the monthly variations of rainfall and temperature.

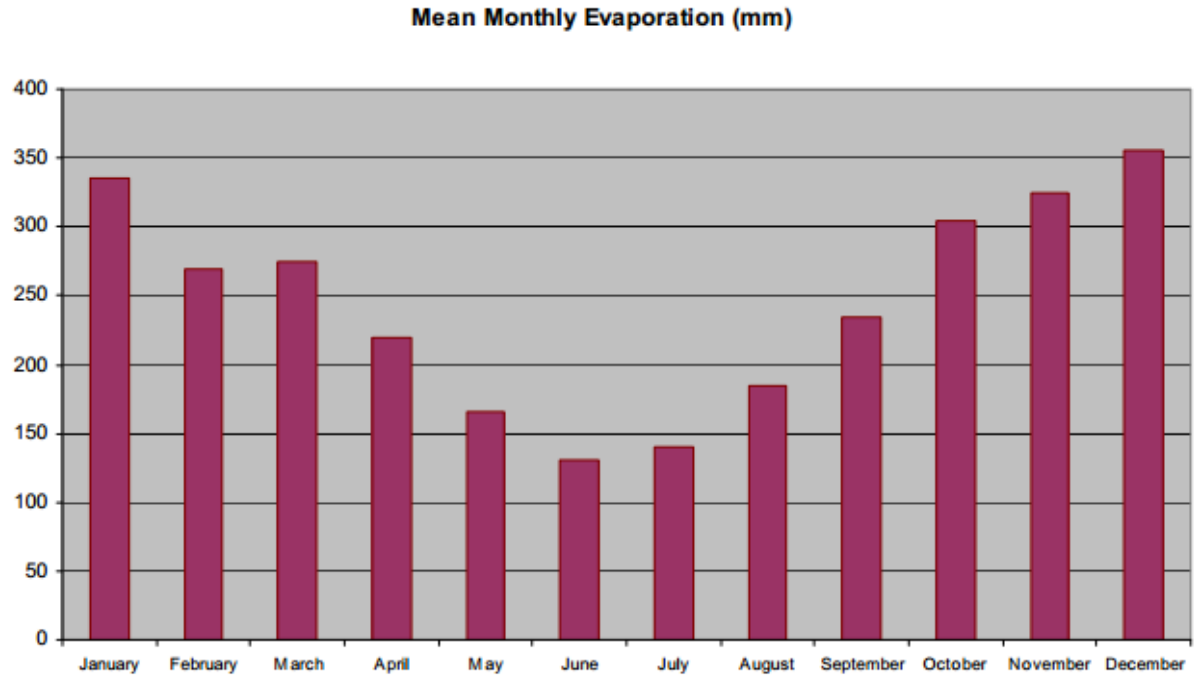
Figure 2 Average Temperature and Rainfall Summary



3.3.2 Evaporation

The average annual evaporation is approximately 2,614 mm. This estimate has been derived from the BOM grid data for the entire Australian Continent. The evaporation rate varies from approximately 12 mm/day in December to 4mm/day in June. The monthly variations for evaporation are presented in **Figure 3**.

Figure 3 Average Monthly Evaporation



Evaporation far exceeds the rainfall in the Broken Hill area, with mean monthly evaporation more than 15 times the mean monthly rainfall in January and approximately 5 times more in July.

3.3.3 Rainfall data

Rainfall data were sourced from BOM and is displayed is **Table 3**.

Table 3 - Design Rainfall Data

DURATION	Rainfall (mm)			
	10 years ARI	20 Years ARI	50 years ARI	100 Years ARI
30 minutes	23.7	28.3	34.5	39.3
1 hour	30.9	36.8	44.9	51
2 hours	38.2	45.6	55.8	64
3 hours	42.6	51	62	71
6 hours	51	61	75	86
12 hours	61	73	90	104
24 hours	73	87	108	124
48 hours	83	101	124	142
72 hours	87	105	130	149

3.3.4 Rainfall Excess Estimation

The surface water storage and drainage of the Mine is designed to manage runoff volumes generated from a 100 year ARI rainfall event. Before runoff can occur, a portion of rainfall is lost to initial absorption by the materials to bring them to field moisture capacity. This loss is termed initial loss which is approximately 15 mm, while a continuing loss due to infiltration is estimated to be 4 mm per hour (Golders 2012). The adopted loss rates were used in conjunction with the design rainfall to derive the rainfall excess or the volume of runoff from each catchment. The estimated rainfall excess for the 100 year event is presented in **Table 4**.

Table 4 - Estimated Rainfall Excess for 100 Year ARI Rain Event

Duration	Rainfall Excess (mm)
30 minutes	28.3
1 hour	39.2
2 hours	49.6
3 hours	55.4
6 hours	64
12 hours	70
24 hours	**73**
48 hours	62
72 hours	55

The critical duration for the 100 year ARI event is the one that corresponds to the largest rainfall excess and hence the volume of runoff. For the 100 year event, the critical rainfall excess occurs for the 24 hour event and is equal to 73 mm, **Table 4**.

3.3.5 Drainage Layout

The drainage layout for the Rasp Mine site is based on the rainfall data and excess rainfall outlined in Sections 3.3.3 and 3.3.4.

Based on the runoff management criteria, the Mine site is subdivided into 64 small catchments and sub-catchments with various engineered water diversions to retain the 1:100 year rainfall event. The catchment runoff volumes and catchment areas are presented in the **Tables 5 and 6**.

4. Water Catchments and Storage

4.1 Water Catchments and Storage

The Mine site has been divided into water catchments which are detailed in **Table 5** and **Figure 1. Table 6** provides details of the 64 catchment areas in regards to runoff management and details which catchment areas report to which individual storage area. Individual catchment calculations were provided by Golders Associates in the original SWMP (2011).

Table 5 - Catchment Details

Catchment Number	Area (ha)	Runoff Volume (100 year event) (m^3)	Catchment Number	Area (ha)	Runoff Volume (100 year event) (m^3)
1	5.099	3,739	**26**	1.669	1,224
1A	4.223	3,097	**27**	1.062	779
2	6.822	5,003	**28**	2.414	1,771
3	0.528	387	**29**	2.083	1,526
4	0.726	533	**30**	0.852	625
5	2.065	1,514	**31**	5.426	3,980
6	1.504	1,103	**32**	1.507	1,105
7	0.842	618	**33**	2.155	1,580
8	0.863	633	**34**	2.937	2,154
9A	0.602	441	**35**	6.152	4,512
9B	0.598	439	**36**	3.002	2,202
10	3.513	2,576	**37**	2.571	1,886
11A	1.355	994	**39**	3.430	2,515
11B	2.298	1,685	**39A**	1.732	1,270
12	0.485	355	**40**	1.345	986
13A	6.658	4,883	**41**	1.241	910
13B	0.652	478	**42A**	3.760	2,758
14	6.299	4,620	**42B**	2.823	2,070
15	0.769	564	**43**	0.45	383
16	0.773	567	**44A**	1.695	1,243
17	2.353	1,725	**44B**	2.606	1,911
18	1.102	808	**45**	1.215	891
19	3.817	2,799	**46**	1.065	781
20A	2.394	1,756	**47**	2.181	1,600
20B	1.513	1,110	**48**	6.881	5,047
21A	1.396	1,024	**49**	2.660	1,951
21B	1.931	1,416	**Horwood Dam**	5.152	3,779
22	4.188	3,071	**Kintore Pit**	13.376	9,810
23	0.392	287	**Little Kintore Pit**	2.623	1,924
24	1.566	1,148	**BHP Pit**	5.984	4,388
25A	1.238	908	**TSF 1**	14.050	10,304
25B	2.164	1,609	**Blackwood Pit**	13.135	9,633

The storage requirements for these water catchments are outlined in **Table 6**.

Table 6 - Water Storage Requirements

Storage	Reporting Catchments	Runoff Volume for Storage (m^3)	Surface Area of Storage (m^2)	Maximum depth of storage (m)[1]	Lined or unlined	Spillway	Comments
C1 West Drain	1	3,739	N/A	N/A	Unlined	No	The West Drain acts as an attenuation drain for the 100 year ARI rainfall event. Overflows from the West Drain for events greater than 100 year ARI event are directed through an existing box culvert S1A.
S1A	1A, 3, 4	4,017	16,300	0.56	Unlined	Yes	Catchment forms storage. Direct runoff from C3 and C4 report to the existing box culvert crossing under the road before discharging into S1A. Overflows from C1 for events > the 100 year ARI event also report through the box culvert under south road to S1A. Underground water storage tanks south of C7, pump sump water into the existing drain in C4 where flow is diverted into S1A. Storage S1A has the capacity to retain the 500 year ARI storm event.
S2	2	5,003	5,320	1.24	Unlined	Yes	Existing storage S2 retains the 100 year ARI storm event with overflows discharging to the drainage channel, via a spillway located in C13A.
S5	5	1,514	2,380	0.94	Unlined	Yes	Overflow path to catchment 13B drainage channel.
S6	6	1,103	2,195	0.80	Unlined	Yes	Storage to retain 100 year ARI storm event, overflowing to S1A through C4.
S8	8	633	815	1.08	Unlined	Yes	S8 does not have the capacity for a 100 year ARI storm event, and overflows to S9B-2.
S9B-1 and S9B-2	9A and 9B	880	1,700	0.82	Unlined	Yes	Retains a 1:100 storm event then overflows to street system.
S11A	11A	994	3,460	0.59	Unlined	Yes	Existing pond, overflows report to S12.
S11B	11B	1,685	3,500	0.78	Unlined	Yes	Existing pond, capacity large enough for a 100 year ARI storm, with overflows diverted into S12 and eventually Horwood Dam.
S12	12	355	1,800	0.50	Unlined	Yes	Existing pond. Overflow reports to drainage channel located in C13A and eventually into Horwood Dam.
S14	7, 10, 13 and 14	13,174	3,467	2.25	Unlined	Yes	S14 receives direct runoff from C7, C10, C13 and C14. Overflow for events greater than a 100 year ARI storm report to C17.
S17-1, S17-2 and S17-3	15, 16, 17 and part of 18 and 20B	4,265	7,425	0.87	Unlined	Yes	Three existing storage areas located either side of the existing tank. Storage areas S17-1 and S17-2 are connected by existing pipes with overflow to be pumped to Horwood Dam.
S18	Part of C18	389	397	1.28	Unlined	Yes	Existing pond receives partial runoff from C18. This pond will capture part of a 100 year ARI storm event, overflows report to S17-3.
Plant Water Pond and Plant Event Pond	39, 39A	3,785	2,150	2.06	Lined	Yes	Receives runoff from Process Plant site and decant water pumped from Blackwood Pit. Water is reused in the Plant and augmented by water from the lined mine water ponds at Mt Hebbard Gully (S22). Overflows from the Plant Water Pond discharge to the Plant Event Pond located in C42B, any overflows are directed to Horwood Dam.
S22	18 (partial), 19, 20A, 21A, 21B, 22 and TSF1	20,489	5,606	3.95	Lined, Mine water compartments only	No	Existing storage area. In addition to providing storage for a 100 year ARI storm event from catchments 18, 19, 20A, 21A, 21B, 22 and TSF1, S22 is used for the storage and settling of water from the operating underground mine workings, and groundwater from Shaft 7. Mine dewatering occupy 2 storage areas within S22. No over flow path is required as the capacity of the gully is in excess of 40,000 m^3.
S22A	Direct	Direct Rainfall	18,000	4.00	Lined	No	Receives excess direct from Shaft 7 water when S22 Lochness is full. A pipe is installed to

Storage	Reporting Catchments	Runoff Volume for Storage (m^3)	Surface Area of Storage (m^2)	Maximum depth of storage (m)[1]	Lined or unlined	Spillway	Comments
	rainfall						provide gravity flow back into S22 when required.
North-Western Drain	23	287	N/A	N/A	Unlined	Outlet	Existing storage channel located within exclusion and rehabilitation zone will receive runoff from the embankment located in C23. BHOP are not responsible for controlling drainage works outside of the exclusion and rehabilitation zones.
S25B	24, 25, 25A, 25B, 26	4,889	2,405	1.45	Unlined	No	Storage volume is sized to contain the 100 year ARI storm, with overflows spread over the floor of C25B.
S28	27, 28, 29, and partial 34	4,613	3,895	1.48	Unlined	Yes	S28 to receive runoff from C28, C29 and part of C34. Overflow will flow onto the existing road and into the existing railway drainage system off site.
S31-1 and S31-2	30, 31, 46, 47	6,761	5,330	2.01	Unlined	Yes	Capacity for a 100 year ARI storm. Overflows from S31-1 to S31-2. Pond includes flow from Federation Way. S31-2 overflows to railway drain.
S35	33, 35	6,092	4,255	1.73	Unlined	Yes	Runoff from C33 flows through existing pipes prior to entering C35. Overflows from S35, for events greater than a 100 year storm, ARI report to Blackwood Pit.
S37	Partial 37	943	1,215	1.08	Unlined	Yes	Receives runoff from approximately half of C37. Overflows to drainage channel in C36 and into BHP Pit. The remaining discharge from C37 flows through to S41.
S41	37 (partial), 38, 38A, 40, 41	3,994	1,980	2.32	Unlined	Yes	None
S42A	42A	2,758	2,565	1.38	Unlined	Yes	Runoff from C42A captured in an existing drainage channel and into S42A. Overflows from S42 report to Horwood dam.
S43	43	383	450	0.5	Unlined	Yes	Receives direct runoff from C43. Designed for 1 in 100yr rainfall event.
S44	44A, 44B	3,154	2,135	1.78	Unlined	Yes	None
Sediment Pond in C44B.	Rail siding area	N/A	N/A	N/A	Unlined		None
S45	45	891	2,170	0.71	Unlined	Yes	None
Drainage Channel in C48	48	5,047	N/A	N/A	Unlined	N/A	None
S49	49	1,951	1,560	1.55	Unlined	Yes	Catchment 49 is a rehabilitated area within CML7. Runoff from this catchment is captured in three small detention ponds within S49.
Little Kintore Pit	Little Kintore Pit	1,924	N/A	N/A	Unlined	No	Only direct rainfall onto catchment reports to Little Kintore Pit.
Kintore Pit	Kintore Pit	9,810	N/A	N/A	Unlined	No	Estimation of direct rainfall volume on Kintore Pit for the 100 year storm event.
BHP Pit	32, Partial 34 and 36, BHP Pit	9,312	N/A	N/A	Unlined	No	Receives runoff from catchments without storage areas and overflows from S37.
Blackwood Pit	Blackwood	9,633	N/A	N/A	Unlined	No	Blackwood Pit receives overflows from S35 when in excess of a 1 in 100 year ARI.

Storage	Reporting Catchments	Runoff Volume for Storage (m^3)	Surface Area of Storage (m^2)	Maximum depth of storage (m)[1]	Lined or unlined	Spillway	Comments
Horwood Dam	42B, 20C, Horwood Dam	7,663	24,729 m^3	N/A	Unlined	Yes	Catchments 20C and 42B report directly to Horwood Dam, with overflows from S14, S17-1, S17-2, S17-3, S41, S42A, S45 also reporting to Horwood Dam. Storage can retain 100 year ARI storm event. However, a spillway is required to provide controlled discharge during extreme storm events (i.e. in excess of a 100 year ARI storm).
Pattos Pond	Direct rainfall	Direct rainfall	1,500	0.5	Lined		Receives water from S22.
Sump at CBP	Direct rainfall	Direct rainfall	2.5	0.5	Unlined		Receives water from batching plant.
Sump at Backfill Plant	Direct rainfall	Direct rainfall	2.5	0.5	Lined		Receives water from backfill plant.

Note 1 = Includes 0.3 m freeboard.

4.2 Peak Flow Estimation

The rational method was applied in estimating the peak flow rates from selected catchment areas that outfall through proposed hydraulic structures, such as culverts and pipes, or into proposed drainage channels. The estimated peak flow may be applied in the preliminary sizing of culverts or in selecting geometric dimensions of drainage channels. The peak flow accounts for flow from basins overflowing into other basins up to a 100 year ARI rainfall event. The construction and shaping of the drainage channels and culverts will include a freeboard of 300 mm above the estimated water level for the 100 year ARI event.

The Rational Method formula applied in the estimation of peak flow is:

Qy = 0.278 CIA (Engineers Australia 1998)

Where:

Qy = Peak flow rate (m^3/s)

C = Runoff Coefficient

I = Average rainfall intensity (mm/hr)

A = Area of the catchment (km^2)

The average rainfall intensity for the time of concentration (Tc) and a 100 year ARI storm was estimated based on BOM design rainfall intensity chart for Rasp Mine area and the Bransby-Williams formula for time of concentration (Engineers Australia 1987). The peak flow rates entering drainage channels and hydraulic structures were estimated by Golder Associates.

5. Site Water Sources

The system for managing water at the Mine is specific to the types of water on the site and are summarised in the following sections.

Broken Hill's water supply comes from the Stephens Creek Reservoir, Umberumeka Reservoir, Imperial Lake and the Menindee Lakes Scheme on the Darling River. Water extracted from underground and Shaft 7 is also used on the Mine site.

The Mine also uses reclaimed water from various sources wherever possible, for example, Horwood Dam, Plant Water Pond, Patto's Pond and any other water storage areas that have sufficient water for pumping.

5.1 Potable and Waste Water

Potable water is supplied by Essential Water from Menindee Lakes. This water is treated raw water. Potable water is stored in a 22.5kL poly tank located near the Mine site boom gate. Potable water is pumped to the Processing Plant, Backfill Plant, workshops, ablution blocks and administration offices. Potable water is used for safety showers and eye-washers, crib huts, ablution blocks, laundry and other washing facilities. It is stored in poly tanks at various locations.

Bottled water is used as drinking water.

Waste water is not treated on site and is removed via the Broken Hill City Council sewerage system.

5.2 Raw Water

Raw water is externally supplied to the Mine from Essential Water and comes from Menindee Lakes. It is used for top up water in the Processing Plant. The main storage tanks for raw water are the Silver Water Tank and the Mill Raw Water Tank.

5.3 Dirty Water

Dirty water from Mine activities typically consists of surface runoff generated within active mining areas of the site including diesel refuelling area (including wash bay), site vehicle wash bay, maintenance workshop area, processing area, backfill plant, concrete batching plant, haul road and general roads and core storage.

Dirty water from these activities is directed to a series of dirty water ponds, open cut pits, and tailings storage facilities, to allow for evaporation, treatment or reuse on the site.

Runoff from the diesel refuelling area and maintenance workshops is directed to an oil/water separator for treatment and reused for site dust suppression. Localised hydrocarbon spills will be

contained and controlled using spill kits provided at various locations around the site. Chemical and hydrocarbon storage and management on site is outlined in the Chemical Management Plan.

Runoff from the Processing Plant area is directed to the lined Process Plant Pond where it is collected for reuse in the Processing Plant, this in turn overflows to the Process Event Pond, which will contain a 1:100 year rainfall event and overflows are directed into Horwood Dam.

Blackwood Pit (TSF2) retains the tailings from the Processing Plant, and supernatant water, when available is transferred to the Process Event Pond and reused in the Plant.

The Backfill Plant is located to the south west of the site in C27. This catchment includes a lined Backfill Plant sediment pond, isolating any potentially contaminated runoff in this area from the general runoff of the site.

A sump collects waste water runoff from the Concrete Batching Plant.

All stormwater is treated as contaminated once it enters the Mine and makes contact with the disturbed surface. A series of sediment / water storage basins across the site is used to collect and manage stormwater runoff and prevent its release. Overflow from dirty water storage basins can be directed to Horwoods Dam where it will be stored temporarily until transferred to process ponds.

TSF2 Embankment Lift

With the lift of the TSF2 embankments a spillway will be installed on the north-eastern corner of TSF2 and direct overflow from TSF2 to storage pond S42A which will overflow to Horwood Dam.

The existing tension cracks at the edge of the Pit at Embankment 1 will be filled with tailings prior to construction of this Embankment. This will occur at the same time as repair works around the existing edge bund located at the Pit rim to the south of British Flats and the old mining residence. Drainage pipes with inspection chambers will also be installed. These minor works will involve the use of a small excavator and roller with manual labour for the placement of the pipes and fill.

Embankments 1 and 3 will be constructed over some tailings as well as weathered bedrock and will require deposition of tailings within the embankment footprint to form a well-drained foundation for the embankments to be confirmed by inspection and assessment of geotechnical condition, and may require the construction of a pioneering layer comprising compacted rockfill over a geotextile. Geomembrane liners will be constructed over the upstream faces over a sand filter curtain. The geomembrane liner will be keyed into the tailing beach.

A Stormwater Collection Pond will be constructed to the north of Embankment 2 to store rainwater from runoff from the outer slope of Embankment 2. The Stormwater Collection Pond will be excavated into in situ materials to form a 1.5 m deep pond for the collection and retention of rainwater runoff from Embankment 2. It is intended to be an evaporation pond similar to some of the other stormwater control ponds at the Mine and will contain a 1 in 100 year 72 hour rainfall event.

5.4 Shaft 7 and Mine Water

Water is extracted from underground via pumps at Shaft 7 and underground mine workings to maintain safety of personnel in the Rasp Mine and also the adjacent Perilya South Mine. This groundwater has been contaminated by the naturally elevated metals consistent with a zinc/lead/silver orebody and by historic mining activities. Water is extracted and stored within lined facilities located within water storage basin S22. S22 has a total storage capacity of approximately 40,000 m^3 and receives runoff from the surrounding catchments and water pumped from the S17 ponds. Lined compartments have been installed within this area for the separate storage and settling of underground extracted water. This water is returned underground for reuse and is treated (in Patto's Pond) and used in the Processing Plant.

5.5 Eyre Street Dam

TSF1 is an historic tailing storage facility and is not used as a tailing facility by the Rasp Mine. According to historical documents Eyre Street Dam was situated adjacent to TSF1 and formed part of the then mine's water management system. An open cut trench running along the toe of TSF1 formerly directed water to the Eyre Street Dam. Water was then pumped from the Eyre Street Dam to the adjacent Horwood Dam which in turn was pumped to the Western Dam now rehabilitated and houses the Olive Grove. The original trench and Eyre Street Dam were decontaminated and filled in as part of rehabilitation works in the early 1990's.

A 2011 investigation into the seepage at the Eyre Street Dam resulted in the construction of a new trench which was designed to intercept potential seepage from TSF1 and direct the water into Horwoods Dam via a pump and pipe system. As part of the groundwater monitoring program, the trench will be inspected weekly to assess changes to water levels that may indicate seepage. Inspection sheets are completed at each inspection. A float pump is installed at the downstream end of the trench to direct any seepage into Horwood Dam.

6. Water Balance

Figure 4 provides a schematic diagram summarising the site water balance. The diagram identifies the water sources, the use and management of water on site.

The primary user of water on site is the Processing Plant and underground mining operations. Water losses occur in water retained in the tailings, water in concentrate, water used for dust suppression, concrete batching, and seepage at the TSF.

The closed water circuit for the mining operations results in complete management of process water with no off-site wastewater discharge directly from the operations. The Plant Water Pond, Plant Event Pond, and TSF2 capture and return potentially mineralised sediment to the processing circuit.

Key aspects of the water management strategy include:

- The separation of raw water and potable water requirements. Raw water requirements includes processing, workshop, vehicle wash-bay and dust suppression, while potable water requirements include showers, toilets and laundry;
- Reclaiming of water from the tailings storage facility to the Processing Plant; and
- Reclaiming of water for preparation and pumping of underground backfill.

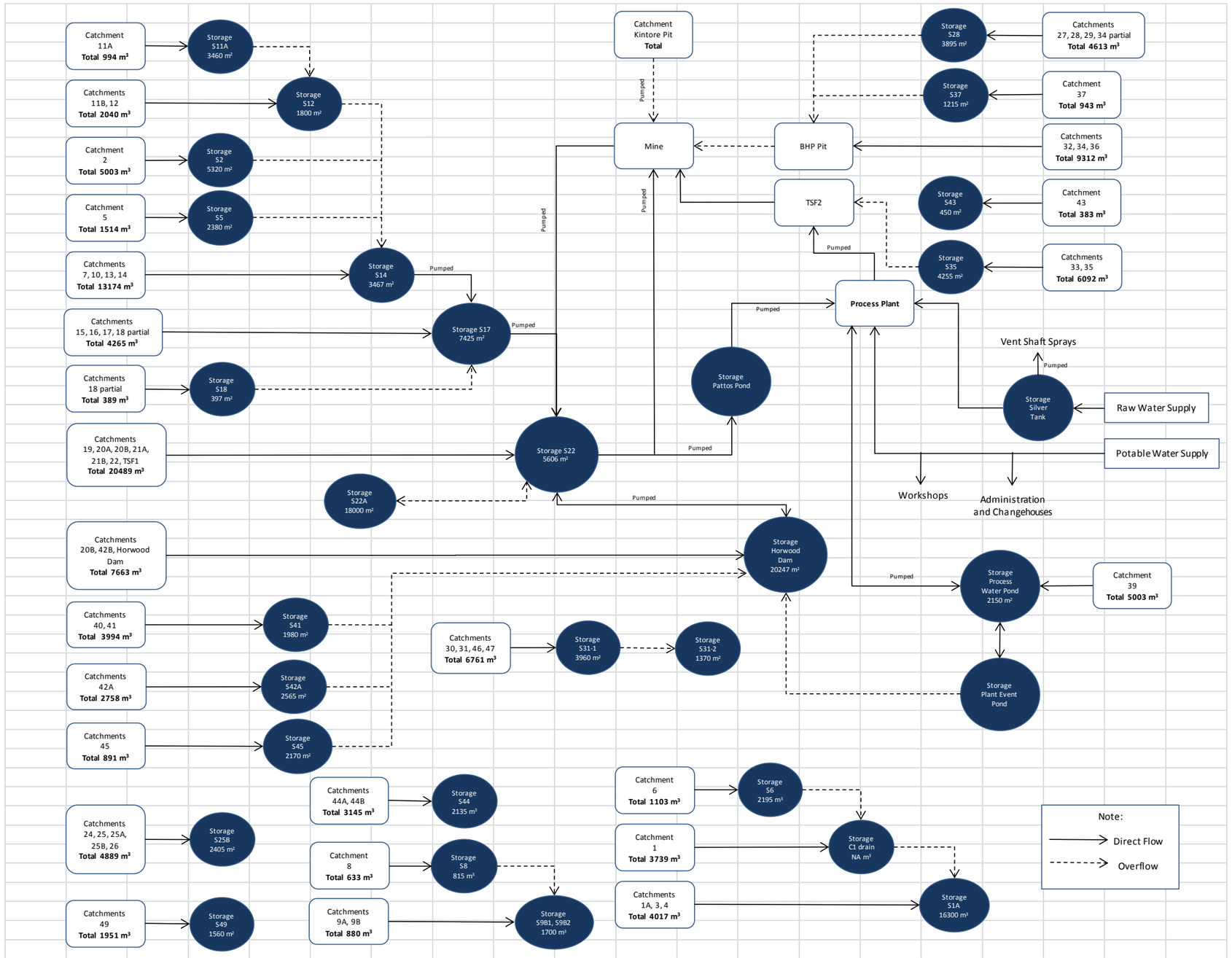
Observations regarding the rate of water usage on site are monitored.

Measures employed to minimise water usage/loss will include:

- Use of water from the dewatering of underground and No 7 shaft extraction;
- Recycling of water from milling operations, particularly tailings thickening;
- Capture of water from stormwater containment for transfer to operations storages and reuse around site and underground;
- Reduce the holding time of stormwater in shallow storages before being transferred to operations storages to minimise evaporation and seepage loss;
- Maintenance of site water management infrastructure to minimise wastage of water;
- Maintain erosion and sediment control structures to maintain quality of captured stormwater;
- Treatment of mine dewatering to enable usage in the processing plant;
- Tailings water to be returned to the processing plant for reuse;
- Water to be recycled from Horwood Dam to the processing plant;
- The silver tank is a raw water holding tank for water to be used in the processing plant, reducing the potential for evaporation from open type storages;
- Investigate the use of grey water from domestic facilities for use in ground management; and
- Installation of flow metres to monitor water usage.
- Treatment of hydrocarbon contaminated water from vehicles washes and workshops for reuse in dust control and milling processes; and

Improvements of underground water balance monitoring will be investigated to improve understanding of water transport underground.

Figure 4 - Schematic for Site Water Balance



7. Groundwater Monitoring Program

The regional groundwater near the site is depressed due to long term pumping from the underground mines in the area, resulting in the depressed groundwater level below the site being more than 100 m below the surface level, with a hydraulic gradient into the site at depth. The groundwater monitoring program will be undertaken with the purpose of recording perched groundwater movement. Due to the depth of the regional groundwater at the site there is little interaction between the shallow perched groundwater and the regional groundwater.

The objectives of the groundwater monitoring program are to:

- Provide a program to monitor seepage movement within and adjacent to the tailings storage facility (TSF2).
- Provide details of parameters and pollutants to be monitored and background local perched groundwater parameters.
- Establish a contingency measure in the event that an unacceptable impact is identified.

7.1 Seepage movement monitoring

Short term perched seepage may occur from surface water infiltration into the permeable rock mounds on the site. When the volume of infiltrated water is high, resulting from sufficient rainfall volume at the site, the rock mounds may reach field capacity and result in seepage through the mound. The seepage may exit laterally from the rock mounds, when the seepage front reaches the high strength low permeable rock formation generally below the site. This form of short term seepage may present itself as near surface seepage zones. Stormwater management has been designed to reduce the extent of surface ponding near those areas (**Table 7-1**) to limit the volume of water infiltration into the rock fill mounds.

The perched groundwater monitoring bores will record the depth at which seepage may occur. The monitoring bore depths do not extend to the drawn down regional groundwater.

Monitoring of the existing and constructed boreholes will provide an early warning if seepage is occurring near the CML7 lease boundary. Water from mine dewatering at Shaft 7 and from underground mine dewatering will form part of the groundwater monitoring program. Samples of groundwater from boreholes is collected every three months; permitting water is present at these times. Mine water samples (Shaft 7 and Mine Dewatering) are collected monthly, with pH recorded using field sheet BHO-FRM-ENV-007.

A summary of the location and function of each borehole is listed in **Table 7** and their locations indicated in **Figure 1**.

Table 7 - Location and Function of Mine Dewatering Samples and Groundwater Monitoring Boreholes

Borehole ID / Mine Dewatering	Monitoring Frequency	Location	Function / Purpose
GW01, GW02	Quarterly	South-East of Mt Hebbard	To monitor if seepage is occurring from Mt Hebbard
GW03, GW04, GW05, GW06, GW07, GW08, GW09	Quarterly	South east of TSF1	To monitor potential seepage flows from the historic TSF1 and Horwoods Dam towards the CML7 boundary. The Eyre Street pit sump was installed to intercept potential seepage from TSF1 and direct the water to Horwoods Dam via a pump and pipe system.
GW10	Quarterly	Downstream of Horwood Dam	According to the investigation of 2011, perched seepage measured at this bore is not considered to be related to water from Horwood Dam and is used to monitor potential seepage from Eyre Street Dam.
GW11, GW12	Quarterly	East of Blackwood Pit	The ground conditions to the south-east of Blackwood Pit are relatively intact with no or limited mine workings in the area. Due to the north-east and south-west length of the Pit there is a possibility for the formation of a perched aquifer as a result of groundwater mounding around the south-east side of the Pit whenever the Pit is receiving tailings. BoresGW11 and GW12 are installed to the south east of the Pit to a depth of 5 m below the base level of Blackwood Pit. These bore locations were selected based on the lower ground level towards the south-east of the Pit, and to be outside the area of influence of the isolated mine drives on the south-east side of the Pit. Borehole to monitor potentially perched water as a result of potential groundwater mounding from TSF2 water
GW13, GW14, GW15	Quarterly	Adjacent to storage areas S44, S31-1 and S31-2	To monitor if movement of perched groundwater is occurring from the storages
GW16	Quarterly	To the west of storage area S49	To monitor potential seepage from S49 towards Ryan Street
Shaft 7	Monthly	Shaft 7 (S22)	To assess groundwater quality of pumped water from Shaft 7
Mine Dewatering (underground feed)	Monthly	Decline at Kintore Pit (S22)	To assess groundwater quality at decline

The area located to the north and east of the Rasp Mine forms part of the adjacent Perilya mine lease. The ore body strikes from the north-east of the Rasp Mine to Shaft 7, where dewatering takes place. The regional groundwater cone of depression is therefore expected to exist along this ore body alignment, resulting in significant depth to regional groundwater north-east and south-west of the CML7.

The south-west to the north-west area of the Rasp Mine was historically extensively mined by underground workings comprising shafts, drives and stopes and as such is not expected that groundwater will be encountered due to the existence of the drained old mine workings.

Seepage collection outlet pipes installed in the TSF2 embankments will include inspection chambers to be inspected and recorded on a monthly basis.

7.2 Groundwater Quality Parameters

7.2.1 Baseline Chemical Properties of Groundwater

Groundwater quality monitoring was undertaken in May 2007 and August 2011 at Shaft 7.

As seasonal or other non-mining influences haven not been characterised at Rasp Mine, these water quality monitoring results act to establish initial baseline parameters and trigger levels for the monitoring program. Groundwater quality results for August 2011 will be used as baseline data for assessing changes in groundwater and perched groundwater quality results.

Groundwater quality results for May 2007 and August 2011 are provided as Appendix E.

7.2.2 Selected Groundwater Quality Monitoring Parameters

Groundwater quality monitoring at the groundwater monitoring locations described in **Table 7** is undertaken in accordance with conditions of the Rasp Mine Environment Protection Licence 12559. **Table 8** indicates the groundwater analytical suite to be monitored.

Table 8 - Groundwater Analytical Suite

Parameter	Unit	Analytical Method	2007 Results	2011 Results	30% Trigger Value
pH1	-	Field Meter	6.1	5.8	4.06 - 7.54
Electrical Conductivity	µS/cm	APHA Method 2510 B	NS	13900	9730
Total Dissolved Solids (TDS)	mg/L	APHA Method 2540 C	11000	8000	5600
Major Ions					
Total Alkalinity	mg/L as $CaCO_3$	APHA Method 2320 C	42	18	12.6
Sulphate (SO_4)	mg/L	APHA 4110	4300	9660	6762

Chloride (Cl)	mg/L	APHA 4110	1500	1360	952
Calcium (ca)	mg/L	USEPA 3015A	575	472	330
Magnesium (Mg)	mg/L	USEPA 3015A	NS	395	277
Sodium (Na)	mg/L	USEPA 3015A	1830	3550	2485
Metals (Dissolved)					
Iron (Fe)	mg/L	USEPA 3015A	0.252	0.2502	0.175
Cadmium (Cd)	mg/L	USEPA 3015A	NS	6.91	4.84
Lead (Pb)	mg/L	USEPA 3015A	0.05	2.02	1.4
Manganese (Mn)	mg/L	USEPA 3015A	340	865	606
Zinc (Zn)	mg/L	USEPA 3015A	790	2890	2023

7.3 Contingency Measures

It is necessary to establish the quality of surface water collected from waterbodies within the Mine lease to compare the results to the measured groundwater quality. This is done to assess whether a change in groundwater and surface water conditions on site is occurring. Any changes will be assessed based on trend changes relative to the baseline chemical properties of 2011.

7.3.1 Groundwater

The site's groundwater is deep and is extracted as part of mining. The underground extraction system results in inward flow of the groundwater into the Mine. Hence, groundwater at the Mine is likely to be impacted by off-site sources due to the inward hydraulic gradient into the Mine. If contaminants are detected greater than 30% above the baseline 2011 groundwater quality values of collected water in the S22 mine water compartments, then an investigation will take place.

7.3.2 Perched Groundwater

Perched groundwater quality is expected to contain significant concentrations of lead, manganese and zinc due to the seepage contact with the near surface materials on site and the surrounding areas. Perched groundwater occurs periodically after significant rainfall, so monitoring ability in some bore locations may be sporadic. Where frequent groundwater seepage is identified, BHOP will investigate options to intercept the seepage and direct the water into an onsite storage area. Measures may include seepage collection drains with a sump, lining of the area related to the source of the seepage or construction of additional surface water management structures to direct flow away from the perched groundwater affected area. Contingency measures to address groundwater impact may also include the investigation of groundwater extraction at the area of concern.

Potential seepage from Blackwood Pit-related tailings may occur. Most of this seepage will occur in the underground workings and will be managed as part of underground water extraction. If seepage occurs towards the east of the area, it is expected to be measured in monitoring bores GW11 and GW12 to the east of Blackwood Pit. If a trend is suspected, or if contaminates are detected at

greater than 30% above the 2011 baseline values, an investigation will be undertaken to determine the source of contamination and the level of environmental risk and the remedial action required. Options for remedial actions include the following:

- Changes to the tailing deposition method and strategy to limit water storage on the tailing surface.
- Changes to the tailing deposition water content to reduce the amount of water in the tailing storage facility.
- Installation of a perched groundwater extraction system through a series of bores or a cut-off trench adjacent to the site boundary.

8. Surface Water Monitoring

8.1 Monitoring Program for Stormwater Ponds

Monitoring of water quality is conducted in accordance with PA07_0018 and EPL 12559 conditions at the following locations listed in **Table 9**. These ponds have the potential to overflow off-site.

Table 9 - Monitored Surface Water Storage Ponds

Storage Ponds w/ Potential for Off-site release	Depth (m)	Surface Area of Storage (m^2)	Location	Description and Flow
S1A	0.56	16,300	Bounded by South Rd, Mine and Olive Grove	Located on a non-active mining area of the site. A large storage and is likely to discharge in very rare events. Capacity to hold a 1:500 storm event then discharges through a culvert in a southerly direction.
S9B-2	0.82	1,700	Adjacent south Rd, at the south east corner of the site	Holds a 1:100 storm event. The contributing catchments to this pond are quite small, discharges to the town's stormwater system.
S31-1	2.01	3,960	North Mine boundary at Federation Way.	Holds a 1:100 storm event. Located on a non-active mining area of the site. A discharge from these slopes flows to the water storage ponds located at the rail complex.
S44	1.78	2,135	Northeast corner of Rail Loadout	Discharges into the existing rail complex surface water storage pond.
S49	1.55	1,560	Below the Block 10 lookout	Located on a non-active mining area of the site. As part of detailed design the option to discharge excess runoff to a local depression immediately to the North West of the storage would be investigated to limit the likelihood of excess flow down Adelaide Street.
Horwood Dam		NA	East of TSF1	Holds four times the est. 1 in 100yr

Storage Ponds w/ Potential for Off-site release	Depth (m)	Surface Area of Storage (m^2)	Location	Description and Flow
				storm event. Discharges off-site into Stephen's Creek catchment.

Sampling is undertaken twice per year at 6 monthly intervals, this has been determined as October, being the wettest month historically and April (meeting the 6 month requirement). The water quality results will also be used to compare groundwater quality measured in groundwater monitoring bores near four of these ponds.

To obtain a representative sample, the pond water quality is measured when the pond has contained water for at least one week and the pond is at a minimum of 20% capacity.

It is expected that the ponds listed above will remain dry for majority of the year so the subgrade around the pond will be partially saturated, resulting in very low permeable conditions. Hence, short term storage of water is expected to result in limited moisture migration into the subgrade which will be extracted by evaporation once the pond is empty again.

8.2 Monitoring Program for Off-site locations

Two off-site locations are included in the surface water monitoring program conducted in accordance with PA07_0018 and EPL 12559 twice per year in October and April (refer above). These are described as Downstream 1 and Downstream 2. The Downstream 1 sampling point is located within a drainage line upstream of Acacia Creek at Bonanza Street, 1.5 Km to the south of the mine. Downstream 2 is located within Stephens Creek, directly upstream of the Stephen's Creek bridge on the Barrier Highway, 7.91 Km to the east of the site. **Appendix 1** shows these locations.

8.3 Selected Surface Water Quality Monitoring Parameters

No initial background water quality values were identified for surface water at the site. **Table 10** provides the surface water analytical suite used to measure surface water quality.

Table 10 - Surface water quality monitoring parameters

Parameter	Unit	Recommended Analytical Method
pH[1]	pH Unit	Field Meter
Electrical Conductivity	µS/cm	APHA Method 2510 B
Total Dissolved Solids (TDS)	mg/L	APHA Method 2540 C
Major Ions		

Parameter	Unit	Recommended Analytical Method
Sulphate (SO_4)	mg/L	APHA 4110
Chloride (Cl)	mg/L	APHA 4110
Sodium (Na)	mg/L	USEPA 3015A
Metals (Dissolved)		
Cadmium (Cd)	mg/L	USEPA 3015A
Lead (Pb)	mg/L	USEPA 3015A
Manganese (Mn)	mg/L	USEPA 3015A
Zinc (Zn)	mg/L	USEPA 3015A

Note 1 = Field analysis only.

8.4 Contingency Measures

Should the measured water quality in Horwood Dam be considered to present a significant risk to the receiving environment (such as the downstream creek and Stephens Creek Reservoir) or have the potential to discharge water, then the water level in Horwood Dam will be lowered by pumping to increase its storage capacity for subsequent rainfall events. Water pumped from Horwood Dam will be stored either in the BHP Pit, Blackwood Pit, or S22. All of these storages have additional capacity compared to the estimated 1:100 year storm event runoff from each of the respective catchments.

The risk to receiving waterbodies is based on the background water quality in the waterway and the water quality of runoff from the catchment of the creek.

8.5 Site Water Management Equipment

All equipment used in the management of site water (eg. pumps and pipes) is included on the routine maintenance schedule to ensure optimum operational condition. Any maintenance works carried out on equipment is recorded on the Pronto maintenance database.

8.6 Water Transfer between Dams

Water transfers from Shaft 7 to S22 and from the Eyre St Trench to Horwoods Dam are measured using flow meters and recorded.

9. Erosion and Sediment Control

Mining activities and weather conditions may result in soil erosion, generation of sediment or flooding.

Mining activities include:

- Underground works with limited surface stockpiling;
- Transportation activities; and
- Maintenance activities on the surface and landscape.

The main prime source for erosion at the Mine is related to weathering due to wind and water runoff.

The susceptibility to soil erosion, the generation of sediment and flooding as a result of water erosion has been minimised by dividing the site into small catchments. The catchment layouts generally conform to the existing landform and where practical, storage areas have been provided within the catchment. The majority of catchments have their own storage pond capturing rainfall and sediment from the surrounding area. Where storage areas are not provided within a catchment, due to site restrictions, drainage channels discharge runoff into nearby catchment storage ponds. This design approach limits the potential for the transportation of sediment to downstream waters and manages the risk of flooding within local catchments. The capacity of the required water storages and channels to meet the requirements of the 1:100 year storm event is described **Table 6**.

9.1 Stormwater Structures Monitoring

The Mine assesses the continued capacity of each storage pond against the required capacity quarterly or after storm events, identifying where repair or upgrade works, desilting, dewatering, or other relevant action is required in order to create and maintain the required water storage capacity. A Surface Water Structure Inspection Form is used for the reporting requirements of this SWMP.

The Erosion and Sediment Control Inspection Procedure outlines the requirements for conducting these inspections.

A storm event is defined as either:

- at least 30 mm of rain is recorded within a 2 hour period; or
- at least 75 mm of rain is recorded within 3 consecutive days.

Pond storage capacity reduction (due to sediment build-up) is monitored using surveying. Where storages are reduced by a maximum of 10% of the design requirement (i.e actual storage capacity is 90% of the design storage requirement), the Mine will carry out de-silting works.

Routine ESC inspections consist of a visual assessment for erosion, flooding, trash, algal growth, or significant sediment build-up. Storage capacity is assessed by viewing sediment depth markers, and volume assessment based on survey data, where appropriate (eg. after significant de-silting). Observations and recommendations are recorded on the ESC Inspection Checklist.

The integrity of the engineered bunds at storage areas S1A, S9B-1 and S9B-2, S31, S44 and S49 will be assessed after heavy rain events to investigate whether additional methods need to be put in place to ensure seepage is prevented / stopped. Observations are recorded in the Surface Water Structure Inspection Form.

9.2 Removal of Sediment from ESC Structures

Accumulated sediment within designated stormwater drains and water storage ponds removed and disposed into one of the existing mine pits on-site. Disposal of sediment into the existing pits reduces the likelihood of the sediments being remobilised. Removal and disposal of sediment from the drainage network is recorded in the ESC Inspection Checklist. The Surface Water Structure Inspection Form highlights areas within the drainage network that are in frequent need of repair and allows the Mine to make informed decisions on the need, location, function, and capacity of additional erosion and sediment control structures.

9.3 Erosion Maintenance on Batter Slopes

As the majority of batter slopes exist on the mine boundary, are relatively steep, and consist of weathered rock or predominantly large rock particles, it is not practical to reshape slopes as an ESC control measure. Historical erosion to the slopes has removed most of the finer materials and the existing surfaces now comprise relatively large and course particles resulting in a self-armoured surface with limited erosion potential. As a control measure to limit further erosion to batters, surface water is diverted away from the batter slopes or to open drainage channels which report to water storages. Most slopes include a stormwater collection drain along the toe draining to a water storage within the catchment.

Soil binder additives are also utilised across all accessible slopes (and free areas) throughout the site. Liquid dust suppressant (usually mixed with green dye) is mixed with water and applied by water truck or water cannon to exposed surfaces annually or as required.

10. Trigger Action Response Plans

Aspect	Normal	Trigger 1	Trigger 2	Notifications
Surface water storage	Storages function as designed and meet design criteria by containing stormwater events.	**Trigger:** Storages fill quicker than expected or are not dewatered prior to a rainfall event. **Response:** Dewater and survey to ensure there is no excess sediment collection and review catchment runoff calculations. Staff training and communication.	**Trigger:** Emergency discharge from Storages **Response:** Collect samples of discharge water. Dewater as soon as possible. Investigate cause. Review storage design. Staff training and communication.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required by PIRMP.
Erosion and Sediment Control	There is no evidence of erosion or sediment build-up.	**Trigger:** Evidence of surface erosion or sedimentation (storage capacity <90%). **Response:** Repair erosion and address	**Trigger:** Offsite erosion or sediment transport **Response:** Contain cause and impact where possible including	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required by PIRMP.

Aspect	Normal	Trigger 1	Trigger 2	Notifications
		runoff cause. Remove sediment.	diverting flows. Review controls.	
Groundwater quality	Variation in long-term groundwater monitoring results <30%.	**Trigger:** >30% variation in long-term results from one monitoring event. **Response:** Re-sample and re-test. Investigate source of variation with aim of determining mine-related impact.	**Trigger:** >30% variation in long-term results from more than one scheduled event. **Response:** Expand investigation with use of specialists. Increase monitoring frequency. Review monitoring locations.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required by PIRMP.
Perched groundwater levels (G11 and G12)	Groundwater level within long-term range	**Trigger:** Increase in level outside expected range **Response:** Re-sample. Investigate source of variation with aim of determining mine-related impact.	**Trigger:** Level does not decrease after one quarter. **Response:** Expand investigation with use of specialists. Increase monitoring frequency. Review monitoring locations.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required.
Groundwater levels	Groundwater level within long-term range considering rainfall	**Trigger:** >1m drop in level	**Trigger:** >1m drop in level does not	**Trigger 1**: Notify Environmental staff.

Aspect	Normal	Trigger 1	Trigger 2	Notifications
		Response: Re-sample. Investigate source of variation with aim of determining mine-related impact.	recover after one quarter **Response:** Expand investigation with use of specialists. Increase monitoring frequency. Revise monitoring locations and potential for bore recovery.	**Trigger 2:** Notify external stakeholders as required.
Surface water quality	Variation in long-term surface water monitoring results <30%.	**Trigger:** >30% variation in long-term results from one monitoring event. **Response:** Re-sample and re-test. Investigate source of variation with aim of determining mine-related impact.	**Trigger:** >30% variation in long-term results from more than one scheduled event. **Response:** Expand investigation with use of specialists. Increase monitoring frequency. Review monitoring locations.	**Trigger 1**: Notify Environmental staff. **Trigger 2:** Notify external stakeholders as required.

11. Reporting and Review

11.1 Reporting Groundwater or Surface Water Incidents

11.1.1 Internal

All incidents related to ground and surface water shall be recorded and reported using the INX InControl system for incident reporting and investigation.

Any operational incident related to ground or surface water includes:

- Any off site release, eg. seepage, leakage, discharge.
- Any exceedances of trigger levels or trend changes to chemical parameters, against the August 2011 groundwater quality results used as baseline data or established values based on monitoring data over time.

11.1.2 External

Incidents that have the potential to cause environmental harm are required to be reported to the:

- Department of Planning and Environment;
- Environment Protection Authority; and
- Other relevant government agencies eg. BHCC, Health, WorkCover, Fire and Rescue.

Notification shall be made immediately to each relevant authority when material harm to the environment is caused or threatened in accordance with the relevant legislation. In this case the Pollution Incident Response Management Plan (PIRMP) shall be implemented and the EPA notified via the Environment Line on 131 555 as soon as practicable.

BHOP will provide a report, as required, within seven days of the date of the incident.

The Senior Environmental Advisor will be responsible for preparing reports to the government agencies which will be signed off by the General Manger prior to submission.

Complaints will be recorded, managed and documented in accordance with the Complaints Handling Procedure.

11.2 Regular Reporting

All monitoring records are kept in accordance with the Rasp Mine's EPL conditions:

- In a in a legible form, or in a form that can readily be reduced to a legible form;
- kept for at least 4 years after the monitoring or event to which they relate took place; and
- produced in a legible form to any authorised officer of the EPA who asks to see them.

The following records will also be kept in respect of air quality monitoring undertaken:

- the date(s) on which the sample was taken;
- the time(s) at which the sample was collected;
- the point at which the sample was taken; and
- the name of the person who collected the sample.

The following reports shall be prepared and submitted.

11.2.1 Monthly Management Report

- Summary of incidents, including cause and actions taken (or to be taken) to reduce the risk of a reoccurrence.
- Summary of monitoring results.

11.2.2 Rasp Mine Website

- Summary of water quality monitoring results, updated monthly.
- Summary of community complaints, updated monthly.
- A current copy of the approved SWMP.

11.2.3 Annual Environment Management Report / Annual Review

The Annual Environment Management Report / Annual Review shall be complied and submitted each year in accordance with conditions of Consolidated Mine Lease 7 (Condition 3) and the Project Approval 07_0018 (modified) (Schedule 4 Condition 3).

The review will:

- Include a comprehensive review of the monitoring results and complaints records of the project over the past year, which includes a comparison of these results against the:
- Relevant statutory requirements, limits or performance measures/criteria
- Monitoring results of previous years
- Relevant predictions in the documents EAR, PPR and their respective response to submissions and BHOP Statement of Commitments.
- Identify any non-compliance over the past year, and describe what actions were (or are being) taken to achieve compliance.
- Identify any trends in the monitoring data over the life of the project.
- List any incidents occurring during the period as described in **Section 10.1.1**.
- List any works to be undertaken in the following year to rectify or improve site water management.
- Provide details of water use or recycling improvement.

The AR will be submitted to the Director General – DP&E to meet this condition.

The Report / Review will be prepared in accordance with relevant guidelines and provided to government agencies for consultation prior to submission to the Department of Planning and Environment (DP&E), and the DPE Resources Regulator (DRR) each year.

11.2.4 Annual Return

An Annual Return outlining ground and surface water quality monitoring results, non-compliances (with respect to EPL 12994) and community complaints will be prepared on the appropriate form and submitted to the EPA as required each year.

11.3 Auditing and Review

11.3.1 Site Water Management and Review

The SWMP will be reviewed, and if necessary revised, within three months of submission of:

- An Annual Review.
- An Incident Report related to ground or surface water.
- Any modification of the Project Approval.
- Variation to the EP License.

Any reviews will reflect changes in environmental expectations, technology and operational procedures as well as operational experience gained as mining progresses.

In addition to the above review requirements, reviews will be conducted to assess the effectiveness of procedures against the objectives of the SWMP. This Plan will be revised due to:

- Deficiencies being identified.
- Extremes in environmental conditions.
- Improvements in knowledge or technology advancements.
- A change in the activities or operations associated with the Rasp Mine.

Any amendments to the SWMP will be undertaken in consultation with the appropriate regulatory authorities and approved in the same manner as the initial SWMP.

The Senior Environment Advisor is responsible for the audit and review of the SWMP under any of the above triggers.

An Independent Environmental Audit of the project will be conducted every three years from December 2011 and will assess the performance of the project and compliance with the approval and any relevant EPL or Mining Lease. Within six weeks of completing the audit, a copy of the audit report will be submitted to the Secretary of the DPE. This plan will be reviewed during the audit.

12. References

Institution of Engineers, Australia (1987) *Australian Rainfall and Runoff: A Guide to Flood Estimation* , Vol. 1, Editor-in-chief D.H. Pilgrim, Revised Edition 1987 (Reprinted edition 1998), Barton, ACT

Landcom. (2004) *Managing Urban Stormwater – Soils and Construction.* 4th Edition, March 2004. Volume 1. (Reprinted edition 2006). Parramatta, NSW

ANZECC. (1992) Australian water quality guidelines for fresh and marine waters. Australian and New Zealand Environment and Conservation Council, Canberra

13. Appendix A - CML7 Environmental Monitoring Locations