PROPOSED SUPER FINES STORAGE FACILITY LINER MOTIVATION

ASSMANG BLACK ROCK MINING OPERATIONS (BRMO),

JOHN TAOLO GAETSEWE DISTRICT MUNICIPALITY, NORTHERN CAPE

17 February 2020

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PROJECT INFORMATION SHEET

PROJECT:

INTEGRATED ENVIRONMENTAL AUTHORISATION FOR PROPOSED SUPER FINES STORAGE

APPLICANT:

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COMPETENT AUTHORITY:

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REPORT HISTORY AND DETAILS:

Report Status: For Stakeholder Review

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1 INTRODUCTION

Assmang Black Rock Mine Operations (BRMO) has appointed EScience Associates (Pty) Ltd (hereafter referred to as EScience), as independent Environmental Assessment Practitioner (EAP), to undertake integrated environmental authorisation and water use licencing for a proposed Super Fines Storage Facility (SFSF). The facility is intended to be constructed at BRMO's Gloria Mine. The purpose of this report is to inform the lining requirements for the proposed SFSF.

The current Tailings Storage Facilities (TSF) at the Gloria mine are approaching full capacity. In addition to this, various authorised upgrades are underway at the mine which will increase production capacity. BRMO proposes to construct a new Super Fines Storage Facility (SFSF) at the Gloria mine to augment the existing TSF and cater for future increases in production rates. The project will include the establishment of two or more storage cells making up the SFSF, and required supplementary infrastructure.

The proposed facility is subject to the requirements gazetted in GN.R 632 of 2015: Regulations Regarding The Planning And Management Of Residue Stockpiles And Residue Deposits, 2015, as amended.

Assmang (Pty) Ltd mines manganese ore in the Black Rock area of the Kalahari, in the Northern Cape Province. The ore is mined from the Kalahari Manganese field. The Black Rock Mine Operations (BRMO) are approximately 80 kilometres (km) north-west of the town of Kuruman, in close proximity to the town of Hotazel.

In 1940, Assmang acquired a manganese ore outcrop on a small hillock known as Black Rock. Several large properties, underlain by ore, were subsequently found and acquired. Manganese ore mining operations were extended and currently include 3 underground mining complexes:

1. Gloria (commissioned in 1975),producing medium-grade carbonated ore.
2. Nchwaning II and Nchwaning III (commissioned in 1981 and 2004 respectively), producing high-grade oxide ore.

The manganese ores of the Kalahari Manganese field are contained within sediments of the Hotazel Formation of the Griqualand West Sequence, a subdivision of the Proterozoic Transvaal Supergroup. The manganese ore bodies exhibit a complex mineralogy and more than 200 mineral species have been identified to date. Some of the ores have been subject to hydrothermal upgrading.

Distal areas exhibit more original and low-grade kutnohorite and braunite assemblages, while areas immediately adjacent to faults exhibit a very high-grade hausmannite ore. The intermediate areas exhibit a very complex mineralogy, which includes bixbyite, braunite, and jacobsite, amongst a host of other manganese-bearing minerals.

A similar type of zoning also exists in the vertical sense. At the top and bottom contacts, it is common to have high iron (Fe) and low manganese (Mn) contents, while the reverse is true towards the centre of the seam. This vertical zoning has given rise to a mining practice where only the centre portion of the seam is being mined. At Gloria Mine, the intensity of faulting is much less, which also explains the lower grade.

Two manganese seams are presently mined. The No. 1 seam is up to 6 metres (m) in thickness, and approximately 400 m underground at Nchwaning II, and 200 m underground at Gloria. No. 2 seam is situated above No. 1 seam, and is accessed via the Nchwaning II mining infrastructure.

1.1 REGIONAL LOCATION

BRMO is situated in the Northern Cape Province, approximately 80 km north-west of the town of Kuruman, and 12 km north-west of the town of Hotazel. BRMO falls within the jurisdiction of the John Taolo Gaetsewe District Municipality.

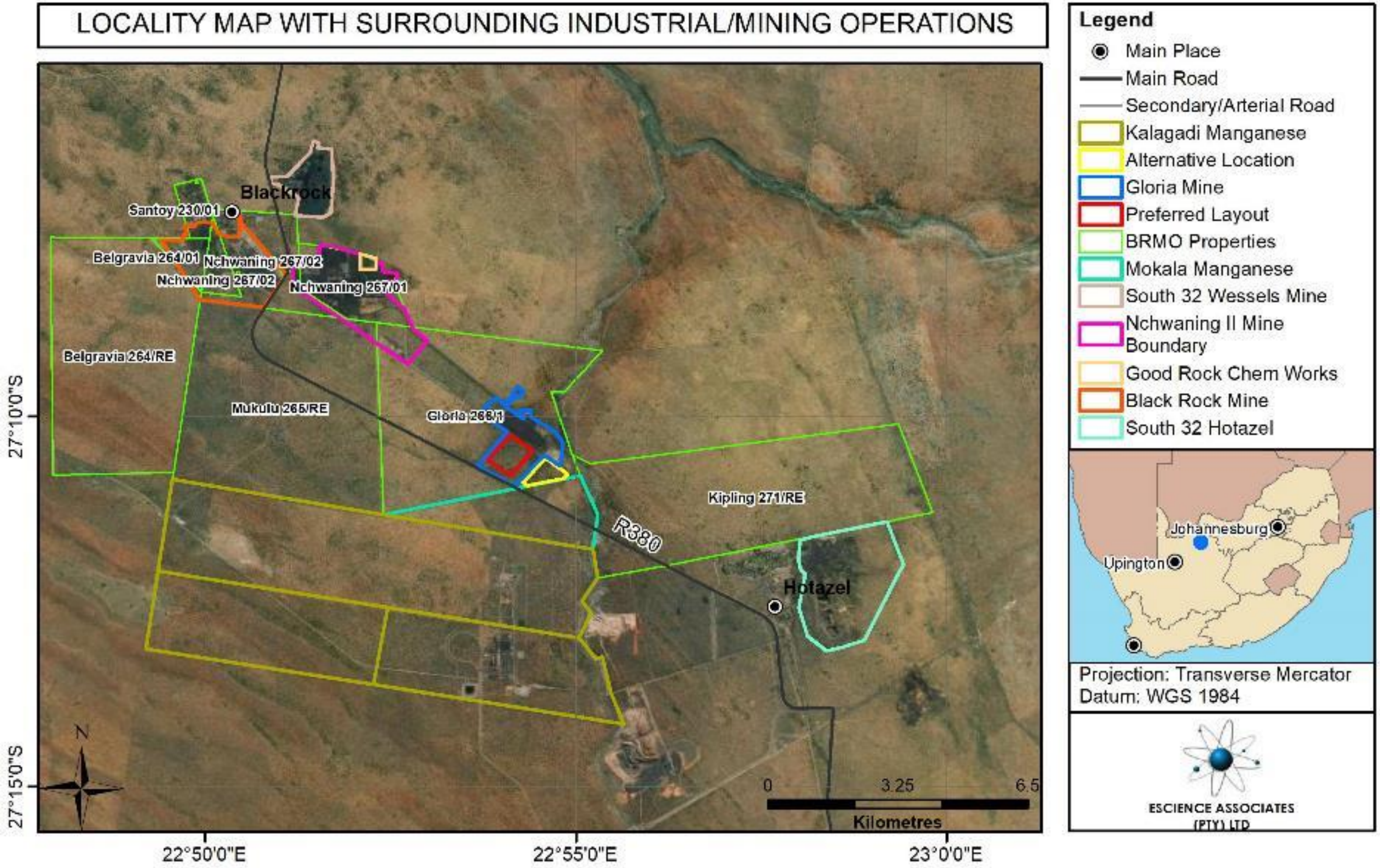
Figure 1-1 and Table 1-2 provide an overview of the BRMO property boundaries and surrounding land uses. Table 1-1 provides a concise overview of mining activities, and neighbouring towns with the Assmang BRMO.

Table 1-1: Neighbouring Towns

Town	Distance/Direction from BRMO
Santoy (Black Rock Mine Village)	Adjacent to BRMO
Hotazel	Approximately 8 km south-east of BRMO
Kuruman	Approximately 80 km south-east of BRMO
Upington	Approximately 267 km south-west of BRMO
Kimberley	Approximately 320 km south-east of BRMO

Table 1-2: Neighbouring Mining/Industrial Activity/ies

Mine/Industry	Distance/Direction from BRMO
Good Rock (Pty) Ltd	Eastern boundary of Nchwaning II Mine
South 32 Wessels Manganese Mine	Approximately 1.3 km north of Nchwaning II Mine
Ntstimbintle Mokala Manganese Mine	Approximately 1.5 km south-west of Gloria Mine
Kalagadi Manganese Mine	Approximately 2.5 km south of Gloria Mine
South 32 Hotazel Manganese Mine	Approximately 7 km south-east of Gloria Mine



Latitude: 27⁰ 10' 19" South	**Longitude:** 22⁰ 54' 33" East

Figure 1-1: Aerial Image Showing Existing Mining/Industrial Land Use in the Vicinity of the Assmang (Pty) Ltd BRMO

1.2 ADMINISTRATIVE INFORMATION

The following section, and associated set of tables, provides pertinent administrative information pertaining to BRMO, its associated mine lease area, as well as the environmental assessment practitioner.

Table 1-3: Name and Address of Mine	
Owner and Name of Mine	Assmang (Pty) Limited, Black Rock Mine Operations
Company Registration	1935/007343/06
Physical Address	Black Rock Mine Operations, Santoy, Northern Cape
Postal Address	PO Box 187, Santoy, 8491
Telephone	(053) 751 5201
Fax	(053) 751 5251
Senior General Manager	Koos Janse van Vuuren

Table 1-4: Details of the Environmental Specialist	
Name	Tshifhiwa Ravele
Physical Address	Main Offices Black Rock Mine Operations, Santoy, Northern Cape
Postal Address	PO Box 187, Santoy, 8491
Telephone	(053) 751 5304
Fax	(053) 751 5251
Email	Tshifhiwar@brmo.co.za

Table 1-5: Details of EAP	
Name of Company	EScience Associates (Pty) Ltd.
Contact Person	Abdul Ebrahim
Postal Address	PO Box 2950, Saxonwold, Johannesburg, 2132
Physical Address	9 Victoria Street, Oaklands, Johannesburg, 2192
Telephone	(011) 718 6380
Fax	072 268 1119
Email	abdul@escience.co.za
Qualifications	Certified EAP, BEng Honours Environmental Engineering

Table 1-6: Mining Rights, Surface Rights, and Title Deed Description Relevant to Gloria.

Mine	**Farm Name**	**Title Deed**	**Surface Rights**	**Mining Rights**
Gloria	Ptn. 1 Gloria 266	No. 506 of 1966	Assmang (Pty) Ltd	Assmang (Pty) Ltd

1.3 LAND TENURE AND ADJACENT LAND USE

Assmang (Pty) Ltd holds both the surface and mining rights over the properties encompassing the greater BRMO, and its constituent mining operations (i.e. Black Rock, Nchwaning, and Gloria Mines). The region surrounding BRMO is dominated by mining, and agricultural (extensive livestock production systems) land uses, with some industrial operations as well (namely Good Rock Chemworks). Land in the immediate vicinity of BRMO that is not used for mining/industrial purposes, is utilised for extensive livestock farming (i.e. sheep, goats, and cattle) and game farming.

1.4 PLANNED LIFE OF MINE

The planned life of mine is approximately 30 years, but may exceed this.

1.5 DETAILS OF THE SPECIALISTS

The assessment for this application was undertaken by EScience Associates (Pty) Ltd, as independent Environmental Assessment Practitioners (EAP) to BRMO. The study team was led by Mr. A. Ebrahim, senior environmental engineer, with more than 20 years' experience in environmental management. Brief details of the key consultants are shown in the table below.

Table 1-7: Details of the EAP

Name	***Qualifications/Registrations***	***Years of Experience***
Abdul Ebrahim	• BEng (Hons) Environmental Engineering • BEng (Hons) Mechanical Engineering • Certified Environmental Assessment Practioner • Registered Engineering Council of South Africa	20
Zayd Ebrahim	• BSc Geology and Environmental & Geographical Sciences	2
Marvin Qhekwana	• MSc. Geography and Environmental Management	1

2 GENERAL DESCRIPTION OF CURRENT AND PLANNED ACTIVITIES

Mining has been undertaken since 1938, starting with Black Rock Koppie, and subsequently the Gloria and Nchwaning mines. The mine supplies high-grade manganese ore to both local and international markets. Only underground mining methods are presently utilised at BRMO. BRMO previously had open cast and adit operations at the Black Rock Koppie. However, these have ceased. The mining method for Gloria, as well as Nchwaning II and III, is via underground bord and pillar methods, making use of trackless machines and underground conveyer systems. The mine has a projected maximum capacity of 6.3 mtpa.

Ore extraction activities are all undertaken below surface. There is no extraction of minerals via open cast operations, with the exception of authorised borrow pits for construction purposes, as part of on-going upgrades. The thickness of the mined seams, in conjunction with underground crushing, ensures that waste rock is not unnecessarily brought to surface. The ore is then further crushed and separated into various grades, which are stockpiled in preparation for transport off the site. Recovery of fines and low-grade ore is also undertaken from surface stockpiles. Product transport is via rail and road.

The general descriptions herein are intended to convey a broad understanding of the facilities and activities associated with the Gloria mine, and the proposed development. These descriptions are not exhaustive. It should be noted that infrastructure typical of such mining activities is encountered on the site, which may not be covered in specific detail herein. These facilities and infrastructure are subject to repairs, general maintenance, and upgrading, in accordance with standard practices, and thus will be altered from time to time. Current infrastructure is within the footprint of existing, historical, and/or authorised activities. Proposed infrastructure will require clearing of undisturbed land where it does not overlap with existing disturbed areas.

2.1 GLORIA MINE

Ore is mined at Gloria using underground bord and pillar methods, making use of trackless machines and underground conveyer systems. The thickness of the mined seams, in conjunction with underground crushing, ensures that waste rock is not unnecessarily brought to surface. At surface, the ore is crushed, and separated into various grades, which are stockpiled in preparation for transport off the site. Transport is via rail and road. Operations at Gloria were commissioned in 1975. The Gloria complex is comprised of several mining and mining related activities, including:

- Offices, administration, and support facilities;
- Engineering services and facilities;
- Underground mining access shafts, vent shafts, and related infrastructure;
- Ore processing plant;
- Ore (including fines) storage and laydown areas;
- Stacking, reclaiming, and loading facilities, for transportation of ore;
- Current and historical tailings facilities;
- Contractor laydown areas;
- Contractor camps;
- Waste storage and separation facilities;

- Historical and current tailings storage facilities;
- Salvage yards;
- Potable water and process water storage and management facilities;
- A sewage treatment plant;
- Sub-stations and electrical works;
- Bulk fuel storage and refuelling station;
- Explosives magazines;
- Unpaved and paved roads, connecting the above and other BRMO operations;
- Other ancillaries typical of such a mining operation.

2.1.1.1 Underground Activities

Ore is drilled, blasted, and crushed underground before being conveyed to the processing facilities on the surface. Operations underground consist mainly of:

- Drilling;
- Blasting;
- Crushing;
- Handling and loading of ore.

Supporting facilities underground include, *inter alia*:

- Water storage and reticulation systems;
- Engineering and support facilities;
- Fuel storage facilities and re-fuelling bays.

2.2 SCOPE OF THE PROPOSED ACTIVITIES

Manganese ore is mechanically processed at BRMO. This includes crushing and screening, which inevitably generates ore fines, which are deposited as tailings. The fines are separated from other ore products during screening and washing. This fine material is transported hydraulically through suspension in process water to fines storage facilities. As technology improves, the amount of fines generated per tonne of product may improve, and in future the fines may be reclaimed for reprocessing.

The current Tailings Storage Facilities (TSF) at the Gloria mine are approaching full capacity. In addition to this, various authorised upgrades are underway at the mine, which will increase production capacity. Consequently, BRMO proposes to construct a new Super Fines Storage Facility (SFSF) at the Gloria mine, to augment the existing TSF and cater for future increases in production rates. The project will include the establishment of two or more storage cells making up the SFSF, and required supplementary infrastructure, which include:

- A return water dam;
- Fines and water conveyance infrastructure (pipelines, pumps, et cetera, and their related civil, mechanical, and electrical works);
- Access and maintenance roads;

- Fencing and access control;
- A contractor laydown area for the construction phase;
- Topsoil and subsoil stockpiles from excavations.

Figure 2-1 shows the basic extent of the preferred area within which the proposed activities will occur.

The proposed facility will have an airspace of 2 000 000 m^3 available for super fines deposition, whilst the return water dam will have 12 650 m^3 operational capacity for holding process water. The fundamental design parameters are outlined below in Table 2-1.

Table 2-1: Deposition Scenarios Proposed for Super Fines Storage Facility

Slimes Deposition Rate	Maximum 180 000 tpa
Design Operational Life	30 years
Return Water Dam Capacity	12 650 m^3 + Freeboard
Design Storm Event	• 1 in 50-year, 24-hour = 102 mm • 1 in 100-year, 24-hour = 116 mm
Freeboard Targets	Minimum freeboard to accommodate the 1 in 50-year, 24-hour storm volume, plus 0.8 m dry freeboard on top of the normal operating level (excluding decant return)
SFSF Liner	Class C equivalent

2.2.1 CONSTRUCTION PHASE

The construction phase will broadly consist of:

- Removal and relocation of protected plant species;
- Clearing of remaining vegetation, and establishment of roads, contractor laydown areas, and project service facilities;
- Excavation and stockpiling of topsoil;
- Excavation and stockpiling of subsoil;
- Site preparation (levelling, compaction, drainage layout, etc.), and establishment of civil structures for the SFSF and RWD;
- Liner installations;
- Installation of fines and water conveyance infrastructure (pipelines, pumps, etc., and their related civil, mechanical, and electrical works);
- Commissioning;
- Erecting a fence around the SFSF.

2.2.2 OPERATIONAL PHASE

The operational phase will consist of:

- Deposition of super fines, and storage and reticulation of carrier water;
- General maintenance of the facility.

2.2.3 CLOSURE AND DECOMMISSIONING PHASE

The closure and decommissioning phase will broadly consist of:

- Shaping and capping of the storage facility;

- Removal of fines and water conveyance infrastructure, and any other structures (e.g. shelters for personnel, return water dam, etc.);
- Ripping and scarifying of roads, and other compacted footprints;
- Depositing of subsoil and topsoil, rehabilitation, and aftercare.

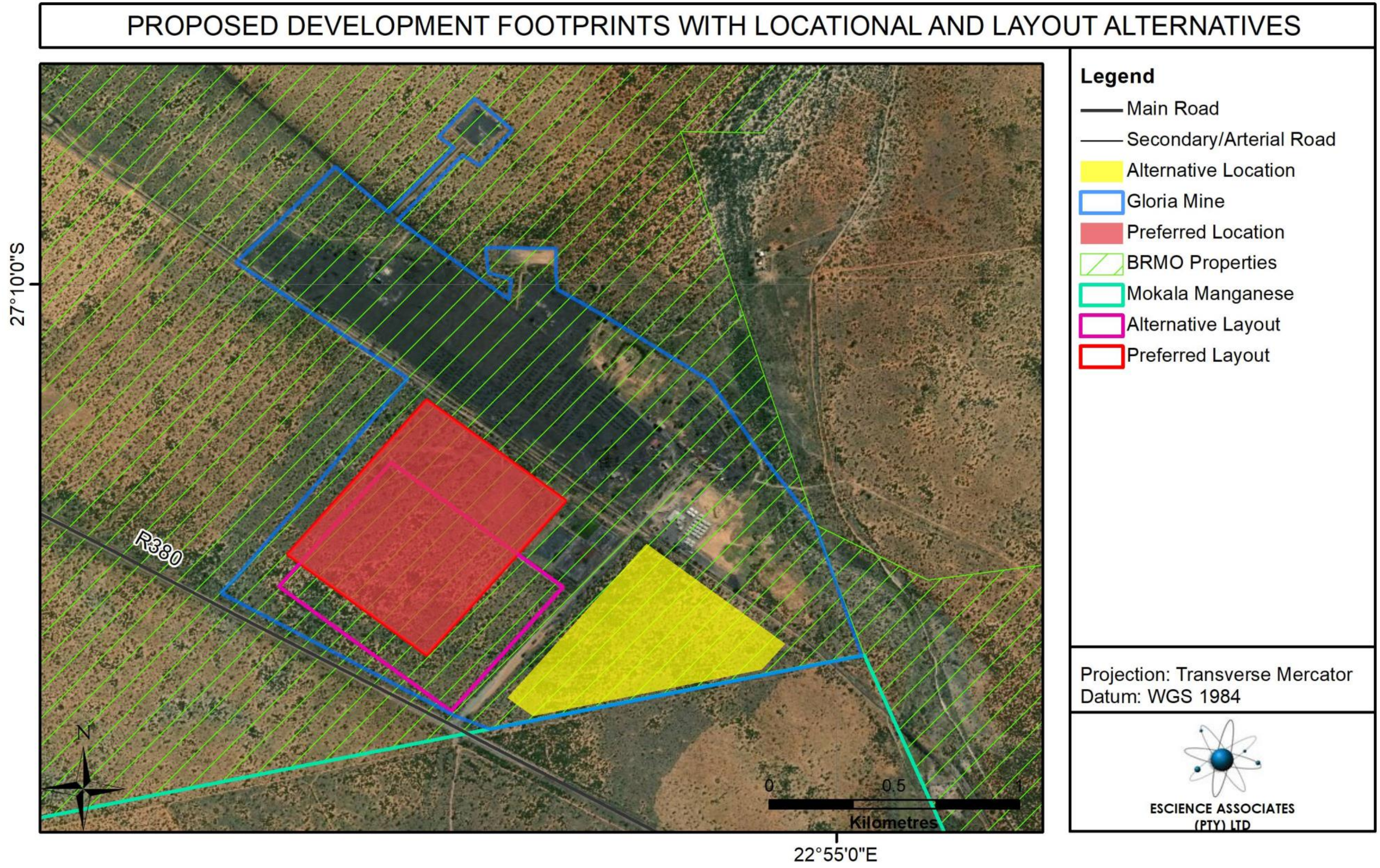


Figure 2-1: Proposed Activities (Preferred Location)

3 LEGAL AND POLICY FRAMEWORK

The purpose of this section is to summarise legislation directly relevant to this application, and the requirements thereof.

3.1 NATIONAL ENVIRONMENTAL MANAGEMENT ACT

The National Environmental Management Act (NEMA), 1998 (Act 107 of 1998, as amended) is South Africa's overarching environmental legislation, and contains a comprehensive legal framework to give effect to the environmental rights contained in Section 24 of The Constitution. Section 2 of NEMA contains environmental principles that form the legislated foundation for sustainable environmental management in South Africa.

3.1.1 DUTY OF CARE

NEMA places a duty of care on all persons who may cause significant pollution or degradation of the environment. Specifically, Section 28 of the Act states:

"28 (1) Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

(2) Without limiting the generality of the duty in subsection (1), the persons on whom subsection (1) imposes an obligation to take reasonable measures, include an owner of land or premises, a person in control of land or premises or a person who has a right to use the land or premises on which or in which-

(a) any activity or process is or was performed or undertaken; or

(b) any other situation exists, which causes, has caused or is likely to cause significant pollution or degradation of the environment.

(3) The measures required in terms of subsection (1) may include measures to-

(a) investigate, assess and evaluate the impact on the environment;

(b) inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;

(c) cease, modify or control any act, activity or process causing the pollution or degradation;

(d) contain or prevent the movement of pollutants or the causant of degradation;

(e) eliminate any source of the pollution or degradation; or

(f) remedy the effects of the pollution or degradation."

Consequently, BRMO must take "reasonable steps" to prevent pollution or degradation of the environment, which may result from the proposed activities. These reasonable steps include the investigation and evaluation of the potential impact, and identification of means to prevent an unacceptable impact on the environment, and to contain or minimise potential impacts where they cannot be eliminated.

3.2 NATIONAL WATER ACT

The National Water Act (NWA), 1998 (Act 36 of 1998) {NWA}, aims to manage national water resources in order to achieve sustainable use of water, for the benefit of all water users. This requires that the quality of water resources be protected, and integrated management of water resources takes place. Although there are various stipulations in the Act which are applicable to BRMO's operations, the summary below focuses on those relating directly to this application.

3.2.1 PREVENTION AND REMEDYING EFFECTS OF POLLUTION

Section 19 of the NWA stipulates a duty to prevent and remedy pollution as follows:

19. PREVENTION AND REMEDYING EFFECTS OF POLLUTION

(1) An owner of land, a person in control of land or a person who occupies or used the land on which –

(a) any activity or process is or was performed or undertaken, or

(b) any other situation exists,

which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.

(2) The measures referred to in subsection (1) may include measures to –

(a) cease, modify or control any act or process causing the pollution;

(b) comply with any prescribed waste standard or management practice;

(c) contain or prevent the movement of pollutants;

(d) eliminate any source of the pollution;

(e) remedy the effects of the pollution; and

(f) remedy the effects of any disturbance to the bed and banks of a watercourse.

BRMO therefore has a duty to prevent and remedy pollution. This duty must be given due consideration in this application.

3.2.2 GN.R 704 – REGULATION OF MINE WATER MANAGEMENT

GN.R 704 of 4 June 1999 (Regulations on Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources) was promulgated under the NWA, with the primary goal of ensuring water resource protection from the effects of mine water management. The aforementioned requirements are summarised in Table 3-1, where relevant to the proposed facilities.

Table 3-1: Applicability of GN. R. 704 of 4 June 1999 to the Assmang BRMO		
Reg	**Specific Condition/s**	**Applicability to Proposed Development**
4)	No person in control of a mine may –	
4 a)	*Locate or place any residue deposit, dam, reservoir, together with any associated structure of any other facility within the 1:100 year floodline or within a horizontal distance of 100m from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked.*	The proposed facilities will be a horizontal distance of approximately 900 m from the Gamagara River and its 1:100y flood lines. There are no water courses or estuaries any closer. Boreholes in the vicinity of the site are monitoring boreholes. The ground is not likely to become water-logged, undermined, unstable, or cracked. A geotechnical assessment has been undertaken for the proposed site (SRK Report Number 547073/1, dated August 2019).
4 b)	*Carry on any underground or opencast mining or prospecting or any other operation or activity under or within the 1:50 year floodline or within a horizontal distance of 100m from any watercourse or estuary, whichever is the greatest, except for matters contemplated under regulation 10 (sand winning).*	
4 c)	*Place or dispose of any residue or substance which causes or is likely to cause pollution of a water resource in the workings of any underground or opencast mine excavation, prospecting diggings, pit, or any other excavation.*	Not applicable.
5)	*No person in control of a mine may use any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource.*	<u>Exempted as per item 19.5 of Water Use Licence No. 10/041M/ABEGJ/3490</u> Low grade ore has been used for construction of laydown areas, roads, rail lines, and other activities. This will be applicable, where practical, for the proposed development, and the related roads to and around it.
6)	Every person in control of a mine must –	
6 a)	*Confine any unpolluted water to a clean water system, away from any dirty area.*	

Table 3-1: Applicability of GN. R. 704 of 4 June 1999 to the Assmang BRMO		
Reg	**Specific Condition/s**	**Applicability to Proposed Development**
6 b)	*Design, construct, maintain and operate any clean water system at the mine so that it is not likely to spill into any dirty water system more than once in 50 years.*	There is no surface water flow on the site. Rainfall tends to seep rapidly into the soil, as well as evaporate rapidly. The tops of the walls of the SFSF and the RWD will be above ground level. Water falling outside of the SFSF and RWD will remain outside the facilities. The facility is designed such that clean water, draining from the slopes, will soak away.
6 c)	*Collect the water arising within any dirty area, including water seeping from mining operations, into a dirty water system.*	The design includes minimum freeboard to accommodate a 1 in 50-year, 24-hour storm volume, plus 0.8 m dry freeboard on top of the normal operating level. The SFSF will have an equivalent Class C liner, and RWD will be HDPE lined.
6 d)	*Design, construct, maintain and operate any dirty water system at the mine so that it is not likely to spill into any clean water system more than once in 50 years.*	
6 e)	*Design, construct, maintain and operate any dam or tailings dam that forms part of a dirty water system to have a minimum freeboard of 0,8m above full supply level, unless otherwise specified for Dam Safety purposes.*	
6 f)	*Design, construct and maintain all water systems in such a manner as to guarantee the serviceability of such conveyances for flows up to and including those arising as a result of the maximum flood with an average period of recurrence of once in 50 years.*	
7)	Every person in control of a mine must take reasonable measures to –	
7 a)	*Prevent water containing waste or any substance which is likely to cause pollution of a water resource from entering any water resource, either by natural flow or seepage, and must retain or collect such substance or water containing waste for use, re-use, evaporation or for purification and disposal in terms of the NWA.*	The SFSF will have an equivalent Class C liner, and RWD will be HDPE lined. Water will be recirculated for conveying fines and for use as process water. The design includes minimum freeboard to accommodate a 1 in 50-year, 24-hour storm volume, plus 0.8 m dry freeboard on top of the normal
7 b)	*Design, modify, locate, construct and maintain all water systems, including residue deposits so as to prevent the pollution of water resources through the operation or use thereof, and to restrict the*	

Table 3-1: Applicability of GN. R. 704 of 4 June 1999 to the Assmang BRMO

Reg	Specific Condition/s	Applicability to Proposed Development
	possibility of damage to the riparian or in-stream habitat through erosion or sedimentation, etc.	operating level. The facilities are also 900 m from the nearest water course.
7 c)	*Cause effective measures to be taken to minimise the flow of any surface water or floodwater into mine workings, opencast workings, other workings or subterranean caverns, through cracked or fissured formations, subsidised ground, sinkholes, outcrop excavations, adits, entrances or any other openings.*	The tops of the walls of the SFSF and the RWD will be above ground level. Water falling outside of the SFSF and RWD will remain outside the facilities.
7 d)	*Design, modify, construct, maintain and use any dam or any residue deposit or stockpile used for the storage or disposal of mineral tailings, slimes, ash or other hydraulic transported substances, so that the water or waste there-in, or falling therein, will not result in the failure thereof or impair their stability.*	The design has been undertaken in accordance with applicable standards as listed in 6.4 of this report.
7 e)	*Prevent the erosion or leaching of materials from any residue deposit or stockpile from any area and contain materials or substances so eroded or leached in such area by providing suitable barrier dams, evaporation dams or any other effective measures to prevent this material or substance from entering and pollution water resources.*	The SFSF will have an equivalent Class C liner, and RWD will be HDPE lined. Water will be recirculated for conveying fines and for use as process water. The design includes minimum freeboard to accommodate a 1 in 50-year, 24-hour storm volume, plus 0.8 m dry freeboard on top of the normal operating level.
7 f)	*Ensure that water used in any process at the mine is recycled as far as practicable, and any facility, sump, pumping installation, catchment dam or other impoundment used for recycling water is of adequate design and capacity to prevent the spillage, seepage or release of water containing waste at any time.*	
8)	Every person in control of a mine or activity must -	
8 a)	*Cause any impoundment or dam containing any poisonous, toxic or injurious substance must be effectively fenced-off to restrict access thereto and must have warning notice boards at prominent locations to warn persons of the hazardous contents thereof.*	The SFSF and RWD will be fenced and access controlled.
8 b)	*Ensure access control in any area used for stockpiling or disposal of any residue or substance which causes, has caused or is likely to*	

Table 3-1: Applicability of GN. R. 704 of 4 June 1999 to the Assmang BRMO		
Reg	**Specific Condition/s**	**Applicability to Proposed Development**
	cause pollution of water resource is required to protect any measures taken in terms of this regulation.	
8 c)	*Not allow the area contemplated in 8 a) and b) above to be used for any other purpose, if such use causes or is likely to cause pollution of a water resource.*	
8 d)	*Protect any existing pollution control measures or replace any measures deleteriously affected, damaged or destroyed by the removing or reclaiming of materials from any residue deposit or stockpile, and must establish additional measures for the prevention of pollution of a water resource which might occur, is occurring or has occurred as a result of such operations.*	Exiting measures in place at the adjacent existing TSF will not be affected. Additional measures include the liner and design factors noted above.
9)	*On decommissioning, to ensure remediation of the affected water resource due to the mining activity.*	Upon reaching its end of life, the facility will be capped, in accordance with the DWAF Minimum Requirements For Waste Disposal By Landfill, and rehabilitated.
12)	Technical investigation and monitoring -	
12 (6)	*(6) Subject to Chapter 4 of the NWA, any person in control of a mine must submit plans, specifications and design reports approved by a professional engineer to the Minister, no later than 60 days prior to the commencement of activities relating to*	The required submissions will accompany the Water Use Licence application.
	(a) The construction of any surface dam for the purpose of impounding waste, water containing waste or slurry, so as to prevent the pollution of a water resource;	
	(b) The implementation of any pollution control measures at any residue deposit or stockpile, so as to prevent the pollution of a water resource;	
	(c) The implementation of any water control measures at any residue deposit or stockpile, so as to prevent the pollution of a water resource.	

3.3 NATIONAL ENVIRONMENTAL MANAGEMENT: WASTE ACT, 2008

The NEM:WA defines 'Waste' as

"(a) any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 to this Act; or

(b) any other substance, material or object that is not included in Schedule 3 that may be defined as a waste by the Minister by notice in the Gazette, but any waste or portion of waste, referred to in paragraphs (a) and (b), ceases to be a waste-

(i) once an application for its re-use, recycling or recovery has been approved or, after such approval, once it is, or has been re-used, recycled or recovered;

(ii) where approval is not required, once a waste is, or has been re-used, recycled or recovered;

(iii) where the Minister has, in terms of section 74, exempted any waste or a portion of waste generated by a particular process from the definition of waste; or,

(iv) where the Minister has, in the prescribed manner, excluded any waste stream or a portion of a waste stream from the definition of waste.".

Schedule 3 of the Act includes the following definition under CATEGORY A: Hazardous Waste:

"hazardous waste" means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste, ***residue deposits*** *and* ***residue stockpiles*** *as outlined below:*

"residue deposits" *means any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right;*

"residue stockpile" *means any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, mineral processing plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated within the mining area for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or, production right or an old order right, including historic mines and dumps created before the implementation of this Act.*

Residue deposits and residue stockpiles include:

1. Wastes resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals	*(a) wastes from mineral excavation*
	b) wastes from physical and chemical processing of metalliferous minerals
	(c) wastes from physical and chemical processing of nonmetalliferous minerals
	(d) wastes from drilling muds and other drilling operations

It is clear from the above that the proposed SFSF will be a residue stockpile, and is thus also a "waste", according to the Act.

3.3.1 GENERAL DUTY IN RESPECT OF WASTE MANAGEMENT

S16 of the Act requires as follows:

"(1) A holder of waste must, within the holder's power, take all reasonable measures to-

(a) avoid the generation of waste and where such generation cannot be avoided, to minimise the toxicity and amounts of waste that are generated;

(b) reduce, re-use, recycle and recover waste;

(c) where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner;

(d) manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odour or visual impacts;

(e) prevent any employee or any person under his or her supervision from contravening this Act; and

(f) prevent the waste from being used for any unauthorised purpose.

(3) The measures contemplated in this section may include measures to-

(a) investigate, assess and evaluate the impact of the waste in question on health or the environment;

(b) cease, modify or control any act or process causing the pollution, environmental degradation or harm to health;

(c) comply with any norm or standard or prescribed management practice;

(d) eliminate any source of pollution or environmental degradation; and

(e) remedy the effects of the pollution or environmental degradation."

3.3.2 REGULATIONS REGARDING THE PLANNING AND MANAGEMENT OF RESIDUE STOCKPILES & RESIDUE DEPOSITS

The Regulations Regarding The Planning And Management Of Residue Stockpiles And Residue Deposits, 2015 (GN. R 632 Of 2015, as amended), promulgated in terms of Section 69(1)(iA) of the Act are of particular significance.

According to the Regulations Regarding The Planning And Management Of Residue Stockpiles And Residue Deposits, an assessment of impacts and analyses of risks relating to the management of residue stockpiles and residue deposits is required to:

- Identify and assess the environmental impacts arising from the establishment of residue stockpiles and residue deposits, as part of an environmental impact assessment.
- Analyse risk based on the characteristics and the classification set out in Regulation 4 and 5, in order to determine appropriate mitigation and management measures.
- Recommend pollution control measures suitable for a specific residue stockpile or residue deposit, on the basis of a risk analysis as contemplated in Regulations 4 and 5.

4. Characterisation of residue stockpiles and residue deposits

(1) Residue stockpile and residue deposit must be characterised to identify any potential risk to health or safety hazard and environmental impact that may be associated with the residue when stockpiled or deposited at the site on a prospecting, mining, exploration or production operation.

(2) Residue stockpile and residue deposit must be characterised in terms of its—

(a) physical characteristics, that must include—

- *i. the size distribution of the principal constituents;*
- *ii. the permeability of the material;*
- *iii. void ratios of the material;*
- *iv. the consolidation or settling characteristics of the material under its own weight and that of any overburden;*
- *v. the strength of material;*
- *vi. the specific gravity of the solid constituents;*
- *vii. the water content of the material at the time of deposition, and at other phases in the life of the deposit; and*
- *viii. the change in the above properties with time.*

(b) chemical characteristics, that must include—

- *i. the toxicity;*
- *ii. the propensity to oxidize and decompose;*
- *iii. the propensity to undergo spontaneous combustion;*
- *iv. the pH and chemical composition of the water separated from the solids;*
- *v. stability and reactivity and the rate thereof;*
- *vi. acid generating and neutralising potential; and*
- *vii. the concentration of the volatile organic compounds.*

(c) mineral content that may include the specific gravity of the residue particles and its impact on particle segregation and consolidation.

5. Classification of residue stockpiles and residue deposits

(1) Residue stockpile and residue deposit must be classified by a competent person.

(2) A risk analysis must be conducted and documented on all residue stockpiles and residue deposits to be established.

(3) (2A) The risk analysis contemplated in subregulation (2) must be undertaken by a competent person.

(4) (3) The classification of residue stockpile and residue deposit must be undertaken on the basis of the—

(a) characteristics of the residue;

(b) location and dimensions of the deposit (height, surface area);

(c) importance and vulnerability of the environmental components that are at risk;

(d) spatial extent, duration and intensity of potential impacts; and

(e) pollution control measures determined as a result of the risk analysis as contemplated in regulations 4 and 5 of these Regulations.

4 DESCRIPTION OF THE RECEIVING ENVIRONMENT AND POTENTIAL IMPACTS

4.1 LOCATION, LAND-USE, AND ZONING

The BRMO active operational areas are zoned for mining activities.

4.2 CLIMATE

There are no South African Weather stations (SAWS) in proximity to the site. As such, data for Kuruman is used to provide an overview of the climatology of the area. Kuruman is approximately 65 km south-east of the BRMO operations. The meteorological conditions at this site may not be exactly representative of meteorological conditions at the site. However, they are expected to be representative of the general conditions of the region.

4.2.1 WIND

The observed wind direction and wind speed are predominantly from the north–northwest, with an average wind speed of 4.1 m/s (for the windier months of the year, July to January) (Figure 4-1). The length of the colour-coded line in the wind roses is proportional to the frequency of occurrence of wind blowing from that direction. Wind speed classes are also colour coded, and the length of each class/category is proportional to the frequency of occurrence of wind speed.

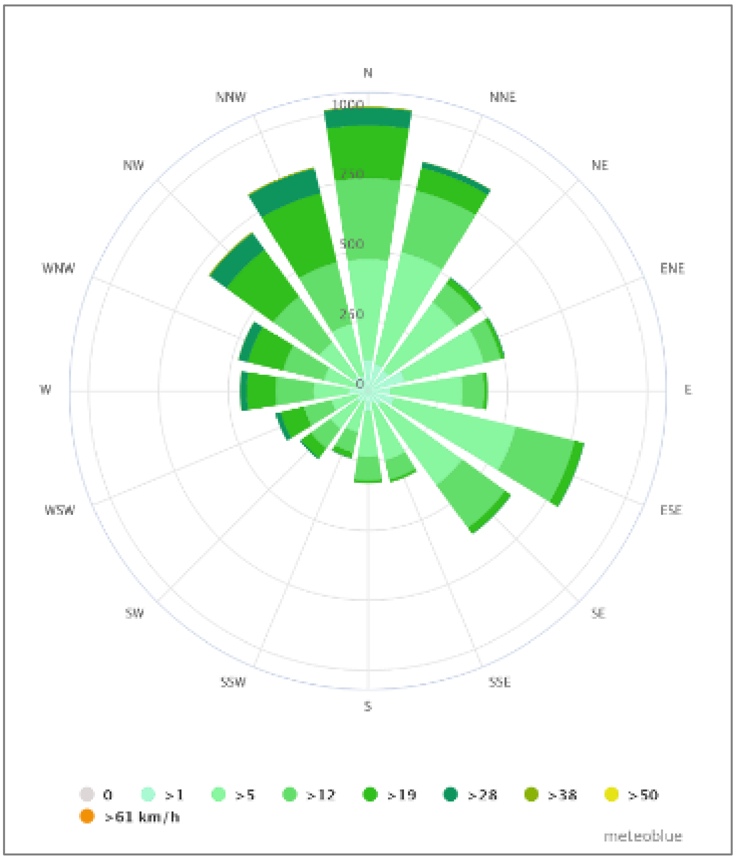


Figure 4-1: Annual Wind Rose for Kuruman (https://www.meteoblue.com)

4.2.2 RAINFALL AND TEMPERATURE

In the absence of significant measured records for the area, climate data is based on available online resources. Rainfall occurs predominantly in summer and autumn (Dec – Apr), while the least amount of rain falls in the months of May to September. The maximum daily temperature occurs in December/January, whilst the minimum daily temperature occurs in July/August for Hotazel (Figure 4-2). Temperatures are high in summer months, with typical average maximum temperatures of approximately 34°C. Winter temperatures may drop below freezing. However, the average minimum temperature reported is approximately 1°C. It is notable that these are average temperatures, whereas maximum daily temperatures may exceed 40 °C in the summer months, and minimum daily temperatures may be below 0°C in the winter months.

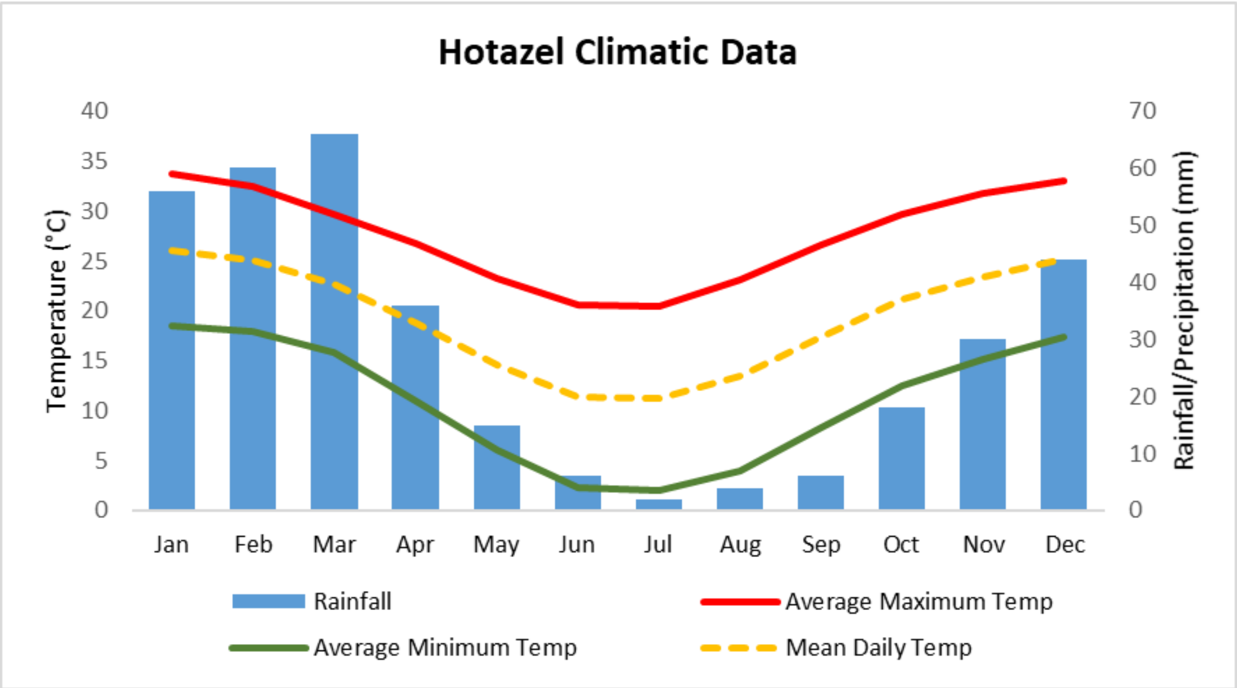


Figure 4-2: Monthly Average Temperature and Rainfall for Hotazel (source https://www.climatedata.org)

4.2.3 EVAPORATION AND CLIMATIC WATER BALANCE

The region is arid, with relatively high evaporation rates and low rainfall. Although site-specific data is not available, the mean annual precipitation versus evaporation rates can be estimated from mean rates from other stations in the area.

Average monthly rainfall and evaporation data for the area was obtained from the following Department of Water and Sanitation monitoring stations:

- Kuruman Station (D4E004), approximately 65 km south-east.
- Olifantshoek Station (D4E002), approximately 85 km north-west.

The average monthly and annual data is summarised in Table 4-1, and illustrated in Figure 4-3 and Figure 4-4.

Table 4-1: Precipitation and Evaporation Data

Month	Kuruman-D4E004			Olifantshoek-D4E002		
	Rainfall (mm)	Evaporation (mm)	Climatic Water Balance (mm)	Rainfall (mm)	Evaporation (mm)	Climatic Water Balance (mm)
January	85.6	259	-173.4	59.6	276.1	-216.5
Feb	82.9	208.4	-125.5	52.1	221.6	-169.5
March	86.5	161.3	-74.8	63.3	191.9	-128.6
April	45.1	122.3	-77.2	33.4	139.8	-106.4
May	21.5	113.2	-91.7	14.1	105.3	-91.2
June	7.4	82.5	-75.1	5.3	79.8	-74.5
July	2.8	99.1	-96.3	3.2	90.7	-87.5
August	9.8	131.2	-121.4	5.5	132.6	-127.1
September	7.9	188.5	-180.6	5.8	180.3	-174.5
October	26.4	236.3	-209.9	19	234.9	-215.9
November	45.1	243.6	-198.5	27.4	266.6	-239.2
December	44.9	272.7	-227.8	32.7	293.2	-260.5
Annual	**465.9**	**2118.1**	-173.4	**321.4**	**2212.8**	-216.5
Annual Water Balance*	**-1652.2**			**-1891.4**		

* The climatic water balance is calculated as total rainfall - total evaporation.

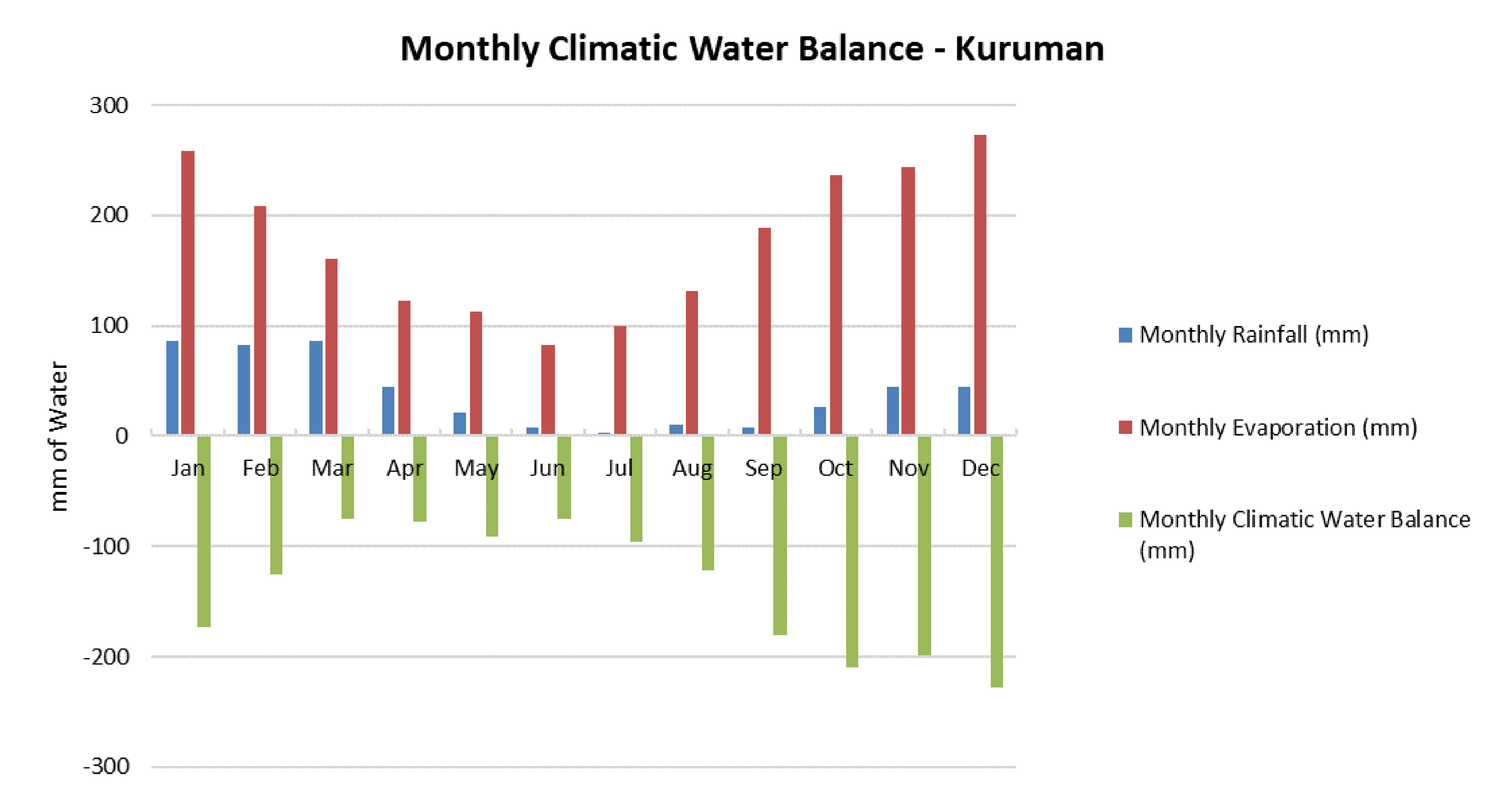


Figure 4-3: Climatic Water Balance - Kuruman

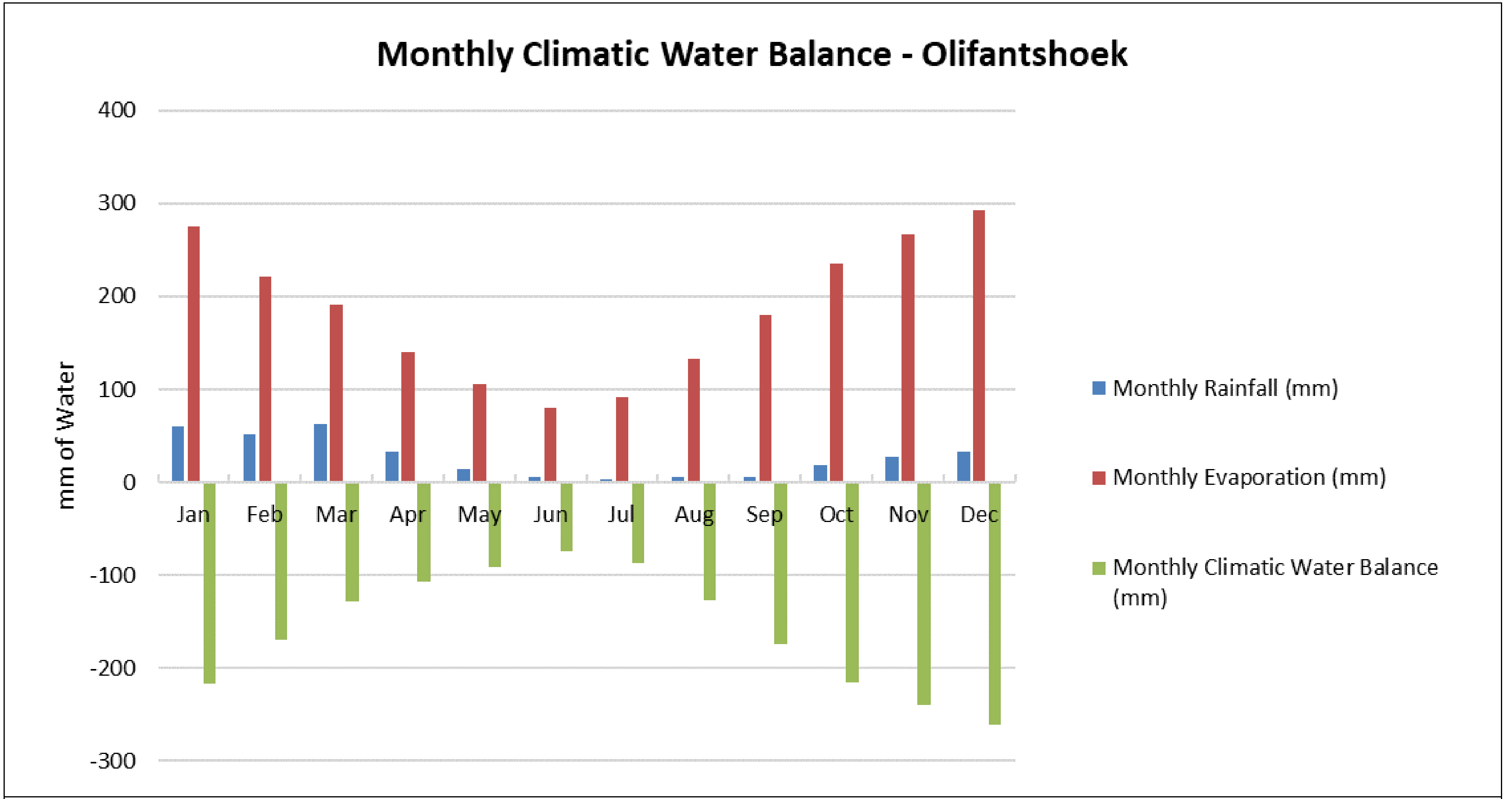


Figure 4-4: Climatic Water Balance - Olifantshoek

It is clear from the above that there is a significantly negative climatic water balance for the area. This is significant for the site, as it implies that there is limited potential for infiltration and leaching of material disposed, and significant potential for loss of water through evaporation, particularly over the long term.

4.3 SURFACE WATER DRAINAGE

4.3.1 QUATERNARY CATCHMENTS

BRMO falls across two quaternary catchments, D41K (which includes Gloria and the proposed SFSF), and D41M, forming part of the Gamagara/Kuruman/Molopo/Orange River catchment. Refer Figure 4-5 for detail of the quaternary catchments.

The Gamagara River runs in a northerly direction, along the western edge of the Gloria operations. Due to the arid nature of the climate in this part of the Northern Cape Province, this river is a non-perennial river for most of its life, in spite of its large catchment surface area of almost 8 100 Km^2. However, there may be occasional floods, as evidenced by the reported washing away of a railway bridge circa 1974 (refer to Figure 4-6).

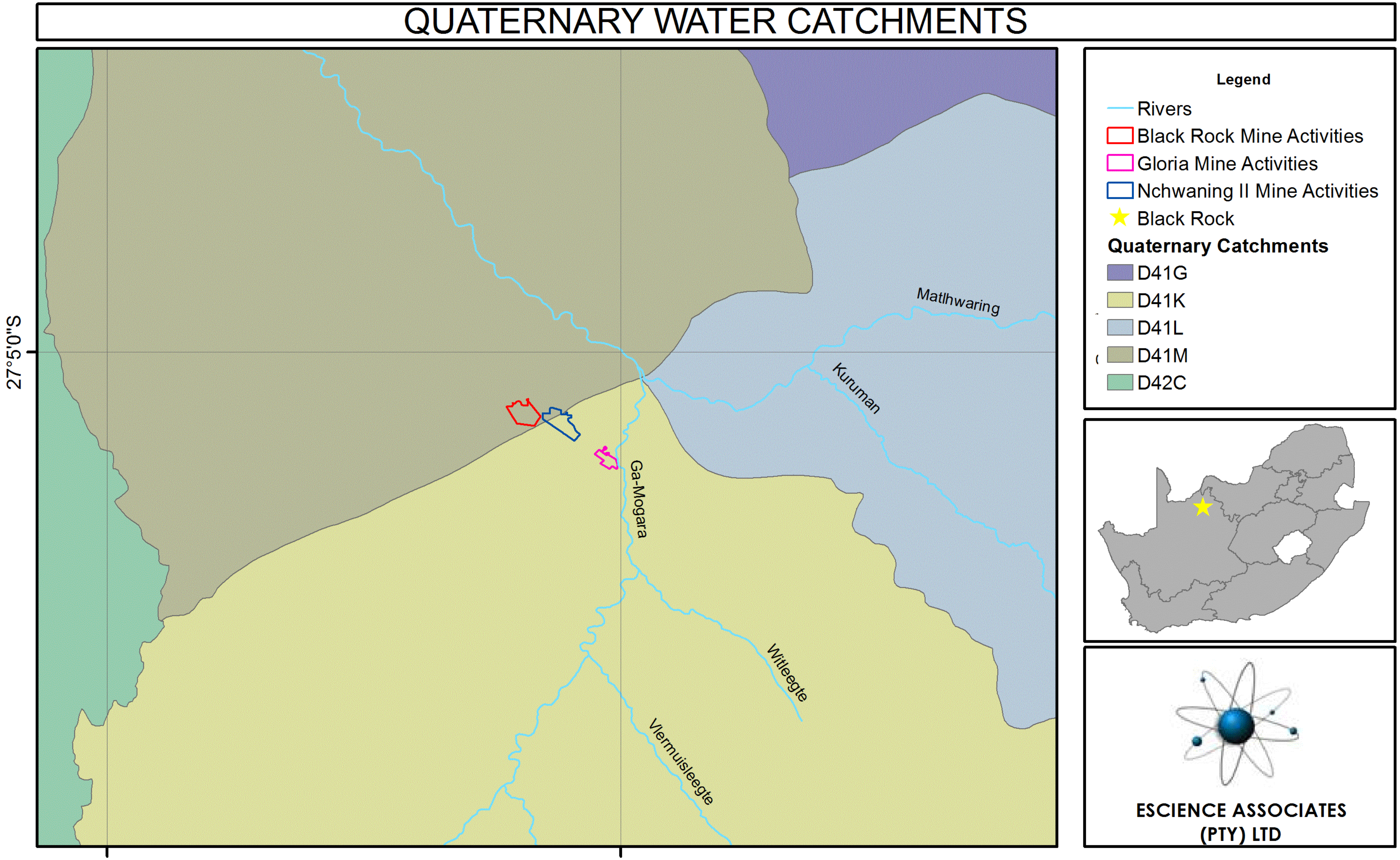


Figure 4-5: Map Showing Quaternary Catchments Relevant to BRMO

Figure 4-6: Old Railway Bridge in Gamagara Riverbed Adjacent to Gloria Mine

The Gamagara River forms part of the Kalahari Basin, which is classified as an '*endorheic basin*' (i.e. no surface water leaves the catchment basin, other than through evaporation and groundwater recharge).

Quaternary catchment D41K has a mean annual precipitation (MAP) of only 344.14 mm and a mean annual run-off (MAR) into surface streams of only 1 mm (Midgley, et al., 1994). This means that on average, only 1 mm of the annual rainfall in this catchment will actually drain into the Gamagara River as surface run-off. Quaternary catchment D41M has a MAP of 304.61 mm and a MAR of 0.6 mm (even less than the MAR of D41K).

In addition to the high average temperatures and very dry climate, a layer of highly porous Kalahari sand, which effectively absorbs any surface run-off that may have otherwise reached surface streams, overlies the geology in this region, hence the low MAR values. As with all the other rivers associated with the Kalahari Basin, this has resulted in the Gamagara River not having any surface flow for most of its life. In fact, several years or even decades can pass without water flowing in this watercourse.

However, this does change occasionally when a large storm occurs over the catchment. During these, relatively rare, occasions, the river will become a torrent of (invariably muddy) water for a few days/weeks, often starting off as an unexpected wall of water flowing down the watercourse. In spite of the fact that there is very little water to be seen in the riverbed of the Gamagara River, a significant, but presently unquantified, volume of the flow occurs below the ground surface, in the shallow alluvial aquifer underlying the river (Krige, 2012).

4.3.2 SURFACE DRAINAGE

Surface water is expected to flow away from Gloria towards the south-east, east, and north-east. Figure 4-7 shows the actual drainage patterns of water across the study area. Figure 4-7 confirms that surface water from the south-eastern and eastern parts of the mine (i.e. falling in quaternary catchment D41K – Gloria Section) drains towards the north and east (i.e. towards the Gamagara River).

The topography of a drainage area also dictates the volumes and speed (energy) at which water would run off a particular piece of land. In other words, if water runs off a very flat area, the amount of water flowing off this area would be less than, for example, water running off a very steep terrain. Water flowing on flat areas has less kinetic energy, thus lower erosion potential, but more importantly, especially in the Kalahari, the water has more time to infiltrate into the ground through the sand. The surface gradients over BRMO mine lease area are flat in most areas (Figure 4-8), indicating that surface run-off will occur at slow rates, providing ample time for infiltration onto the ground. Most of the surface has a slope of less than 0.5°. Correspondingly, there is no evidence of surface flow on the site. There are no observable natural drainage channels.

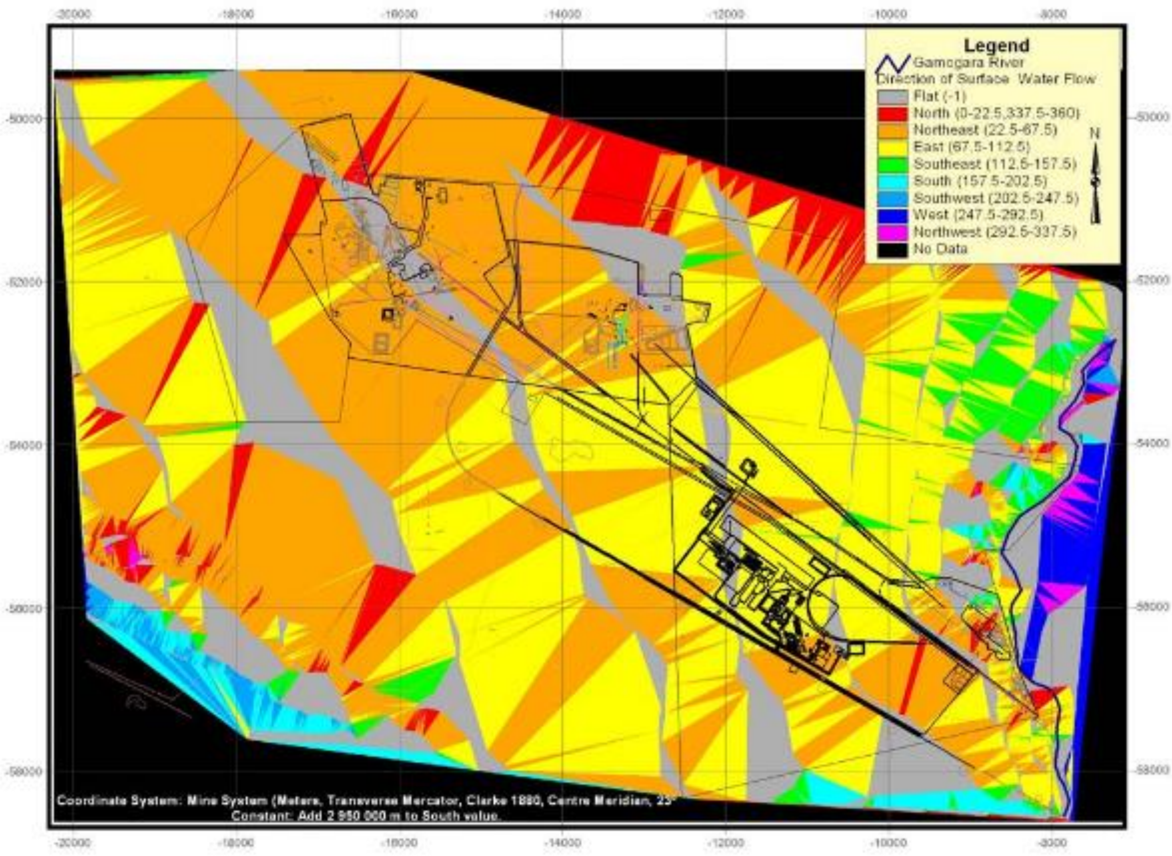


Figure 4-7: Modelled Surface Water Flow Direction Across BRMO (Krige, 2012).

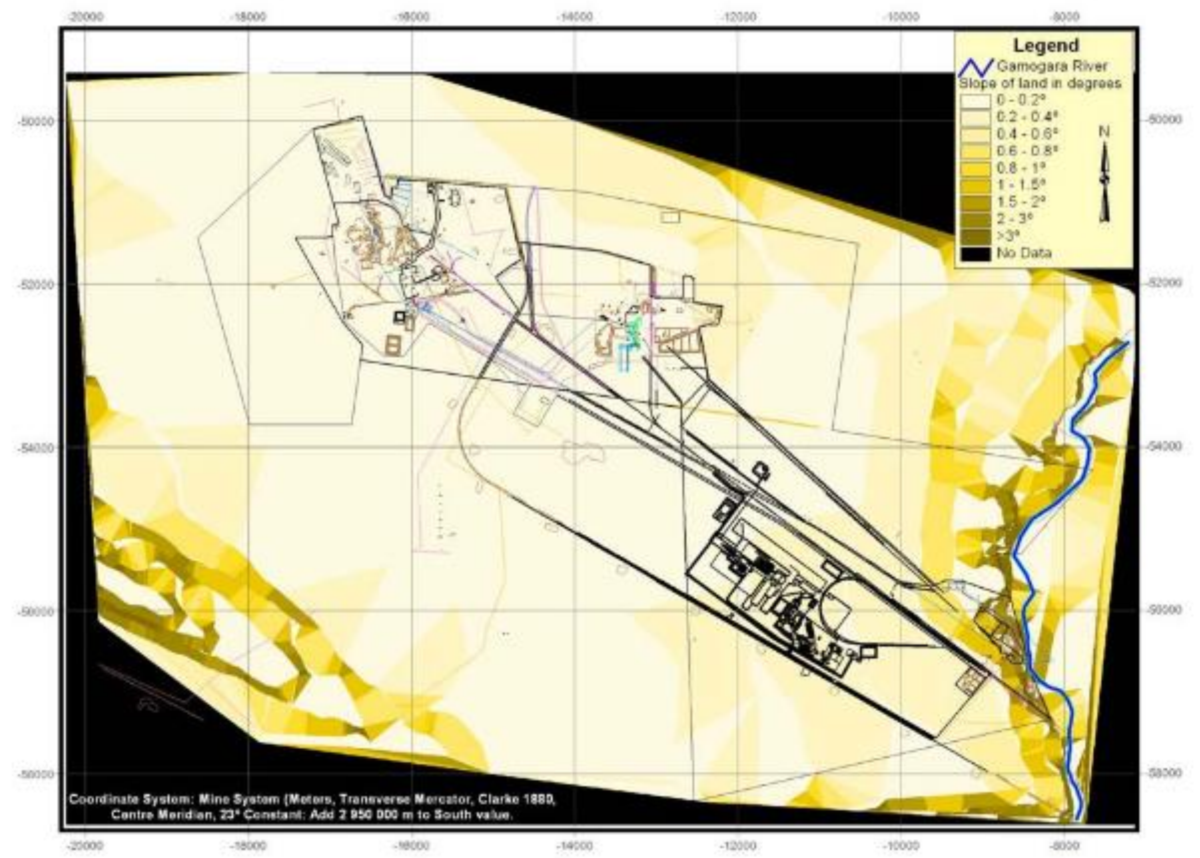


Figure 4-8: Surface Slope Gradients Across BRMO (Krige, 2012)

4.3.3 GAMAGARA RIVER FLOOD LINES

GN.R 704 legislates that no residue deposit, dam, reservoir, or any of its associated infrastructure (e.g. pollution-control dams or pump stations), may be placed within the 100-year flood lines or within 100 m from a watercourse, whichever is the greatest. The regulation continues that no open cast or underground mine may be located within the 50-year flood line of a stream or river (or within 100 m, whichever is the greatest), and neither may one erect any sanitary convenience, fuel depots, reservoir, or depots, for any substance which causes or is likely to cause pollution of a water resource within the 50-year flood line of any watercourse.

The 100-year flood lines for the Gamagara River relevant to BRMO's eastern boundary are present in Figure 4-9 (Krige, 2012). It must be acknowledged that the data used to model the flood lines was deemed to be of a poor nature, with contour data for the eastern section of the Gamagara River missing in places. The resultant flood lines are thus incomplete. The effect of the existing railway bridge was also not taken into account. For this reason, the relevant specialist, who modelled the flood lines, will not certify the flood lines produced using this data. The flood lines can, however, in the specialist's opinion, be used as a guideline. The proposed activities are clearly well outside the 100-year flood lines of the Gamagara River.

Existing mining activities have altered surfaces. Various laydown areas have compacted surfaces, which retard surface water flow. When rainfall falls on these areas, the water tends to pond and evaporate, with possible percolation at a slower than normal rate than for the rest of the site. There is no evidence of surface run-off into areas outside of the disturbed mining areas or into the Gamagara River.

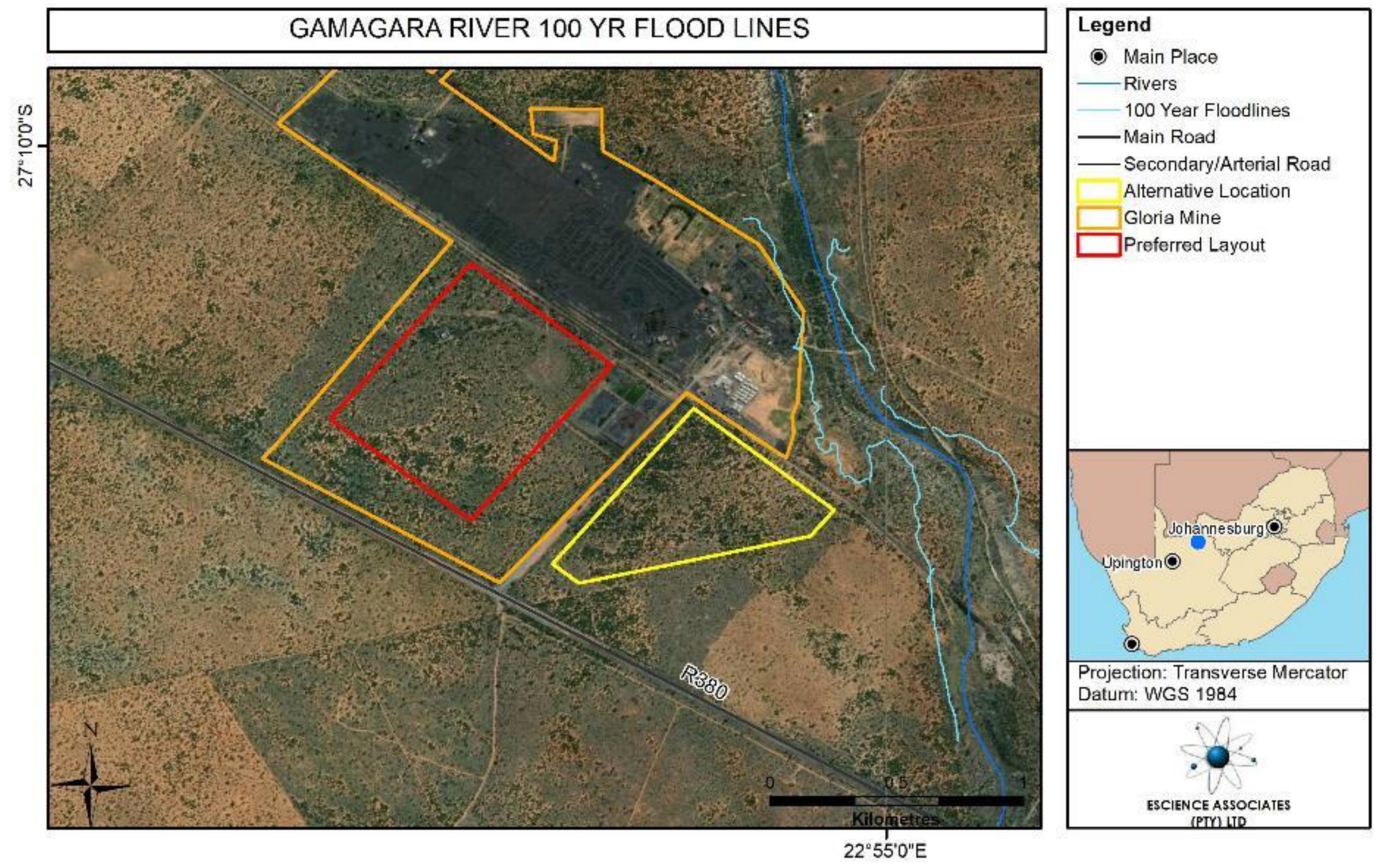


Figure 4-9: 100-Year Flood Line for the Gamagara River in the Vicinity of Gloria Mine

4.4 GEOLOGY AND GROUNDWATER

Various groundwater studies have been undertaken at BRMO since 2011. Recent assessments include:

- An impact assessment for the proposed SFS (GPT 2020).
- A consolidated impact assessment, in 2018, of all potentially significant sources of impact on the site, as required by the site's WUL (Envass 2018).
- A groundwater supply feasibility study in 2017 (GPT 2017).
- A consolidated impact assessment, in 2016, of all potentially significant sources of impact at BRMO, as required by the site's WUL (GPT 2016).

The summary presented below is largely based on information from the most recent assessment, unless otherwise noted.

According to the 1:500'000 Hydrogeological Map Series (2722 Kimberley) the site is underlain by intergranular aquifer units, with a median borehole yield between 0.1 and 0.2 l/s. Aquifers to the west and east of the site are mapped as intergranular and fractured aquifers, with the same median borehole yield. Water strikes within the site region were intersected predominantly between 40 and 70 m depths, with limited intersections after 125 m (i.e. approximate depth of the Kalahari Formation).

4.4.1 SATURATED ZONE

The hydrogeological specialists notes that in the saturated zone, at least two aquifer types may be inferred from knowledge of the geology of the area:

- A shallow aquifer formed in the weathered zone, perched on the fresh bedrock.
- An intermediate aquifer formed by fracturing of the underlying tillite, shales, iron formation and manganese ore bearing layers.

Although these aquifers vary considerably regarding hydrogeological characteristics, they are seldom observed as isolated units. Usually they would be highly interconnected by means of fractures and faults. Groundwater will thus flow through the system by means of the path of least resistance in a complicated manner that might include any of these components.

4.4.2 SHALLOW PERCHED AQUIFER

A near surface weathered zone is comprised of transported quaternary sediments and in-situ weathered rock and is underlain by tillite, shales, iron formation and manganese ore bearing rock. Groundwater flow patterns usually follow the topography, often coming very close to surface in topographic lows, sometimes even forming natural springs. The average groundwater recharge to the perched groundwater aquifer can reach up to 10% of the Mean Annual Precipitation (MAP) in the unconsolidated sand and calcrete.

4.4.3 FRACTURED ROCK AQUIFERS

The host geology of the mining area consists of tillite, shales and banded iron formation with interbedded manganese ore bearing rock. Geology underlying the mining area consists mainly of lavas from the Ongeluk Formation. Most of the groundwater flow will be along the fracture zones that occur in the relatively competent host rock. The geology map does not indicate any major fractures zones in the mining area, but from experience it can be assumed that numerous major and minor fractures do exist in the host rock. These conductive zones effectively interconnect the strata, both vertically and horizontally into a single, but highly heterogeneous and anisotropic unit. Major fault zones were, however, observed on the geology map, west of the mining area, running in a north-south direction.

4.4.4 UNSATURATED ZONE

The unsaturated zone in the mining area can be up to 40 metres thick (based on static groundwater levels from BRMO's monitoring in the existing boreholes and consists of quaternary sediments at the top, underlain by tillite, shale and banded iron formation with interbedded manganese ore bearing rock that become less weathered with depth.

4.4.5 WATER LEVELS

BRMO borehole monitoring data has been measured over a period of 6 years. The water levels vary between 33.47 m up to 101.10 m below ground level in the area surrounding the mine.

Usually a good relationship should hold between topography and static groundwater level. This relationship can be used to distinguish between boreholes with water levels at rest, and boreholes with anomalous groundwater levels due to disturbances such as pumping or local hydrogeological heterogeneities. The relationship using the boreholes from BRMO's monitoring report (Figure 4-11) is illustrated in Figure 4-10 below. This general relationship shows a correlation with a regression value (R^2) of 0.26.

A likely reason for this correlation could be that borehole GPT09 and GPT02 with water levels of 99.22 and 70 meters below ground level is being pumped. These static water levels (excluding borehole being pumped) were also subtracted from the elevations to determine the unsaturated aquifer thicknesses of different points over the study area. These values are intrinsically the same as the depth to the natural groundwater level measured from the surface. The average depth to the groundwater level in the intergranular and fractured aquifer in the project area is 46 meters.

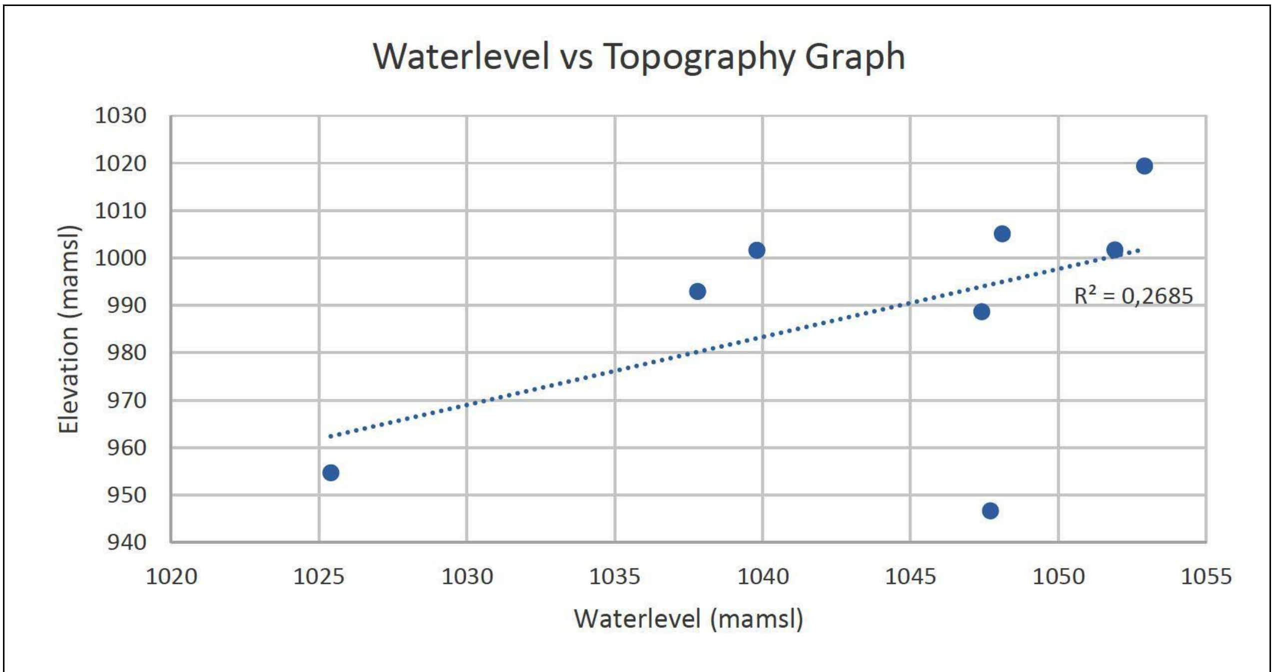


Figure 4-10: Cross-Section of Monitoring Boreholes (GPT, 2019)

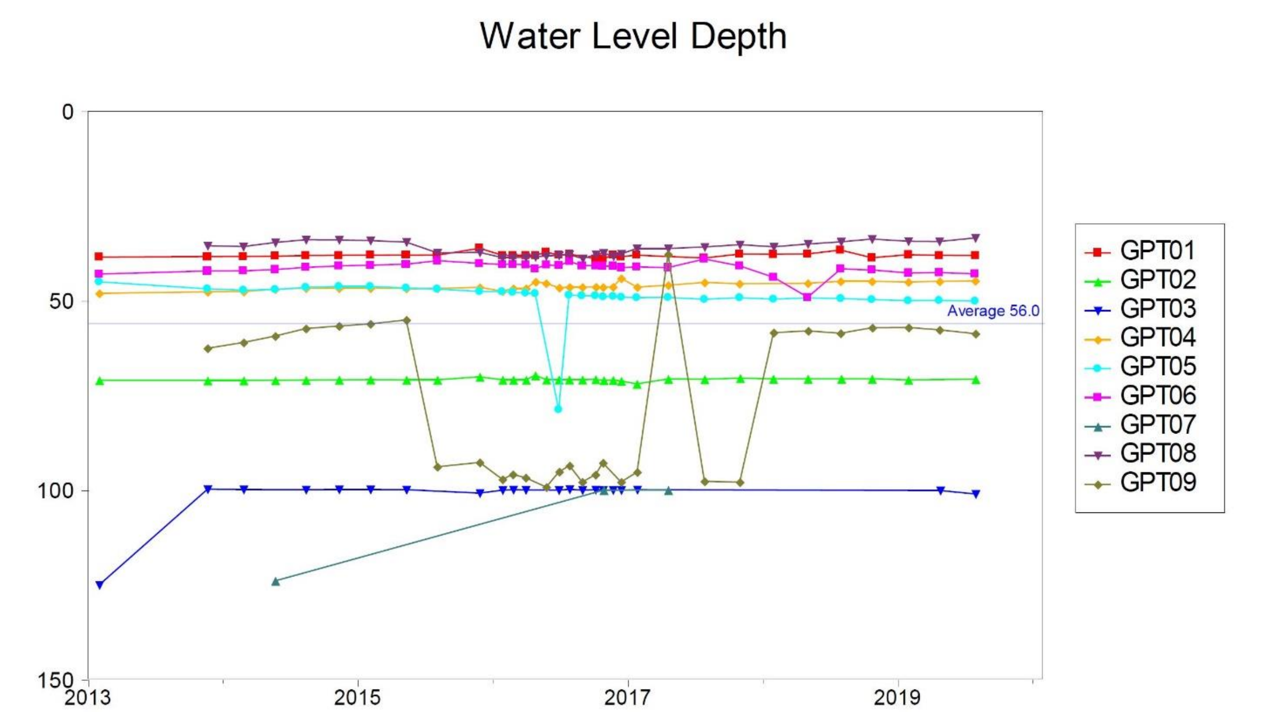


Figure 4-11: Measured GW levels

Inferred groundwater flow directions are illustrated in Figure 4-12).

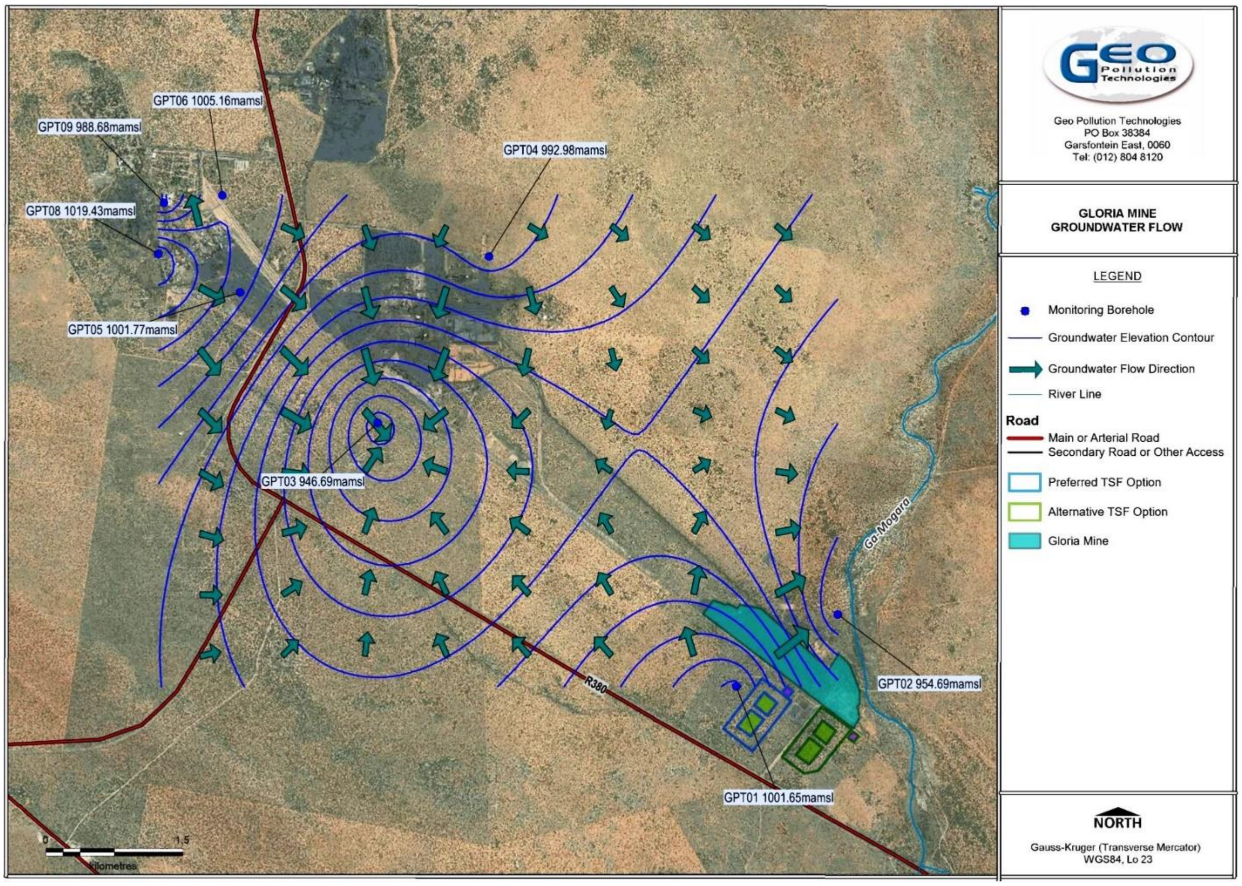


Figure 4-12: Groundwater Flow Directions

5 CHARACTERISATION OF FINES

5.1 PHYSICAL PROPERTIES

Representative disturbed samples of fines were assessed by the geotechnical design team, and are presented in Table 5-1 below.

Table 5-1: Physical Properties

	Property	Unit	Value					
			Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
1	Particle Size Distribution							
1	< 2-micron	%	5	7	8	8	6	6.8
1	> 75-micron	%	59	43	39	22	6	33.8
2	Specific Gravity							
2.1	S.G.	ratio	4.21	4.28	4.32	4.34	4.33	4.296
3	Settling Density & Moisture Content							
3.1	Settling Density	t/m^3	1.896	1.914	1.802	1.734	1.921	1.8534
3.2	% H_2O	%	9.7	10.7	7.1	13.2	12.6	10.66
4	Maximum Dry Density & Optimum Moisture Content							
4.1	MOD AASHTO	t/m^3	2.68	2.68	2.98	2.86	2.51	2.742
4.2	Moisture Content	%	12	11	7.3	9.4	8.3	9.6
5	Direct Shear Strength							
5.1	Friction Angle	degree	39	38	38	38	38	38.2
5.2	Cohesion	kPa	0	0	0	0	0	0
6	Permeability							
6.1	Falling Head	m/s	3.50E-07	-	-	-	2.30E-08	1.87E-07

5.2 CHEMICAL PROPERTIES

The chemical composition of samples assessed for waste classification is presented below in Table 5-2 and Table 5-3.

Table 5-2: Major Constituents

Major Elements		Major Element Concentration (wt %)[o]
Silica	SiO_2	9.28
Titanium	TiO_2	<0.01
Aluminium	Al_2O_3	0.12
Iron	Fe_2O_3	7.72
Manganese	MnO	49.23
Magnesium	MgO	3.43

Table 5-2: Major Constituents		
Major Elements		**Major Element Concentration (wt %)[o]**
Calcium	CaO	13.51
Sodium	Na_2O	0.16
Potassium	K_2O	0.03
Phosphorous	P_2O_5	0.07
Chromium	Cr_2O_3	0.02
Sulphur	SO_3	0.41
Loss on Ignition (1000 ºC)	LOI	16.5
Total		100.48
Loss of Moisture (105 ºC)	H_2O-	0.01
Mineral Composition (%)		
Mineral		Amount (weight %)
Bixbyite	$(Mn,Fe)_2O_3$	5.2
Kutnohorite	$CaMn^{2+}(CO_3)_2$	3.4
Kanoite	$(Mg,Mn^{2+})_2Si_2O_6$.	5.4
Neltnerite	$CaMn^{3+}{}_6(SiO_4)O_8$	0.9
Hausmannite	$Mn^{2+}Mn^{3+}{}_2O_4$	1
Amorphous fraction		84

Table 5-3: Trace Constituents		
Trace Element		**Trace Element Concentration (ppm)**
Arsenic	As	<0.43
Barium	Ba	6 474
Bismuth	Bi	<0.68
Cadmium	Cd	<3.04
Cerium	Ce	<3.08
Chlorine	Cl	225
Cobalt	Co	<0.56
Caesium	Cs	0.51
Copper	Cu	43.2
Galium	Ga	<3.21
Germanium	Ge	<0.50
Hafnium	Hf	<0.38
Mercury	Hg	<1.00
Lanthanum	La	9.99
Lutetium	Lu	<0.61

Table 5-3: Trace Constituents

Trace Element		Trace Element Concentration (ppm)
Molybdenum	Mo	3.29
Niobium	Nb	7.3
Neodymium	Nd	55.3
Nickel	Ni	<5.14
Lead	Pb	67
Rubidium	Rb	<0.42
Antimony	Sb	36.1
Scandium	Sc	109
Selenium	Se	<0.36
Samarium	Sm	<1.62
Tin	Sn	<0.08
Strontium	Sr	202
Tantalum	Ta	8.01
Tellurium	Te	<0.16
Thorium	Th	<0.88
Thallium	Tl	28.9
Uranium	U	<0.74
Vanadium	V	89.3
Tungsten	W	5.78
Yttrium	Y	6.1
Ytterbium	Yb	<1.05
Zinc	Zn	5 128
Zirconium	Zr	7.75

The material consists of stable, non-reactive minerals. Based on the composition of the material, and current tailings in situ, it is clear that the material does not have the propensity to oxidise and decompose in a SFSF, as proposed. There are no combustible components, or organic content, and thus, there is no potential for spontaneous combustion.

6 RISK ASSESSMENT

6.1 LEACHABILITY OF THE SUPER FINES

The National Norms and Standards for the Assessment of Waste for Landfill Disposal, published in GN 635 of 2013, prescribe the requirements for the assessment of waste, prior to disposal to landfill. These regulations were promulgated in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) prior to its amendments. At that time, the Act did not apply to residue deposits and stockpiles[1]. Although these regulations may not specifically apply to residue stockpiles and residue deposits, the requirements thereof have been considered as a guideline when assessing leach potential. GN 635 requires that all wastes that are to be disposed of in landfills, be assessed in terms of their composition and leaching properties. The total concentrations, and leachable concentrations, of specified analytes, are used to assess the waste. These values are then compared to leachable concentrations thresholds (LCT) and total concentration thresholds (TCT), to determine the waste "type".

There are five waste types, numerically ordered from Type 0 to Type 4. Type 0 waste being most hazardous in respect of landfilling risk, and Type 4 being the least hazardous. The waste types are determined as shown in Table 6-1.

Table 6-1: Waste Type Classification of Waste According to Concentration Thresholds from the National Norms and Standards (GN 635 of 2013)

Leachable Concentration	**Total Concentration**	**Waste Type**
LC ≤ LCT0	TC ≤ TCT0	Type 4
LCT0 < LC ≤ LCT1	TC ≤ TCT1	Type 3
LCT1 < LC ≤ LCT2	TC ≤ TCT1	Type 2
LCT2 < LC ≤ LCT3	TCT1 < TC ≤ TCT2	Type 1
LCT3 < LC	TCT2 < TC	Type 0

The National Norms and Standards for Disposal of Waste to Landfill, gazetted in GN 636 of 2013, stipulate the applicable landfill classes for disposal of each waste type, as presented in Table 6-2. It must be noted that the Regulations Regarding The Planning And Management Of Residue Stockpiles And Residue Deposits, 2015, GN.R 632 of 2015, subsequently amended by GN 990 of 2018, stipulate the means by which the pollution control, mitigation, and management measures must be determined for residue deposits and stockpiles. The liner requirements from GN 636 are used here as a guideline.

Table 6-2: Landfill Requirements Based on Waste Type (per GN 636 of 2013)

Waste Type	**Landfill Requirements**
Type 0	*The disposal of Type 0 waste to landfill is not allowed. The waste must be treated and re-assessed in terms of the Norms and Standards for Assessment of Waste for Landfill Disposal.*

[1] NEMWA (Act No. 59 of 2008), Section 4. (1)(b) This Act does not apply to residue deposits and residue stockpiles that are regulated under the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).

Table 6-2: Landfill Requirements Based on Waste Type (per GN 636 of 2013)	
Waste Type	**Landfill Requirements**
Type 1	*Type 1 waste may only be disposed of at a Class A landfill designed in accordance with Section 3(1) and (2) of these Norms and Standards, or, subject to Section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a Hh/HH landfill, as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., Department of Water Affairs and Forestry, 1998).*
Type 2	*Type 2 waste may only be disposed of at a Class B landfill designed in accordance with Section 3(1) and (2) of these Norms and Standards, or, subject to Section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a GLB+ landfill, as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).*
Type 3	*Type 3 waste may only be disposed of at a Class C landfill designed in accordance with Section 3(1) and (2) of these Norms and Standards, or, subject to Section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a GLB+ landfill, as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).*
Type 4	*Type 4 waste may only be disposed of at a Class D landfill designed in accordance with Section 3(1) and (2) of these Norms and Standards, or, subject to Section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a GLB landfill, as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).*

A composite sample of fines, from the current deposition process, was supplied by BRMO. This consisted of five samples taken at different times. The fines were assessed, in accordance with the leaching criteria in the National Norms and Standards for the Assessment of Waste for Landfill Disposal, published in GN 635 of 2013. Samples provided by BRMO were leached, in accordance with the requirements for mono-disposal of non-putrescible waste.

Results from the leach test exceeded the relevant LCT0 values for barium (Ba), boron (B), and manganese (Mn). Nitrates also exceeded the LCT0 value, but this is likely due to nitrate residue adsorbed to the sample materials from blasting. All other analytes are below their LCT0 values. There were no exceedances of the LCT1 values. The results are presented Table 6-3 below. The materials are classified as a Type 3 waste, based on the leach results, implying that a Class C liner is applicable for the proposed facility.

Table 6-3: Tailings Leach Test Results						
Analyte	**Units**	**LCT0**	**LCT1**	**LCT2**	**LCT3**	**Leach Results**
			Metal Ions			
Arsenic, As	mg/L	0.01	0.5	1	4	BDL
Boron, B	mg/L	0.5	25	50	200	2.24

Table 6-3: Tailings Leach Test Results						
Analyte	**Units**	**LCT0**	**LCT1**	**LCT2**	**LCT3**	**Leach Results**
Barium, Ba	mg/L	0.7	35	70	280	4.03
Cadmium, Cd	mg/L	0.003	0.15	0.3	1.2	BDL
Cobalt, Co	mg/L	0.5	25	50	200	BDL
Chromium, Cr	mg/L	0.1	5	10	40	BDL
Hexavalent Chromium, Cr^{6+}	mg/L	0.05	2.5	5	20	BDL
Copper, Cu	mg/L	2	100	200	800	BDL
Mercury, Hg	mg/L	0.006	0.3	0.6	2.4	BDL
Manganese, Mn	mg/L	0.5	25	50	200	1.92
Molybdenum, Mo	mg/L	0.07	3.5	7	28	BDL
Nickel, Ni	mg/L	0.07	3.5	7	28	BDL
Lead, Pb	mg/L	0.01	0.5	1	4	BDL
Antimony, Sb	mg/L	0.02	1	2	8	BDL
Selenium, Se	mg/L	0.01	0.5	1	4	BDL
Vanadium, V	mg/L	0.2	10	20	80	BDL.
Zinc, Zn	mg/L	5	250	500	2 000	BDL
Iron, Fe	mg/L					BDL
Inorganic anions						
TDS	mg/L	1 000	12 500	25 000	100 000	-
Chloride, Cl	mg/L	300	15 000	30 000	120 000	140
Sulphate, SO_4	mg/L	250	12 500	25 000	100 000	120
Nitrate as nitrogen, NO_3 as N	mg/L	11	550	1 100	4 400	16
Total Fluoride	mg/L	1.5	75	150	600	<4.0
Total Cyanide	mg/L	0.07	3.5	7	28	-
Waste Type						***Type 3***

Compositional analyses of the materials were also undertaken. Total concentrations (TC) exceeding the relevant TCT0 values for arsenic (As), barium (Ba), and boron (B), are noted. These are reflected in the leaching results. Manganese (Mn) concentration represents the highest TC, being recorded at a concentration exceeding the TCT2 range. This is, of course, expected as the material is a manganese bearing ore. Refer to Table 6-4. It is notable that the manganese concentration in the leach results is low (much less than LCT1).

Table 6-4: Tailings Total Concentration Test (TCT) Results					
Constituents	**Units**	**TCT0**	**TCT1**	**TCT2**	**Tailings**
Metal Ions					
Arsenic, As	mg/kg	5.8	500	2 000	9.17

Table 6-4: Tailings Total Concentration Test (TCT) Results					
Constituents	**Units**	**TCT0**	**TCT1**	**TCT2**	**Tailings**
Boron, B	mg/kg	150	15 000	60 000	516
Barium, Ba	mg/kg	62.5	6250	25 000	2 894
Cadmium, Cd	mg/kg	7.5	260	1040	BDL
Cobalt, Co	mg/kg	50	5 000	20 000	49.37
Chromium, Cr	mg/kg	46 000	800 000	N/A	4.79
* Hexavalent Chromium, Cr^{6+}	mg/kg	6.5	500	2 000	4.79
Copper, Cu	mg/kg	16	19 500	78 000	BDL
Mercury, Hg	mg/kg	0.93	160	640	BDL
Manganese, Mn	mg/kg	1 000	25 000	100 000	373 200
Molybdenum, Mo	mg/kg	40	1 000	4 000	BDL
Nickel, Ni	mg/kg	91	10 600	42 400	12.77
Lead, Pb	mg/kg	20	1 900	7 600	BDL
Antimony, Sb	mg/kg	10	75	300	BDL
Selenium, Se	mg/kg	10	50	200	BDL
Vanadium, V	mg/kg	150	2680	10 20	BDL
Zinc, Zn	mg/kg	240	160 000	640 000	38.7
Iron, Fe	mg/kg				45 200
	Inorganic anions				
TDS	mg/kg				
Chloride, Cl	mg/kg				
Sulphate, SO4	mg/kg				
Nitrate as nitrogen, NO3 as N	mg/kg				
Total Fluoride	mg/kg	100	10 000	40 000	-
Total Cyanide	mg/kg	14	10 500	42 000	-
Waste Type Category (including Mn)					*Type 0*
Waste Type Category (Excluding Mn)					*Type 3*

In cognisance of the total concentration results, in particular manganese, it is necessary to further review potential risk associated with the deposition of the materials. BRMO undertakes water quality monitoring, at various monitoring boreholes on the site, as well as from the existing Gloria TSF return water dam. The results for analytes of interest are presented below, along with relevant discussion of the significance thereof. It must be noted that borehole GPT01 is hydraulically up-stream of GPT02. The water level at GPT01 is approximately 40 mbgl, whereas GPT02 is approximately 70 mbgl, and ground level at GPT02 is 14 m lower than at GPT01. Groundwater flow is noted to be approximately northerly.

6.1.1 MANGANESE

The manganese within the tailings material appears to be relatively immobile, based on the manganese concentrations in the return water, and the surrounding groundwater (refer to Figure 6-1 below). The monitoring results generally indicate low or undetectable concentrations. Notably, the leach results indicate a higher concentration of manganese in the sample leachate than in the return water at the site. It is expected that the return water is more representative of the actual potential for leaching of manganese. There is a negative water balance, and thus constant replenishment of process water lost to evaporation, implying that there should be a build-up of solutes over time. Thus, the low manganese concentration the return water further supports the expectation that potential for leaching is low, and the use of leaching as a basis for selecting the class of liner should suffice, from a precautionary perspective. It is notable that all the values are well below (less than 10% of) the LCT1 threshold of 25 mg/L.

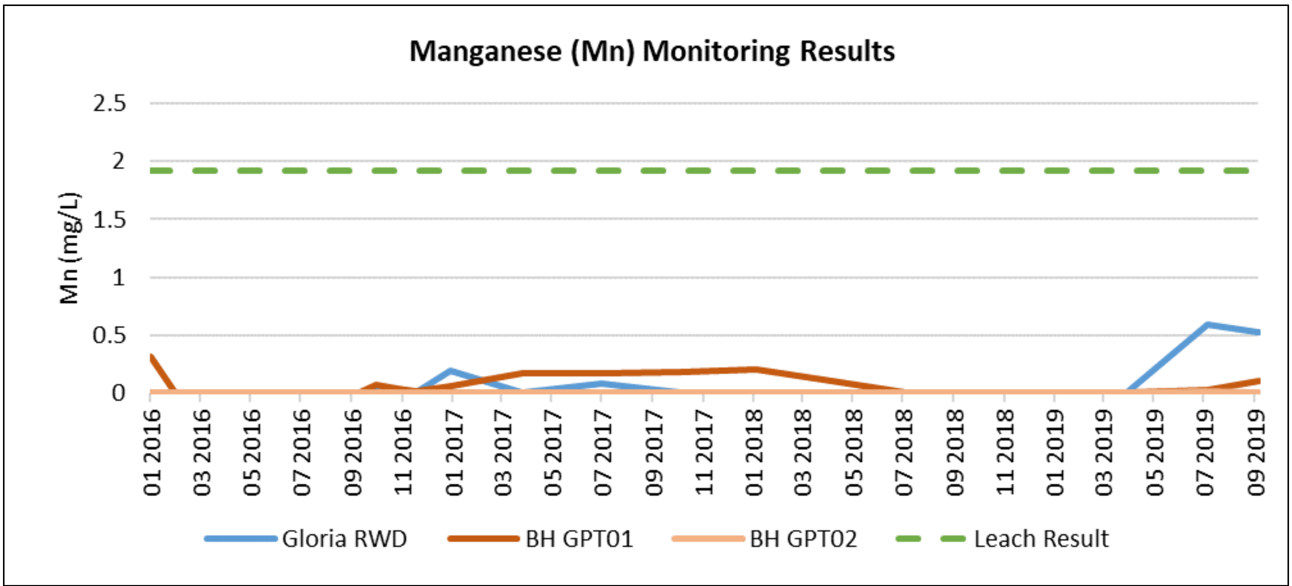


Figure 6-1: Manganese Monitoring Results, Gloria Boreholes and RWD

Further to the above, the borehole monitoring results for the rest of the site do not indicate manganese concentrations which can be associated with leaching from the existing unlined TSFs at the Nchwaning and Gloria mines. These unlined TSFs have been in operation for over 20 years. It is notable that the data does not present any evidence which would suggest that there are higher downstream concentrations of manganese in the groundwater than in the upstream groundwater. The differences in concentrations are random, with instances where upstream boreholes have higher concentrations than corresponding downstream boreholes. Refer to Figure 6-2 below.

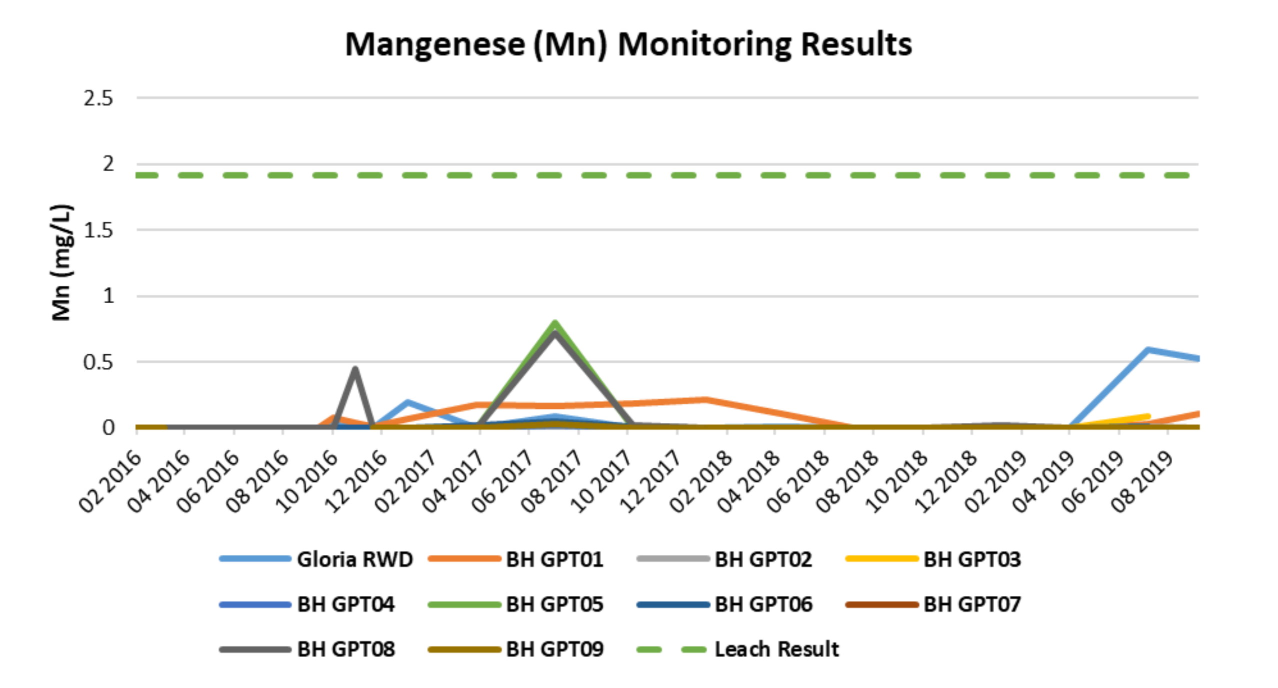


Figure 6-2: Manganese Monitoring Results, All BRMO Boreholes

6.1.2 BORON

Boron is present in concentrations, and leaches at a level that indicates that the materials should be classified as a Type 3 waste. Additionally, based on the boron concentrations in the return water (refer to Figure 6-1 above), the Type 3 three classification holds true.

The monitoring results generally indicate low concentrations of boron in the groundwater. Notably, the return water analyses indicate a higher concentration of boron than the leach results. As previously noted, there is a negative water balance, and thus constant replenishment of process water lost to evaporation, implying that there should be a build-up of solutes over time. The existing TSF has been in operation for over 20 years. This may explain the higher boron levels in the return water. It is notable that the all the values are still well below the LCT1 threshold of 25 mg/L.

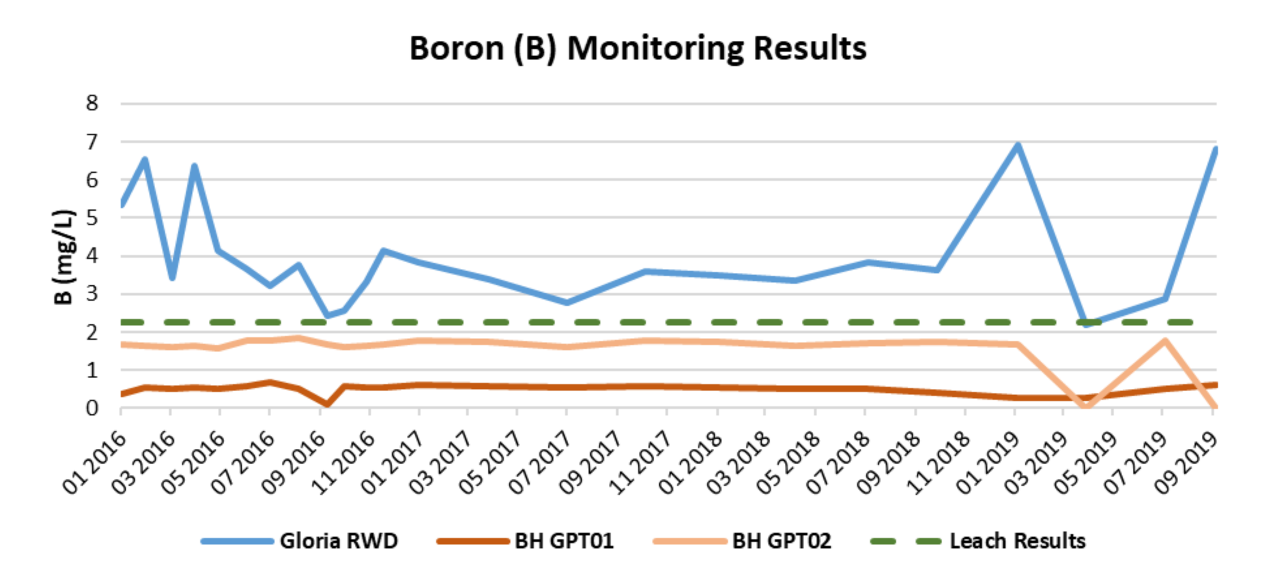


Figure 6-3: Boron Monitoring Results, Gloria Boreholes and RWD

As with manganese, the borehole monitoring results for the rest of the site do not indicate boron concentrations which can be associated with leaching from the existing unlined TSFs at the Nchwaning and Gloria mines. These unlined TSFs have been in operation for over 20 years. It is notable that the data does not present any evidence which would suggest that there are higher downstream concentrations of boron in the groundwater than in the upstream groundwater. The differences in concentrations are random, with instances where upstream boreholes have higher concentrations than corresponding downstream boreholes. Refer to Figure 6-4 below.

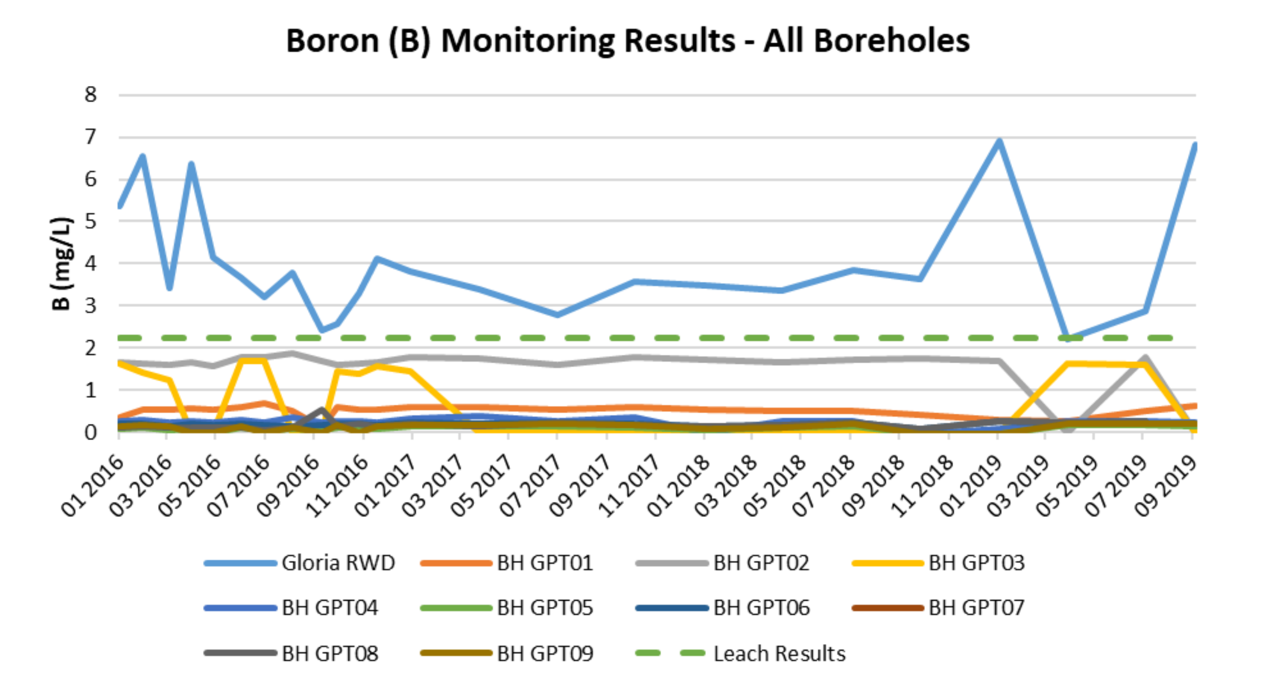


Figure 6-4: Boron Monitoring Results, All BRMO Boreholes

6.1.3 BARIUM

Barium is present in concentrations, and leaches at a level that indicates that the materials should be classified as a Type 3 waste. Barium concentrations in the return water (refer to Figure 6-1 above) are much lower than the leach results, and are, in fact, below the LCT0 of 0.7 mg/L. The monitoring results generally also indicate very low concentrations of boron in the groundwater. The conclusion, that a Type 3 classification applies, is still applicable, from a precautionary perspective.

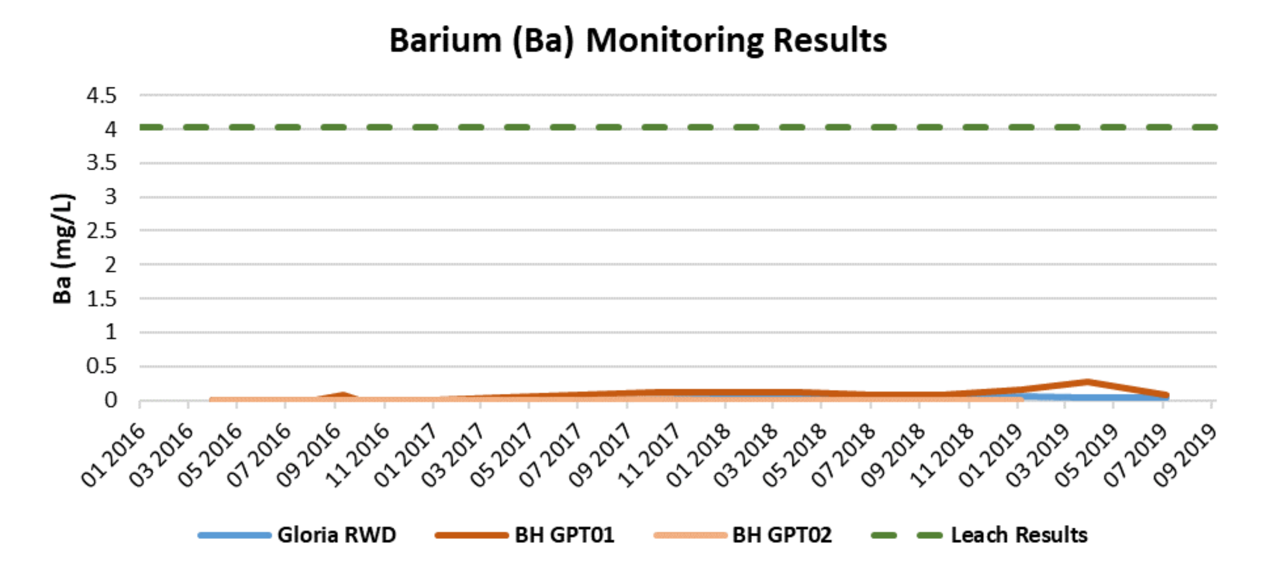


Figure 6-5: Barium Monitoring Results, Gloria Boreholes and RWD

As with manganese, the borehole monitoring results for the rest of the site do not indicate barium concentrations which can be associated with leaching from the existing unlined TSFs at the Nchwaning and Gloria mines. These unlined TSFs have been in operation for over 20 years. It is notable that the data does not present any evidence which would suggest that there are higher downstream concentrations of barium in the groundwater than in the upstream groundwater. The differences in concentrations are random, with instances where upstream boreholes have higher concentrations than corresponding downstream boreholes. Refer to Figure 6-6 below.

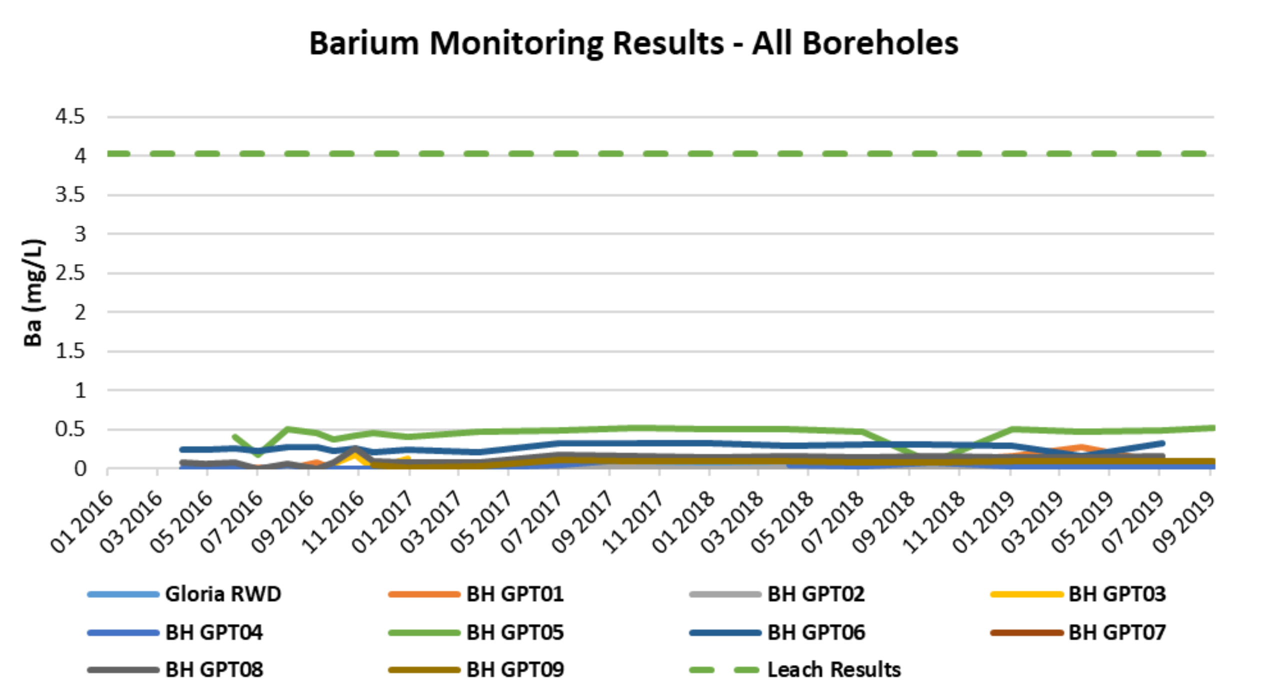


Figure 6-6: Barium Monitoring Results, All BRMO Boreholes

6.1.4 NITRATES

Nitrates are present in the leach at a level that indicates that the materials should be classified as a Type 3 waste. Additionally, based on the nitrate concentrations in the return water (refer to Figure 6-7 below), the Type 3 three classification holds true. The conclusion, that a Type 3 classification applies, is still applicable, from a precautionary perspective.

The monitoring results generally indicate potentially significant concentrations of nitrates in the groundwater. The borehole monitoring results for the rest of the site also indicate nitrate concentrations of potential significance. Refer to Figure 6-8 below. According to a BRMO geohydrological impact assessment, undertaken by Envass (Report Number: GEO-REP-107-18-19), in an effort to characterise potential nitrate sources at the site, isotopes were analysed in the water and soil samples taken at the site. The water isotope results were plotted against measured NO_3-N concentrations, and interpreted based on observations made by Tredoux (1993). All of the site borehole samples plotted within the soils sector of the diagram. The natural groundwater concentrations for the site area are expected to be elevated (Tredoux, 2009).

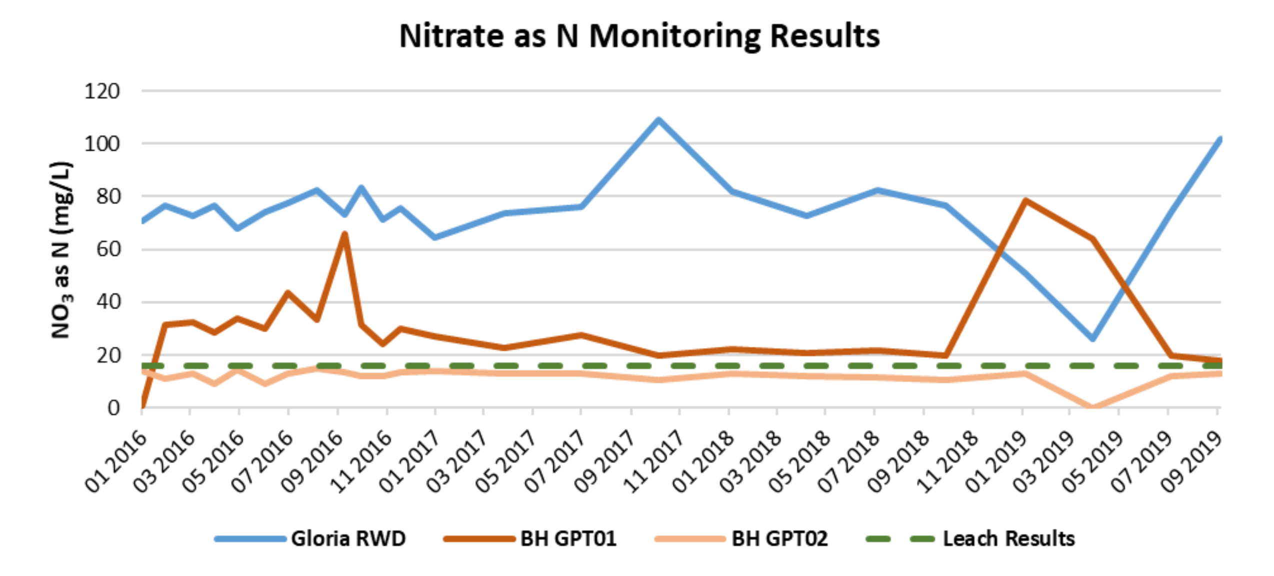


Figure 6-7: Nitrate Monitoring Results, Gloria Boreholes and RWD

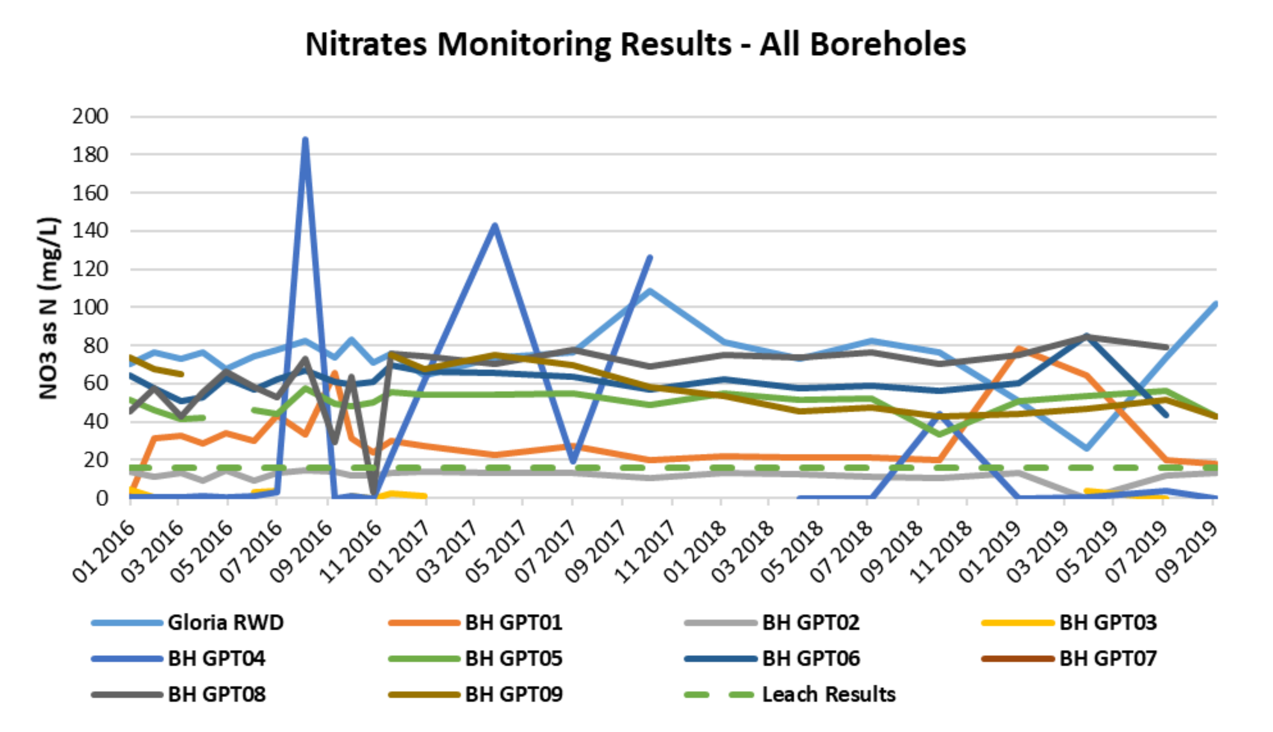


Figure 6-8: Nitrate Monitoring Results, All BRMO Boreholes

6.2 ACID GENERATION POTENTIAL

The pH of both the ground water and the return water is slightly alkaline, more so for the return water, and relatively consistent over the period reported (refer to Figure 6-9 below). Given that the ore is a carbonate ore, and that no potential acid generating minerals have been identified in the ore, the potential for generation of acid leach is negligible. This is reflected in the alkaline return water, which is recirculated for transporting tailings the existing TSF.

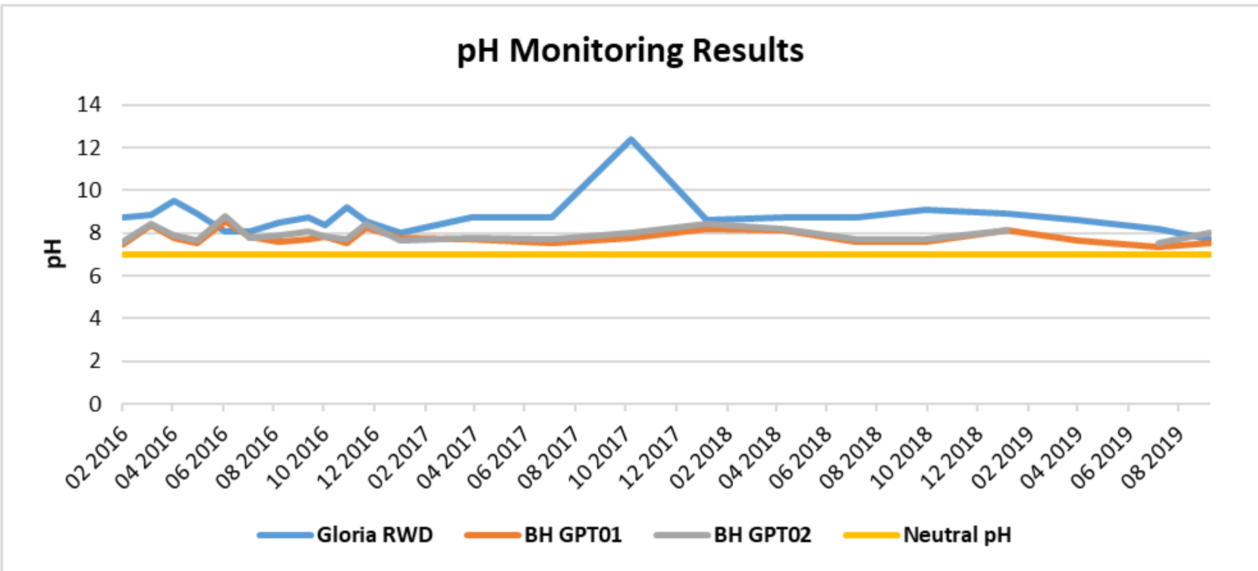


Figure 6-9: pH Monitoring Results, Gloria Boreholes and RWD

6.3 GROUNDWATER IMPACT ASSESSMENT

GPT undertook a risk-based assessment, specifically to inform liner requirements for the proposed expansion of the Gloria Tailings Storage Facility (GPT 2020). The risk assessment approach aims to describe and define the relationship between the cause (source) and the effect on the receptor, through the groundwater pathway.

The scope of the assessment, aimed to inform the design process for the SFSF, included:

- Potential groundwater impacts from the SFSF;
- Unsaturated and saturated flow below the SFSF;
- Monitoring network for the SFSF;
- Determine the rate of movement of the groundwater pollution plumes from the SFSF;
- Predict long term groundwater pollution plume positions, using calculated contaminant loads that may be released by the SFSF;
- Determine the seepage to the potentially affected groundwater resources & rivers/streams in the area.

The planned SFSF was modelled as if it would not be lined, thereby presenting a worst-case scenario. Two potential SFSF positions were modelled: the preferred position, and the alternative position. From the modelling results, it was concluded that the preferred option would likely have the least potential impact on possible receptors, due it being further away from the Gamagara River. In both of the modelled locations, the depth to water level limits the risk to groundwater, in an event where a leakage would occur.

A source-pathway-receptor approach was used. The groundwater risk assessment methodology is based on defining and understanding the three basic components of the risk, namely:

- o The source of the risk (source term);
- o The pathway along which the risk propagates; and,
- o Finally, the target that experiences the risk (receptor).

The risk assessment approach is therefore aimed at describing and defining the relationship between cause and effect. In the absence of any one of the three components, it is possible to conclude that groundwater risk does not exist (Framework for the Management of Contaminated Land, May 2010).

The specialist concludes that from a hydrogeological perspective and based on the available information supplied by the client, it is recommended that the proposed preferred SFSF is authorised on condition that the lining requirements as set out in the waste classification (based on leach results[1]) are met, and that the proposed groundwater monitoring is conducted and reported as described in the DWAF Best Practice Guidelines A2: Water Management for Mine Residue Deposits. Further recommendations were made by the specialist which should be incorporated into the Environmental Management Programme and integrated water and waste management plan unless stipulated otherwise in the site's Water Use Licence.

[1] The classification referenced in the assessment (GPT 2020) is based on leach results for the fines.

6.4 SURFACE WATER RISKS

As noted previously, BRMO is in a region with a significantly negative climatic water balance. The site is generally very flat, with highly permeable Kalahari sand to depths of several tens of metres below ground level, and there is no evidence of surface water flow.

Existing tailings facilities have, and the proposed facility is designed with, paddocks in place to contain overflow, should it occur. The SFSF has been designed to cater for a 1 in 100 year storm event (116 mm in 24h), and thus, overflow is highly unlikely. A minimum freeboard to accommodate the 1 in 50-year (102 mm in 24h), storm volume, plus 0.8 m dry freeboard on top of the normal operating level (excluding decant return), has been incorporated into the design of the SFSF and return water dam.

In the unlikely event of failure of the facility, i.e. contents of the SFSF materials' outflow, it is not expected that material would reach the Gamagara River, due to the distance from the preferred location to the river. A dam failure risk assessment was undertaken, for the purposes of dam safety classification, by the appointed geotechnical design team, which shows that the anticipated zone of influence.

This classification defines the potential consequences of a failure of the storage facility. It is important to note that a storage facility that may be classified as having a "high" hazard rating may not have an associated "high" risk. The risks (or the likelihood of adverse impacts – that is, probability of occurrence x consequence of occurrence) can be reduced and minimised through the implementation of risk management techniques.

The Code of Practice for Mine Residue (SANS 10286) is utilised, for classification purposes. SANS 10286 calls for a safety classification, to differentiate between residue deposits of high, medium, and low hazard rating, based on their potential to cause harm to life or property within the zone of influence. The classification should be based on the anticipated configuration of the storage facility at the end of its design life.

The zone of influence is presented in Figure 6-10 below. The hazard rating for the SFSF can be summarised as follows:

- Number of residents in zone of influence: Low
- Number of workers in zone of influence: High
- Value of third-party property in zone of influence: Low
- Depth to underground mine workings: Low

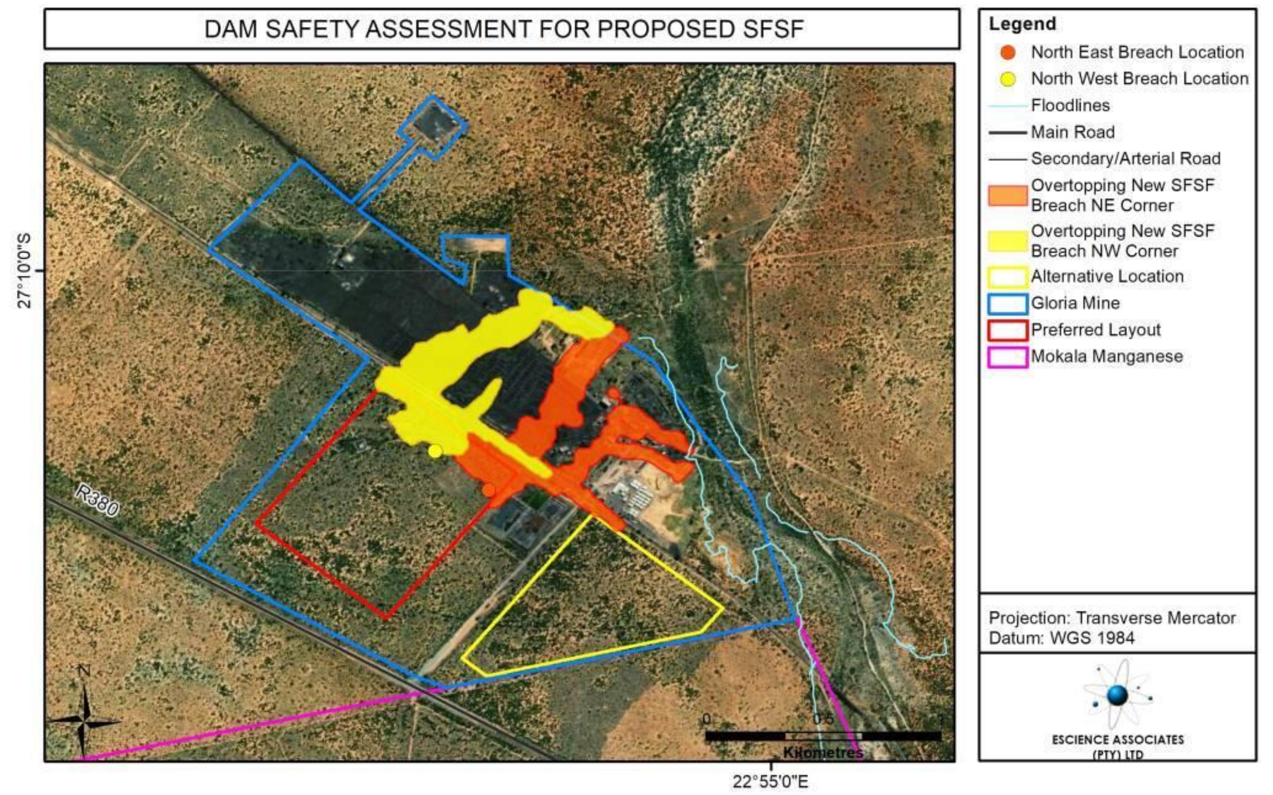


Figure 6-10: Zone of Influence

The potential for dam failure is mitigated through the design of the facility by a competent, registered engineer. The design engineer reports that the following national and international regulations and standards have been considered during the design:

- Code of Practice, Mine Residue, SANS 10286: 1998;
- Guidelines for the Compilation of a Mandatory Code of Practice on Mine Residue Deposits - Ref. No. DME 16/3/2/5-A1, 30 November 2000, Department of Minerals and Energy, Republic of South Africa;
- DWS, 2007, Best Practice Guideline A2: Water Management for Mine Residue Deposits;
- Government Notice R 632 (Government Gazette No. 10473, 24/07/2015 and as Amended GN990/2018 - 21 September 2018), pertaining to the National Environmental Management Waste Act (Act No. 59 of 2008) by the Department of Environmental Affairs, Regulations Regarding the Planning and Management of Residue Stockpiles and Residue Deposits from a Prospecting, Mining, Exploration, or Production Operation;
- DWS, 1999, Government Notice 704, Regulations on Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources, Department of Water Affairs and Forestry, South Africa;
- Water Act 1956 (Act 54 of 1956), Regulation 9C - Dam Safety;
- Middleton, B.J. and Bailey, A.K., Water Resources of South Africa, 2005 study (WR2005), 2009. WRC Report No. TT 382/08;
- Adamson, P.T., Southern African Storm Rainfall, Department of Environment Affairs, Technical Report TR102, Pretoria, 1981;
- Midgley, D.C., Pitman, W.V., Middleton, B.J., Surface Water Resources of South Africa, 1990. WRC Report No. 298/2.1/94, Volume 2;
- Guidelines on the Safe Design and Operating Standards for Residue Storage - Department of Minerals and Energy (DME), Western Australia;

- Guidelines on the Development of an Operating Manual for Residue Storage - Department of Minerals and Energy (DME), Western Australia;
- A Guide to the Management of Residue Facilities - The Mining Association of Canada (MAC) - A Guide, released in September 1998 by the MAC, to encourage mining companies to practice safe and environmentally responsible management of residue facilities through the development of customised, site-specific management systems;
- ICOLD Bulletin 139, Improving Tailings Dam Safety, 2011;
- Guidelines on the Safe Design and Operating Standards for Residue Storage - Department of Minerals and Energy (DME), Western Australia;
- Guidelines on the Development of an Operating Manual for Residue Storage - Department of Minerals and Energy (DME), Western Australia;
- A Guide to the Management of Residue Facilities - The Mining Association of Canada (MAC) - A Guide, released in September 1998 by the MAC, to encourage mining companies to practise safe and environmentally responsible management of residue facilities through the development of customised, site-specific management systems.

All rainfall that falls inside the facility will be contained, and become part of the process water reticulation circuit. Water falling outside the facility will not be contaminated, as it will not come into contact with the super fines or the process water.

6.5 OTHER ENVIRONMENTAL CONSIDERATIONS

It is notable that numerous other environmental impact considerations apply to the locating and design of the SFSF. These include, for example, impact on biodiversity, air quality, heritage resources, noise, and several more. These have not been elaborated on here, as they are addressed in the Environmental Impact Report, developed for the application for Environmental Authorisation and Water Use Licensing. These impacts are also of limited, if any, relevance to the liner.

6.6 ASSUMPTIONS AND LIMITATIONS

The SFSF has been designed by a registered, professional engineer, with due cognisance of the requirements of the NEMWA Regulations Regarding The Planning And Management Of Residue Stockpiles And Residue Deposits.

Physical aspects of the proposed SFSF, such as the dimensions, physical stability (e.g. side slope stability), safety risk, pool control, geotechnical aspects of the site. et cetera, of the SFSF have been considered in the SFSF design by the appointed professional design engineer.

Accordingly, the detailed design, and other aspects, are not reviewed within this assessment, as it is considered that they are adequately addressed by the appointment of a competent engineer, as required by the regulations.

7 CONCLUSIONS AND RECOMMENDATIONS

In respect of lining for the proposed Gloria tailings facility, it is recommended that an equivalent Class C liner be approved, in cognisance of the risks assessed, in particular:

- The findings of the groundwater specialist's assessments and their recommendations.
- The findings of the waste type analysis.
- The leach results for tailings.
- Existing monitoring results for the site, which span over seven years.
- The climatic water balance, and the absence of evidence of surface water flow.

It is notable that, with exception of total manganese concentration in the fines, a Class C liner would be applicable, in terms of the NEMWA National Norms and Standards for Disposal of Waste to Landfill, gazetted in GN 636 of 2013, as informed by the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GN 635 of 2013). It is, however, also notable that the manganese is not mobile, as evidenced in the leach tests, as well as the composition of carrier water currently in use for hydraulic transport of the fines to the current TSF. There is no evidence of significant manganese concentrations in the borehole monitoring data either, that can be attributed to leaching from existing tailings facilities at BRMO which are not lined and have been in existence for over 20 years.

It is also notable that, per the site's Water Use Licence:

- Condition 11.5 of Appendix IV of the existing WUL requires "*All authorised future expansion works must be lined in accordance with a Class C barrier system from Regulation 636 of National Environmental Management: Waste Act. Act No. 59 of 2008 or equivalent as a concrete structure above ground compliant with BS 8007 for retaining structures.*"

The recommendations and management measures as detailed in the groundwater assessment (GPT, 2020) should be implemented unless otherwise stipulated by the site's Water Use Licence.

8 DECLARATION

EScience Associates (Pty) Ltd, as the specialist, led by Abdul Ebrahim, hereby affirms that:

- The information herein is true and correct to the best of our knowledge.
- We have acted as independent specialists and declare that we do not have any interest, be it business, financial, personal, or other, in any proposed activity, application, or appeal, in respect of this application, other than fair remuneration for work performed, specifically in connection with the Environmental Impact Assessment.
- We further declare that we are confident in the results of the studies undertaken, and conclusions drawn as a result.

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NAME OF SPECIALIST

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SIGNATURE DATE

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