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Burnstone Gold Mine Integrated Water Use License Application (IWULA) and Integrated Water and Waste Management Plan (IWWMP)

Report

Version – Draft for Public Review

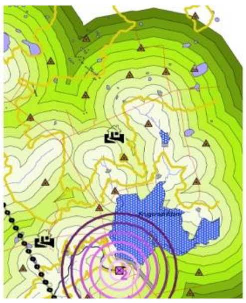
28 March 2019

Sibanye-Stillwater

GCS Project Number: 17-0916

Client Reference: 4900174880

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Title	Burnstone Gold Mine Integrated Water Use License Application (IWULA) and Integrated Water and Waste Management Plan (IWWMP)		
	Name	**Signature**	**Date**
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Document Reviewer	Kate Cain	[signature]	28 March 2019
Director	Jacques Harris	[signature]	28 March 2019

EXECUTIVE SUMMARY

Background:

Sibanye Gold Limited (trading as Sibanye-Stillwater, hereafter Sibanye) owns the previously mined Burnstone Gold Mine (Burnstone). Burnstone is located 6km east of Balfour, at latitude 26°39'15''S and longitude 28°39'56"E, in the Mpumalanga Province of South Africa. Balfour is located in the heart of the world-renowned coalfields and goldfield belts. This modern and predominantly industrial town is located in close proximity (80km) to the nationally well-known industrial areas of Johannesburg. The mining area is located in the Dipaleseng Local Municipality, which forms part of the Gert Sibande District Municipality.

The western boundary of the Burnstone Mining Right Area (MRA) is directly east of the town Balfour, from where it extends eastwards for a distance of approximately 17km. The site is accessed via the R23 from Balfour to Standerton, as well as a network of unpaved secondary roads. The mine was previously operated by Great Basin Gold (GBG) Limited through its wholly owned subsidiary, South Gold Exploration (Pty) Limited (SGEO) until 2012 when it filed for bankruptcy under South Africa's business rescue procedures. The mine has been operating under the banner of Sibanye Gold Limited (trading as Sibanye-Stillwater) on care and maintenance since 2014. Sibanye is currently in the process of developing the gold mine to be able to commence with production in 2019. .

Licensing of Water Uses:

In terms of the requirements of the National Water Act, 1998 (Act No. 36 of 1998) (NWA), Burnstone (under Southgold Exploration Pty Ltd) was issued with a Water Use Licence (WUL) (Licence No. **27/2/2C221/103/9**) dated the 23rd July 2010 by the Department of Water and Sanitation (DWS). The WUL was issued in compliance with Chapter 4 of the NWA. The following water uses have been authorised as part of the Integrated WUL issued under Section 21 of the NWA:

- Section 21(a) – 'Taking water from a water resource;
- Section 21(e) – 'Engaging in a controlled activity identified as such in section 37 (1) or declared under section 38 (1);
- Section 21(g) – 'Disposing of waste in a manner which may detrimentally impact on a water resource; and
- Section 21(j) – 'Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

As a result of Sibanye proposing to commence with mining at Burnstone, additional water uses have been identified that require authorisation in terms of Section 21 of the NWA. The following additional water uses are required to be licenced for the Burnstone Gold Mine:

- Section 21(a) – 'Taking water from a water resource;
- Section 21(c) – 'Impeding or diverting the flow of water in a watercourse;
- Section 21(f) – 'Discharging waste or water containing waste into water resource through a pipe, canal, sewer, sea outfall or other conduit;
- Section 21(g) – 'Disposing of waste in a manner which may detrimentally impact on a water resource; and
- Section 21(i) – 'Altering the bed, banks, course or characteristics of a watercourse.

In addition to the further water uses identified, amendments to the licensed water uses are also required. GCS Water and Environment (Pty) Ltd (GCS) were requested by Sibanye to compile the Integrated Water Use License Application (IWULA) for submission to the DWS in order to apply for authorisation of the water use activities applicable to the Burnstone mine.

This report serves as the technical document to authorise all water uses triggered at Burnstone. This document has been compiled in the format of an Integrated Water and Waste Management Plan (IWWMP) in line with the requirements of the DWS operational Guideline dated 2010. This document includes the operations being undertaken at the Burnstone gold mine. The main purpose of this report is to consolidate all the various site specific activities such as water balances, storm water management, water reuse, water conservation, waste minimization and recycling into a simple implementable management plan.

Information		Included? (Yes/No)	Relevant section of IWWMP Report
Evaluate to determine if the following aspects are addressed in the FINAL / BRIEF APPLICATION (IWWMP) REPORT:			
Introduction			
1.1	Activity Background	Yes	1.1
1.2	Contact Detail	Yes	1.2
1.3	Regional setting and location of activity	Yes	1.3
1.4	Property description	Yes	1.4
1.5	Purpose of IWWMP	Yes	1.5
Conceptualisation of activity			
2.1	Description of activity	Yes	2.1
2.2	Extent of activity	Yes	2.2
2.3	Key activity related processes and products	Yes	2.3
2.4	Activity life description	Yes	2.4
2.5	Activity infrastructure description	Yes	2.5
2.6	Key water uses and waste streams	Yes	2.6
2.7	Organisational structure of activity	Yes	2.7
2.8	Business and corporate policies	Yes	2.8
Regulatory water and waste management framework			
3.1	Summary of all water uses	Yes	3.1
3.2	Existing lawful water uses	Yes	3.2
3.3	Relevant exemptions	Yes	3.3
3.4	Generally authorized water uses	Yes	3.4
3.5	New water uses to be licensed	Yes	3.5
3.6	Waste management activities (NEMWA)	Yes	3.6
3.7	Waste related authorizations	Yes	3.7
3.8	Other authorizations (EIAs, EMPs, RODs, Regulations)	Yes	3.8
Present Environmental Situation			
4.1	Climate	Yes	4.1
4.1.1	Regional Climate	Yes	4.1.1

Information		Included? (Yes/No)	Relevant section of IWWMP Report
4.1.2	Rainfall	Yes	4.1.2
4.1.3	Evaporation	Yes	4.1.3
4.2	Surface Water	Yes	4.2
4.2.1	Water Management Area	Yes	4.2.1
4.2.2	Surface Water Hydrology	Yes	4.2.2
4.2.3	Surface Water Quality	Yes	4.2.3
4.2.4	Mean Annual Runoff (MAR)	Yes	4.2.4
4.2.5	Resource Class and River Health	Yes	4.2.5
4.2.6	Receiving Water Quality Objectives and Reserve	Yes	4.2.6
4.2.7	Surface Water User Survey	Yes	4.2.7
4.2.8	Sensitive Areas Survey	Yes	4.2.8
4.3	Groundwater	Yes	4.3
4.3.1	Aquifer Characterisation	Yes	4.3.1
4.3.2	Groundwater Quality	Yes	4.3.3
4.3.3	Hydro-census	Yes	4.3.4
4.3.4	Potential Pollution Source Identification	Yes	4.3.5
4.3.5	Groundwater Model	Yes	4.3.6
4.4	Socio-economic environment	Yes	4.4
Analyses and characterisation of activity			
5.1	Site delineation for characterisation	Yes	5.1
5.2	Water and waste management	Yes	5.2
5.2.1	Process water	Yes	5.2.1
5.2.2	Storm water	Yes	5.2.2
5.2.3	Groundwater	Yes	5.2.3
5.2.4	Waste	Yes	5.2.4
5.3	Operational Management	Yes	5.3
5.3.1	Organisational structure	Yes	5.3.1
5.3.2	Resources and competence	Yes	5.3.2

Information	Included? (Yes/No)	Relevant section of IWWMP Report
5.3.3 Education and training	Yes	5.3.3
5.3.4 Internal and external communication	Yes	5.3.4
5.3.5 Awareness raising	Yes	5.3.5
5.4 Monitoring and control	Yes	5.4
5.4.1 Surface water monitoring	Yes	5.4.1
5.4.2 Groundwater monitoring	Yes	5.4.2
5.4.3 Bio monitoring	Yes	5.4.3
5.4.4 Waste monitoring	Yes	5.4.4
5.5 Risk assessment / Best Practice Assessment	Yes	5.5
5.6 Issues and responses from public consultation process	Yes	5.6
5.7 Matters requiring attention / problem statement	Yes	5.7
5.8 Assessment of level and confidence of information	Yes	5.8
Water and waste management		
6.1 Water and waste management philosophy (process water, storm water, groundwater, waste)	Yes	6.1
6.2 Strategies (process water, storm water, groundwater and waste)	Yes	6.2
6.3 Performance objectives / goals	Yes	6.3
6.4 Measures to achieve and sustain performance objectives	Yes	6.4
6.5 Option analyses and motivation for implementation of preferred options (Optional)	Yes	6.5
6.6 IWWMP action plan	Yes	6.6
6.7 Control and monitoring	Yes	6.7
6.7.1 Monitoring of change in baseline (environment) information (surface water, groundwater and bio-monitoring)	Yes	6.7.1
6.7.2 Audit and report on performance measures	Yes	6.7.2
6.7.3 Audit and report on relevance of IWWMP action plan	Yes	6.7.3
Conclusion		
7.1 Regulatory status of activity	Yes	7.1
7.2 Statement on water uses requiring authorization, dispensing with licensing requirement and possible exemption from regulations	Yes	7.2
7.3 Section 27 motivation	Yes	7.4

Information		Included? (Yes/No)	Relevant section of IWWMP Report
7.4	Proposed licence conditions	Yes	7.5
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1 INTRODUCTION

1.1 Activity Background

Burnstone Gold Mine (Burnstone), a division of Sibanye Gold Limited (trading as Sibanye-Stillwater, hereafter Sibanye) and is located to the east of Balfour in Siyathemba, Mpumalanga Province. Geologically, Burnstone is located in the South Rand Basin, a subsidiary of the Witwatersrand Basin. The mine was previously operated by Great Basin Gold (GBG) Limited through its wholly owned subsidiary, South Gold Exploration (Pty) Limited (SGEO) until 2012 when it filed for bankruptcy under South Africa's business rescue procedures. The mine has been operating under the banner of Sibanye Gold Limited (trading as Sibanye-Stillwater) on care and maintenance since 2014. Sibanye is currently in the process of developing the gold mine to be able to commence with production in the near future.

The Burnstone Operations have a New Order Mining Right (MR) [Ref. No. MP30/5/1/2/2/(248)MR], valid from 17 February 2009 to 16 February 2027 in respect of an area totalling 13 136 ha, located in the Dipaleseng District Municipality in the Mpumalanga Province of South Africa. The Burnstone area also includes Prospecting Rights (PRs), with renewal periods of 3 years, granted by the Department of Mineral Resources (DMR) [Ref. No. MP30/1/1/2/(1030)PR; MP30/1/1/2/(1059)PR; MP30/5/1/1/2/(1065)PR; MP30/1/1/2/(1218)PR; MP30/5/1/1/2(1107)PR; MP30/1/1/2(703)PR; MP5/2/2/(22)PR; MP30/5/1/1/2/(1469)PR; MP30/5/1/1/2(1038)PR and MP30/5/1/1/2(1101)PR].

In terms of the Water Use Authorisation, Burnstone (under Southgold Exploration Pty Ltd) holds a Water Use Licence (Licence No. **27/2/2C221/103/9**) granted on the 23rd of July 2010 by the Department of Water and Sanitation (DWS) in terms of chapter 4 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA), The following water uses have been authorised:

- Section 21(a) – Taking water from a water resource;
- Section 21(e) – Engaging in a controlled activity identified as such in section 37 (1) or declared under section 38 (1);
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource; and
- Section 21(j) – Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

On 5th July 2013, Wits Gold informed its shareholders that it had submitted a final binding offer to the business rescue practitioner of SGEO, the sole owner of Burnstone. The offer was included in the business rescue plan that was approved by the creditors of SGEO on 11 July 2013. All the outstanding conditions precedent were met on 1 July 2014, and Sibanye, through the acquisition of Wits Gold, took 100% control of Burnstone from that date, also the date on which SGEO came out of business rescue. Sibanye acquired all of the shares of SGEO together with shareholders and inter-group loans against SGEO for a purchase consideration of approximately $7.5 million.

The decision to acquire Burnstone presents an attractive opportunity for Sibanye from a strategic and operational perspective in terms of the purchase of existing infrastructure, underground access, metallurgical plant and favourable debt funding terms. In addition, the acquisition would contribute positively to free cash flow and enhance Sibanye's long-term value, consistent with Sibanye's strategy of extending the operating life of the company in support of their dividend yield strategy.

The gold bearing reef on the Burnstone property is the Kimberley Reef which occurs at depths between 250 – 1 000 m below surface. Gold in the Kimberly Reef will be mined underground by conventional, mechanised and hybrid narrow vein techniques. The main surface infrastructure, which is located in the already established Area 1, includes a Tailings Storage Facility (TSF), Waste Rock Dump (WRD), processing plant, shaft infrastructure, sewage treatment plant, and administration buildings.

1.2 Contact Details

Sibanye is the applicant for this Integrated Water Use License Application (IWULA). Refer to Table 1.1 for the contact details of the applicant as well as the details of the consultant compiling this application.

Table 1.1: Contact Details

Applicant	
Company Name	Sibanye-Stillwater
Telephone Number	011 278 9770
Contact Person	Alfonzo Le Roux
Contact Person Mobile Number	082 803 5082
Email Address	Alfonzo.LeRoux@sibanyestillwater.com
Postal Address	P.O. Box 190 Westonaria 1780
Physical Address	Libanon Business Park, 1 Hospital street (off Cedar avenue), Libanon, Westonaria, 1780
Environmental Consultant	
Company Name	GCS Water and Environment (Pty) Ltd

Telephone Number	011 803 5726
Contact Person	Kate Cain
Email Address	kate@gcs-sa.biz
Postal Address	PO Box 2597 Rivonia 2128
Physical Address	63 Wessel Road Rivonia 2128

1.3 Regional Setting and Location of Activity

1.3.1 Regional Setting

Sibanye owns the previously mined Burnstone Gold Mine (Burnstone). Burnstone is located 6km east of Balfour, at latitude 26°39'15''S and longitude 28°39'56"E, in the Mpumalanga Province of South Africa. Balfour is located in the heart of the world-renowned coalfields and goldfield belts. This modern and predominantly industrial town is located in close proximity (80km) to the nationally well-known industrial areas of Johannesburg. The mining area is located in the Dipaleseng Local Municipality which forms part of the Gert Sibande District Municipality.

Other close-by towns include:

- Nigel – 36 km north-west of the proposed mine on Route 51;
- Devon - 40 km north of the proposed mine on Route 548;
- Heidelberg –30 km north-west of the proposed mine on Route 23; and
- Greylingstad –19 km south-east of the proposed mine on Route 23.

1.3.2 Magisterial District and Local Municipality

The mining right area falls within the Dipaleseng Local Municipality, which is situated in the southern part of the Gert Sibande District Municipality (Figure 1.1).

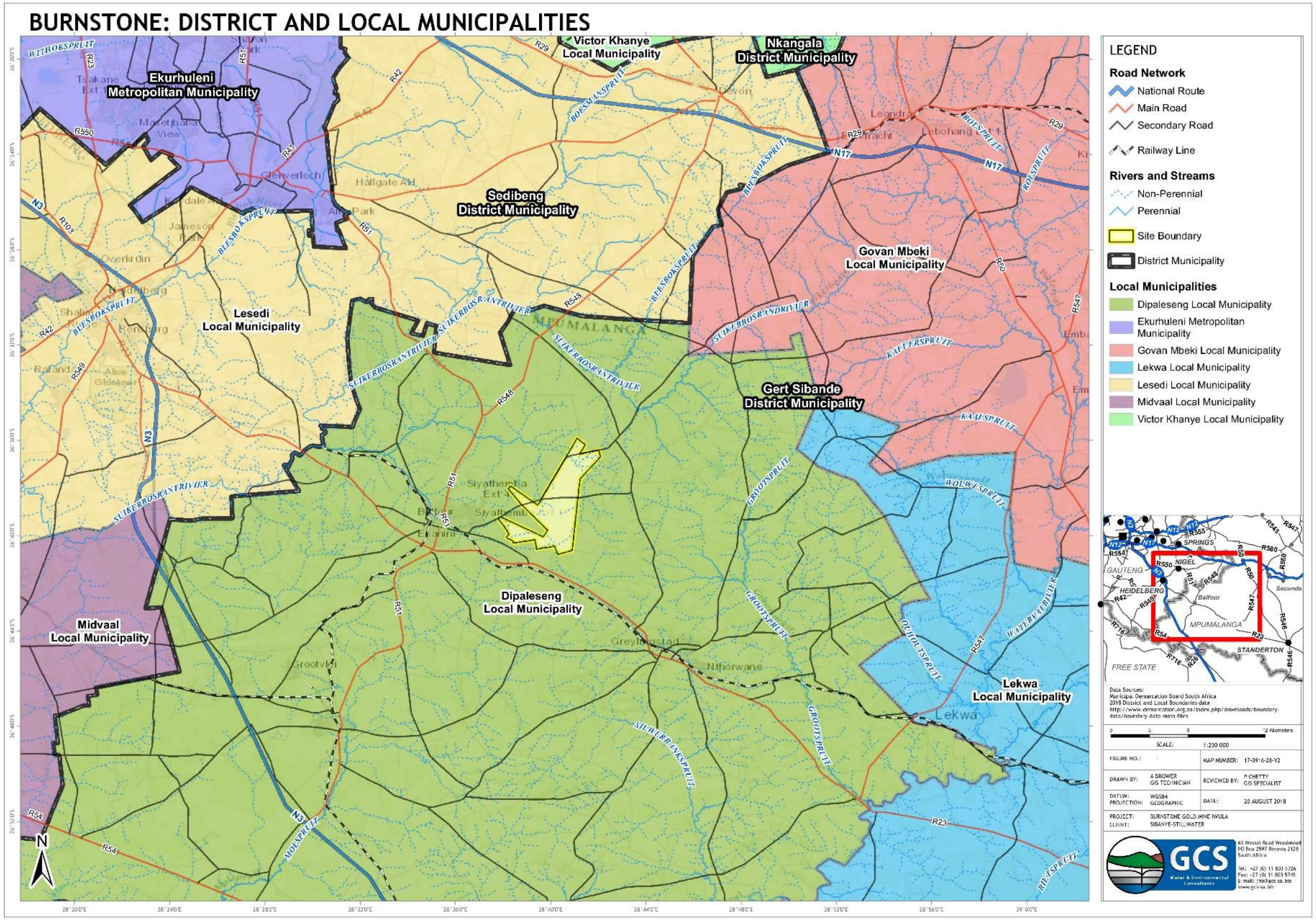


Figure 1.1: Burnstone locality

1.4 Property Description

The Burnstone mine is located on portions on farm Vlakfontein and Brakfontein (Refer to Table 1.2 and Figure 1.2 for details relating to these farm portions).

Table 1.2: Property Details

Parent Farm	Portion	Area (Ha)	Title Deed
Brakfontein 513 IR	RE 2/513	234.8682	T131162/2007
Vlakfontein 556 IR	7/556	51.8373	T131162/2007
Brakfontein 513 IR	8/513	215.749	T131162/2007
Brakfontein 513 IR	RE 10/513	171.3064	T141272/2006
Brakfontein 513 IR	11/513	271.1226	T141272/2006
Brakfontein 513 IR	15/513	10.3556	T155902/2006
Brakfontein 513 IR	13/513	256.9596	T139277/2006
Brakfontein 513 IR	RE/513	311.8654	T162692/2006
Vlakfontein 556 IR	RE 4/556	83.9587	T119315/2006
Vlakfontein 556 IR	11/556	54.2913	T131162/2007
Vlakfontein 556 IR	15/556	256.9596	T119315/2006
Vlakfontein 556 IR	30/556	353.9729	T119315/2006
	Total area:	2273.2466	

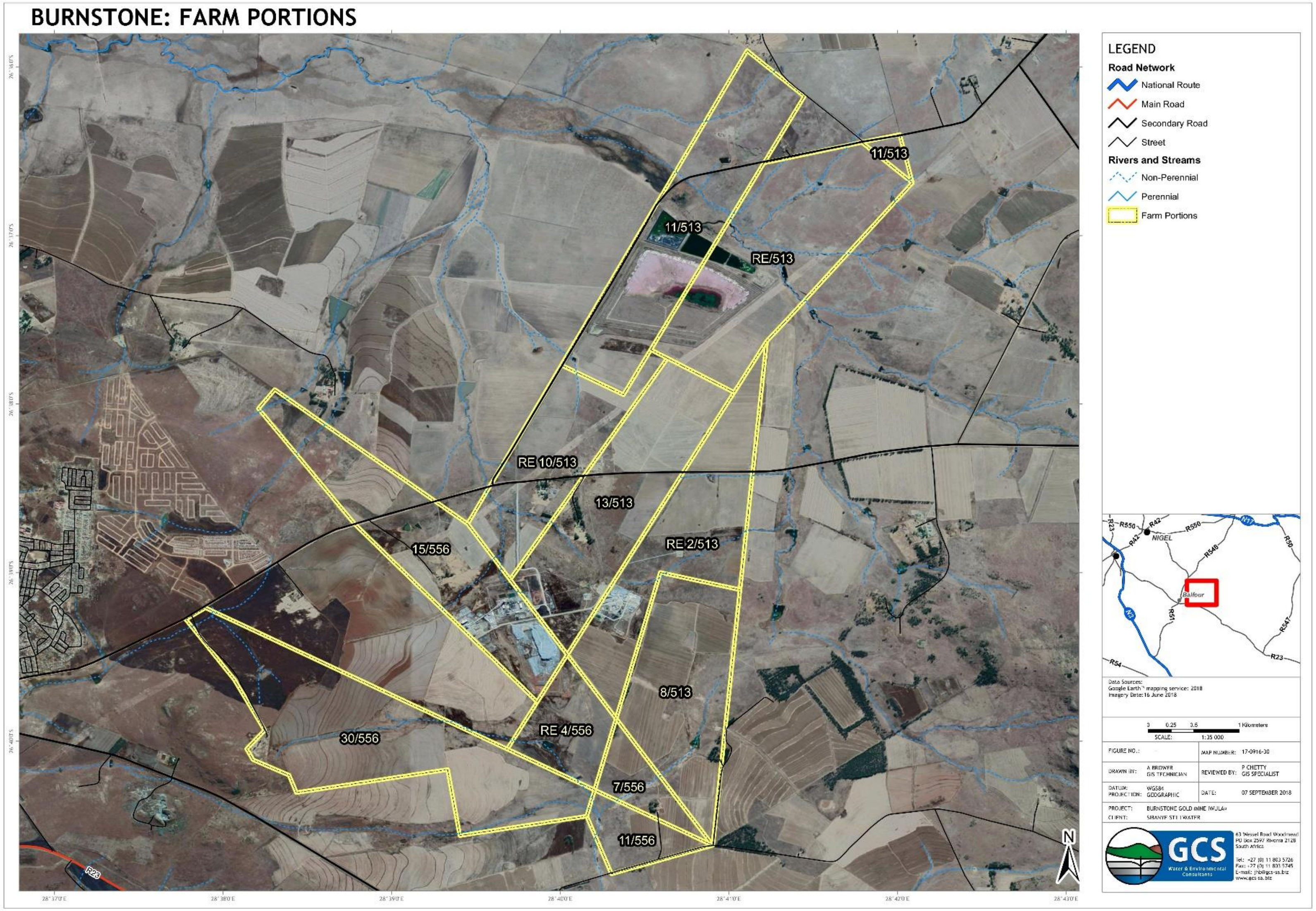


Figure 1.2: Burnstone farm portions

1.5 Purpose of the IWWMP

This document serves as the technical report to motivate the authorisation of the water uses triggered by the proposed Burnstone operation.

As there are waste related uses associated with the proposed development, this report has been structured in line with the approved Integrated Water and Waste Management Plan (IWWMP) Operational Guideline compiled by the DWS.

The purpose of the IWWMP includes:

- Compilation of a site specific, implementable, management plan addressing all the identified water use and waste management relates aspects of a specific activity, in order to meet set goals and objectives in accordance with Integrated Water Resource Management (IWRM) principles;
- Provision of a management plan to guide the water user regarding the water and waste related measures which should be implemented on site in a progressive, structured manner in the short, medium and long term;
- Documentation of all the relevant information, as specified in the IWWMP Guideline as compiled by the DWS, to enable DWS to make a decision regarding the authorisation of a water use;
- Clarification of the content of the IWWMP for DWS officials and the water users, as the various regional offices of DWS might have different interpretations regarding the contents of the IWWMP;
- Standardisation of the format of supporting documentation which DWS requires during the submission of an IWULA;
- Provision of guidance on the content of information required in an IWWMP as part of the water use authorisation process and level of detail that DWS requires to enable them to evaluate the supporting documentation to make a decision on authorising a water use; and;
- Ensuring that a consistent approach is adopted by DWS and the various Regional Offices and Catchment Management Agencies (CMA) with regards to IWWMPs.

The IWWMP also strives to show the DWS that the selected management measures included into the IWWMPs action plan adhere to the SMART concept which refers to:

- S – Sustainable;
- M – Measureable;
- A – Achievable;
- R – Resources Allocated; and
- T – Timeframe Specific.

2 CONCEPTUALISATION OF THE ACTIVITY

2.1 Description of the Activity

Sibanye propose to re-commence with mining at the Burnstone Gold mine and is currently developing the infrastructure to be able to do so. The gold bearing reef on the Burnstone property is the Kimberley Reef which occurs at depths between 250 – 1 000m below surface. Gold in the Kimberly Reef will be mined underground by conventional, mechanised and hybrid narrow vein techniques.

The main surface infrastructure, which is located in the already established (Area 1), includes a Tailings Storage Facility (TSF), Waste Rock Dump (WRD), processing plant, shaft infrastructure, sewage treatment plant, and administration buildings. The ore will be processed using the conventional carbon in leach process.

The proposed expansion (Area 2) will consist of four additional mining blocks to be extracted from underground and the storage dam that will have a minimum capacity of 400 000 m^3 (Knight Piésold, 2011). The only new surface infrastructure proposed for the expansion project is the bulk water storage dam, a decline shaft, and two vent raises. The preferred storage dam alternative is located on the approved TSF footprint. It is proposed to alter the design of the approved TSF to incorporate the bulk water storage dam (BWD). This TSF/BWD is situated on land already owned by Sibanye. The access shaft will also be located on a property owned by Sibanye. The two vent raises will be located on the farms Dagbreek 551 and Rustfontein 548 respectively. These farms are not owned by Sibanye.

Area 1 and Area 2 will be accessed by separate primary infrastructure and will not be linked via the underground workings. The Area 2 Portal will contain the access for the double decline, ore and waste stockpiles and compressors, with a header tank for potable water and electric power facilities. No other facilities will be provided at the Area 2 Portal and all personnel and servicing will come from Area 1.

2.1.1 Mining Method

Burnstone will use a mechanised longhole stoping mining method. Mining is concentrated on the reef horizon to the nature of the ore body. Off-reef mining is done to access different mining blocks using High Profile (HP) ends (Knight Piésold, 2011). Twin HP ends are developed to blocks for the intake and return of ventilation.

On-reef development consists of HP ends, which are developed to accommodate HP equipment and Low Profile dilution for Low Profile (LP) equipment (Knight Piésold, 2011). Mining in the reef horizon will be by the conventional breast mining method and this allows the dilution of gold to be minimised. Supporting footwall infrastructure is planned to be trackless, due to the complicated structural geology and the nature and grade distribution of the deposit (Knight Piésold, 2011).

The cost per ounce of gold produced is minimised by using conventional hand held stoping methods. The narrow width of the mineralised channel, and the dips of this ore body, make it particularly difficult to mine using mechanised methods (Knight Piésold, 2011). This type of Witwatersrand deposit is ideally suited to hand held drilling and conventional narrow reef mining as practiced on many gold and platinum mines in Southern Africa. The primary and footwall infrastructure layout is such that a change to hybrid or mechanised mining at a later stage can easily be accommodated (Knight Piésold, 2011).

The expected mining depths range between 200m and 850m and hence all mining will take place in a shallow mining environment. Access to the mine will be via a conventional sunk, lined and equipped vertical shaft and a decline developed from surface (Knight Piésold, 2011).

2.1.1.1 On-reef Excavations

Stoping will be conventional breast mining with panel lengths being 30m, and the design stoping width will be 60cm (Knight Piésold, 2011). An allowance was made for 10cm of unplanned dilution resulting in an actual stoping width of 70cm. Where the channel width is greater than 60cm, the planned stoping width will be equal to the channel width plus 10cm of expected dilution (Knight Piésold, 2011).

The dip or back lengths between stope access points will be 192m in the plane of the reef. The vertical back length will depend on the dip in the particular area. The back length of 192m allows for six sets of panels of 30m in each stope and for strike pillars of 2m width between panels (Knight Piésold, 2011). The strike distance between raise lines will be set to allow for the required regional pillar between stopes, taking into consideration a maximum strike length of 75m for each panel.

2.1.1.2 Stope Access Development

All rock produced from a stope will be cleaned down dip to one ore pass sited in the raise. Each ore pass will service a group of 12 panels, that is, six panels either side of the raise (Knight Piésold, 2011). Ore passes will be developed at 2.5m by 2.5m and will have a minimum length of 30m. This cross-section will provide a large enough capacity in the ore pass to cater for the production from 12 mining panels (Knight Piésold, 2011).

Access to the reef horizon will be via travelling ways developed from the cross cut in the footwall infrastructure. Travelling ways will be developed at 34 degrees and will be 3m wide and 2.5m high (Knight Piésold, 2011). On completion of the development, the excavation will be equipped with a mono-winch for materials transport and a ladder way for man travelling. Services for the mining operations will also be carried in this excavation.

2.1.1.3 Footwall Layouts

The location of the various mining blocks in both the vertical and lateral planes some 250m to 850m below surface dictated the employment of a trackless access system. The access to the underground workings is via a 4.5m x 4.5m decline from surface developed at 9° and is 2 600m in length to the tip level of the main rock hoisting shaft (Knight Piésold, 2011). Access to the mining blocks from the shaft is via 4.5m x 4.5 m access drives. Each production level in a mining block will be serviced by a 4.0m wide by 4.0m high footwall drive to be used as roadways for the transportation of men, material and rock and will also house the service reticulation and act as a conduit for ventilation air (Knight Piésold, 2011).

The footwall drives within a particular mining block will be connected by footwall ramps to be developed at a maximum inclination of 9° to the horizontal and are 5m wide by 5m high. The footwall ramps will form the main trucking route in the mining block connecting to the mining block access ramp. At each raise position along the footwall drive, two cross cuts will be developed, one in each direction. An ore pass will be developed from each cross cut to connect to the raise above, which forms the centre gully of the stope. A travelling way will be developed from the end of the cross cut, on the down dip side of the footwall drive, up to the raise position above.

2.1.1.4 Primary Access

A single decline system at an inclination of 8° and a vertical shaft to a depth of 495m is planned (Knight Piésold, 2011). The decline will be developed to the shaft bottom position and the vertical shaft will be raise bored. On commissioning, the vertical shaft will be used to hoist all broken rock to surface. The decline will be used as a service decline in which various utility vehicles will be used to transport men and materials. Additionally, it will be used to haul development rock to surface in the short term until the vertical shaft is commissioned.

Rock will be delivered to the shaft ore pass system by Articulated Dump Trucks (ADTs) operating in the mining blocks. The planned shaft of 7.5m in diameter is governed by ventilation requirements (Knight Piésold, 2011). The shaft will primarily be used for hoisting all blasted rock from underground to surface. Additionally, the shaft will act as a major intake airway for the mine as well as having the main service supplies installed through it. The shaft will be equipped with rope guides for rock hoisting and a small service hoist for emergency and maintenance purposes. Rock will be fed via conventional loading flasks into skips, which will be held in fixed guides at the loading and unloading positions. In the rest of the shaft, the skips will run on the rope guides described above (Knight Piésold, 2011). Skips will tip into the headgear bin from where the rock will be conveyed to a transfer tower for transfer to the ore stockpile conveyor, the waste dump conveyor or the emergency stockpile. The ramp to the bottom of the shaft will continue to be used for spillage removal by Load Haul Dump truck (LHD).

2.1.2 Mineral Processing

The mine will mine gold in underground workings and will process the ore using the Carbon-In- Leach Process (CIL). The gold will be processed in the following steps (Knight Piésold, 2007):

- 1. SAG milling of underground ore to 75 % -75µm;
- 2. Dense cyclone overflow (40 % solids);
- 3. Cyanidation in six tank carbon-in-leach circuit;
- 4. Gold adsorption onto activated carbon and stripping via Zadra elution;
- 5. Carbon regeneration in horizontal electric kiln;
- 6. Gold electrowinning and smelting;
- 7. Tailings thickening; and
- 8. Tailings disposal to conventional TSF.

2.2 Extent of the Activity

The IWWMP is developed to cover the project sites entire area of operations in order to manage all water and waste issues on site. The mining right area will be over a total area of 2 273.2466Ha.

2.3 Key Activity Related Processes and Products

After the ore is extracted underground, the plant will treat 125 000 tonnes per month of ore and will consist of the following process steps (Knight Piésold, 2007):

- Jaw crushing;
- SAG/Ball milling of underground ore to 80 % -75 µm;
- Dense cyclone overflow (40 % solids);

- Gravity separation of cyclone underflow material;
- Cyanidation in six tank carbon-in-leach circuit;
- Gold adsorption onto activated carbon and stripping via Zadra elution;
- Carbon regeneration in horizontal electric kiln;
- Gold electrowinning and smelting;
- Tailings thickening; and
- Tailings disposal to conventional TSF.

Ore Receiving

Underground ore at –200mm will be delivered onto a conveyor, which will in turn deposit the ore onto a 6 000 ton-covered stockpile (Knight Piésold, 2007). A combination of five vibrating feeders will then withdraw the ore from the stockpile onto the mill feed conveyor. Two of the feeders will always be operational. Hydrated lime will be fed via a rotary valve and screw feeder from the lime bin onto the mill feed conveyor. A mass meter will measure the mill feed tonnage. Stockpile drain and fine spillage will be pumped to the mill discharge sump by a sump pump located at the end of the reclaim tunnel. A ramp and tipping (reloading) bin will be provided on the stockpile feed conveyor, together with two more vibrating feeders.

Milling

Underground ore and lime will be fed to the closed circuit (Semi-Autogenous Grinding) SAG mill. Gravity scalping screen oversize, mill inlet (process) water and cyclone underflow slurry will also report to the mill inlet hopper. The mill will discharge onto a trommel screen and undersize flows will be diverted to a splitter box. Dilution water and Gravity Tails slurry will also report to the splitter box (Knight Piésold, 2007).

The splitter box will be equipped with two plug valves, allowing slurry to feed either of the two compartments of the mill sump. A single stage, variable speed, mill discharge pump will draw slurry from the active compartment of the sump and feed the cyclone cluster. A standby mill discharge pump will be installed.

There will be five cyclones in the cluster, two of which will be used to feed the gravity concentrator (one standby for maintenance), and three are intended for returning slurry back to mill for regrind. Fine solids will pass through the cyclone vortex finders at a solids concentration of 41%. Steel balls will be added to the mill using a ball kibble, which will then be hoisted to a chute to be located alongside the mill feed hopper. Oversize from the trommel will report to a bunker for removal by Bobcat or wheel loader (Knight Piésold, 2007).

A spillage pump in the mill bunded spillage area, at the discharge end of the mill, will pump spillage back to the mill sump. The spillage pump is to be situated in a drop out sump arrangement. Coarse solids will settle out and the spillage pump will return only excess water and slimes to the mill sump. Periodically, the Bobcat will be used to remove accumulated settled solids from the drop out sump. Gland service water will be provided at the mill pumps.

Gravity Circuit

The bleed stream, diverted to gravity concentration from the mill cyclone cluster underflow, will be passed over a vibrating scalping screen to remove coarse (+3mm) particles, which will gravitate back to the mill inlet chute. Spray water will be applied to the screen deck to improve screening. Screen underflow will gravitate to the centrifugal concentrator for recovery of the coarse free gold particles (Knight Piésold, 2007). Concentrator tails will gravitate to the mill discharge sump. The centrifugal concentrator will operate in batch mode, with a concentrate flushing cycle varying between 2 to 4 hours. Accumulated concentrate will then be discharged to the In-line Leach Reactor concentrate tank for batchwise intensive cyanidation. During concentrate discharge, the concentrator feed slurry will be by-passed back to the mill sump splitter box. The In-line Reactor will operate batch-wise to produce clarified pregnant liquor, which will then be pumped to a dedicated electrowinning cell in the gold room (Knight Piésold, 2007).

Carbon in Leach Processing

Mill cyclone overflow slurry will flow onto a linear trash screen for removal of natural and mining debris such as woodchips, cloth, plastic and wire. The trash screen underflow will gravitate through a slurry sampler and then into the first leach tank where cyanide solution is added. Tramp screen overflow will report to a grit-basket with a wedge-wire base where excess water is drained.

Slurry will overflow from the mechanically agitated leach tank and flow through five subsequent, mechanically agitated (Carbon-in leach) CIL tanks to enable maximum possible dissolution of gold as a cyanide complex and adsorption onto activated carbon. Planned slurry residence time in the six tanks is 24 hours (Knight Piésold, 2007). Cyanide solution will then be added from the reagent ring main to the CIL feed splitter box with the facility to add cyanide to the next two subsequent tanks, should it be required. Oxygen will be injected into the leach tank and alternate CIL tanks, to provide oxygen for acceleration of the cyanidation reaction. All the tanks will be equipped with two plug valves on the outlet. The normally open valve will pass slurry to the next tank downstream. The second valve will allow diversion of slurry to the subsequent tank downstream so that any tank may be by-passed, should the need arise. Baffles will be fitted to the inner walls of the tank to ensure efficient mixing. Tanks will also be fitted with manholes and drain valves (Knight Piésold, 2007).

The CIL area will be bunded to retain any overflow or spillage, and will be provided with a spillage pump. The pump will deliver spillage back to the feed splitter, as well as to the tailings screen. Elution effluent will also report to the spillage pump (Knight Piésold, 2007). Each CIL tank will be equipped with a Kemix MPS (P type) inter-stage screen mechanism, with a cylindrical, basket-type, stainless steel, wedge-wire screen surface. The mechanism drive will turn both wiper blades mounted on the outside of the basket and a pumping impeller inside the basket. The wiper blades keep the screen surface clear of carbon and allow slurry to flow through, while the coarser carbon will be retained in the tank (Knight Piésold, 2007).

Recessed-impeller pumps, located in each CIL tank, will be used for carbon transfer. Loaded carbon in the CIL slurry will be pumped from the first stage adsorption CIL tank onto the loaded carbon screen for removal of the slurry. The clean, loaded carbon will discharge from this screen into the elution plant.

Tailings

Tailings slurry from the last CIL tank will gravitate to the tailings vibrating screen for carbon recovery in the event of damage, wear or incorrect installation of the final stage inter-stage screen. Carbon recovered on the screen will report to a bulk bag for re-use (Knight Piésold, 2007). Tailings discharging from the tailings linear screen will gravitate, via a sampler, to the tailings thickener. Dilute flocculant will then be added to the thickener feed stream. The flocculated solids will settle in the thickener and will then be raked into the central cone, for withdrawal by one of two underflow pumps (Knight Piésold, 2007). Clear solution will then overflow the thickener into the process water tank. Tailings return water will also report to the process water tank.

Strong flocculant will be mixed in batches in the flocculant mixing tank, using dry powder flocculant and a water eductor. After sufficient hydration time, the strong flocculant will gravity flow to the flocculant dosing tank. Flocculant solution will be pumped to the thickener feed box and will be diluted in-line with raw water. The flocculant will increase the solids settling rate by causing particles of milled ore to bind together (Knight Piésold, 2007).

Acid Wash and Elution

Loaded carbon from CIL will be received in the acid wash tank. Once a batch has been accumulated, it will be washed with dilute hydrochloric acid (at 2-3% HCl) to remove scale prior to elution (Knight Piésold, 2007). On completion of acid washing, the acid washed carbon will be rinsed and then dropped into the elution column.

Periodically, when the dilute acid wash liquor is too contaminated to be reused, it will be neutralised with excess caustic soda and pumped to the tailings tank. The elution section will use a pressurised Zadra system. Loaded carbon will be eluted by pumping a hot caustic cyanide solution (eluant), typically 1,0 – 3,0% NaOH and 0,2 – 0,6% NaCN, through the column at 130°C under pressure (Knight Piésold, 2007). Gold adsorbed onto the loaded carbon will be eluted off the carbon and recovered in the eluate solution. The eluate will be passed through electrowinning cells to remove gold from the circulating eluate stream by electroplating onto stainless steel wool. Electrowinning tails will return to the eluant tank. The elution section will be housed in a fenced security area adjacent to the CIL circuit, while electrowinning will be housed in the gold room. The elution column and piping will be lagged to minimise heat losses. Spillage from the elution section will gravitate to the CIL bunded area.

Carbon Regeneration

Eluted carbon will be transferred hydraulically from the elution column to the eluted carbon tank. Carbon will be withdrawn from the eluted carbon tank by screw feeder, which discharges the carbon to an electrically heated rotary kiln for thermal regeneration. The kiln will operate in the range of 700-750°C (Knight Piésold, 2007). Regenerated carbon will be quenched in the quench pan and screened to remove fines, before gravitating to a transfer tank. When the transfer tank is full, the regenerated carbon will be hydraulically transferred to the last CIL tank. Regeneration spillage will gravitate to the CIL bund. Carbon fines passing through the quench screen deck will gravitate to the tails screen, where any fugitive coarse carbon can be recovered for reuse.

Gold Room

The three electrowinning cells will be located in the gold room for security. Two of the cells will receive pregnant eluate from Elution, while the third cell will receive loaded liquor from the In-line leach reactor. The electrowinning cells will be the stainless steel, sludging type. Loaded cathodes will be removed from the cells at regular intervals and washed with a high pressure gun to remove sludge. Excess water will be decanted and the moist sludge will be loaded onto the calcine oven trays and calcined overnight (up to 16 hours) ~800°C, to ensure that the contents will be sufficiently oxidised and dried (Knight Piésold, 2007). Once calcining is complete, the trays will be removed from the calcine oven, cooled and weighed. The net contents mass will then be calculated and the required quantity of flux determined.

Dried, weighed calcine will be fluxed and charged into a crucible designed for the smelting furnace. The crucible will be heated in the electric smelting furnace to approximately 1,160°C for four hours, before being removed from the furnace for pouring into moulds (Knight Piésold, 2007). Once the gold is cool, it will be removed from the mould, cleaned of all adhering slag, weighed, sampled and stored in the gold room safe for later dispatch to Rand Refinery. Smelt slag will then be returned to the mill feed belt. The Gold Room will have an independent fume extraction system installed to remove all gases generated by the electrowinning cell and the furnace.

2.3.1 Tailings Storage Facility

The planned mine throughput will be at a rate of 2.1 million t/year or 125 000 t/month, for Area 1. During the first year the throughput will be somewhat less, at approximately 1.0 million tons. The total tailings production, over a period of 17 years, will be of the order of 25 million tons of dry solids. Plant operation is assumed to be for 7 days per week, 24 hours per day.

Several feasible sites for the TSF were investigated and a flat site, sloping gently to the north, has been selected on land approximately 3 km to the north of the proposed plant site. This site is covered by a significant thickness of clay of low permeability, which will seal the area under the TSF and reduce seepage of process water into the ground. The TSF must accommodate approximately 125 000 tons of dry tailings per month, pumped to the dam through a 200 mm diameter pipeline as a slurry containing 48 to 50% solids by mass. The mine will likely use the conventional ring paddock deposition system: a series of flat storage basins or "paddocks", formed around the perimeter of the dam to provide the containment structure for the bulk of the tailings. Tailings are deposited into the wall area during daylight hours, while during the night, the tailings are simply "open ended" into the central basin of the deposit.

The paddocks are formed by low walls along the length of the outside edge and a short distance (usually between about 6m and 20m), to the inside of the top surface of the deposit, with cross walls at intervals of up to 150m. These low walls are built up to a height of about 1.0 to 1.5m, using light earthmoving machinery. The tailings slurry is deposited into each one of the paddocks in turn and allowed to settle and dry out.

Excess (clear) supernatant water is decanted to the central pool area. The whole cycle of deposition around the full perimeter of the dam usually takes about 10 days, depending on the allowable rate of rise and the drying and consolidation characteristics of the tailings.

Supernatant water that accumulates in the central pool will be removed through a gravity decant system, with a central penstock tower and a buried 600 mm steel pipeline discharging into the return water dam. In times of storm, this will overflow into a stormwater retention dam. The water will be abstracted and pumped back to the plant for re-use in the process.

The TSF currently is planned to be rehabilitated *in-situ* for closure purposes but as with all TSFs should the grade prove sufficient then reclamation may be the preferred alternative. This will only be further explored nearer to the closure phase of the mine, as it cannot be implemented while the TSF is actively deposited on.

2.3.2 Waste Rock Dump

Waste rock will be produced by the decline and vertical shaft excavations and subsequently in the development of the underground mine over its planned life. The production rate will vary from 3 000 t/month to 75 000 t/m, generally of the order of 50 000 t/m, resulting in a total waste rock production of over 5 million tonnes, possibly even as much as 7.5 million tonnes at the end of life.

The waste rock naturally takes up an angle of repose of 37º when dumped. However, an overall outer slope of 17º is preferable for eventual rehabilitation. The WRD will thus be constructed in 3m thick lifts, spread over the whole footprint area, with stepbacks to form the required final slope. The waste material is trucked from the shaft to the WRD. The ramp for the trucks should not exceed a 9º gradient.

The insitu dry density of the dumped rock would be close to 1.9 t/m^3. Hence the WRD would occupy a volume of approximately 2.82 million m^3. The maximum height has been specified not to exceed 35m. Under these conditions, the footprint of the WRD will occupy an area of 16 to 20ha. However, the WRD may be reduced as the material may be used elsewhere around the mine or reclaimed should sufficient grade be found in the future. Arising from an alternatives analysis of the three locations, the site to the south of the plant area was selected because of its central location relative to the initial development excavations and to the eventual main hoisting shaft, and because the prevailing winds would not carry dust from there into the working areas and the vent shafts.

Once the gold is processed, moulded, weighed and sampled, the gold is dispatched to Rand Refinery.

2.4 Activity Life Description

In consideration of historical underground mining which seized in 2012, proposed future mining due to start in 2019, should the economic climate allow it, with development and equipping ongoing at present and dewatering from the underground mine during the interval period, future underground mining will have a life of mine (LOM) from 2019-2036 with active dewatering.

2.5 Activity Infrastructure Description

Burnstone will mine gold from underground and will use the Carbon in Leach process to extract gold from ore. The following infrastructure will be used for the mine:

- CIL plant;
- TSF and associated infrastructure such as a slurry pipeline from the plant to the TSF;
- RWD and associated infrastructure such as a return water pipeline from the TSF to the plant;
- Raw water reservoir and associated infrastructure such as pipelines;
- Shaft infrastructure – 1 decline shaft, 1 vertical shaft for ore and 7 ventilation shafts;
- Conveyance infrastructure;
- Office administrative block;
- Solid waste site or skips for waste transfer;
- Sanitation infrastructure;
- Stormwater management infrastructure;
- Workshops and service bay;
- Fuel bay;
- Mine storage and salvage yard;
- Vehicle parking;
- Change house;
- Lamp room and control gateway;
- Settling / Pollution Control dams;
- Explosive magazine;
- Sewage treatment plant (able to treat sewage for 3 000 people); and
- Access roads.

2.6 Key Water Uses and Waste Streams

2.6.1 Water Uses

The following water uses are triggered in terms of Section 21 of the NWA at the Burnstone gold mine:

- Section 21(a) – Taking water from a water resource;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;

- Section 21(f) – Discharging waste or water containing waste into water resource through a pipe, canal, sewer, sea outfall or other conduit;
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse; and
- Section 21(j) - Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

2.6.2 Waste Streams

The waste streams associated with the Burnstone mining operation are limited to discard, polluted mine water, sewage, hydrocarbon wastes, and general waste. These include:

- Mine Residue Deposit (MRD), which includes discard and tailings;
- Polluted mine water, which includes pollution control dams;
- Hazardous waste such as fluorescent tubes, contaminated soil, old batteries, etc.
- Hydrocarbon waste such as oil, diesel & grease; and
- General waste which is limited to domestic and commercial waste.

Refer to Section 5.2.4 of this report for more details pertaining to the waste generated on site and the management thereof.

2.7 Organisational Structure of Activity

Refer to Figure 2.1 for the organisational structure at Burnstone Mine.

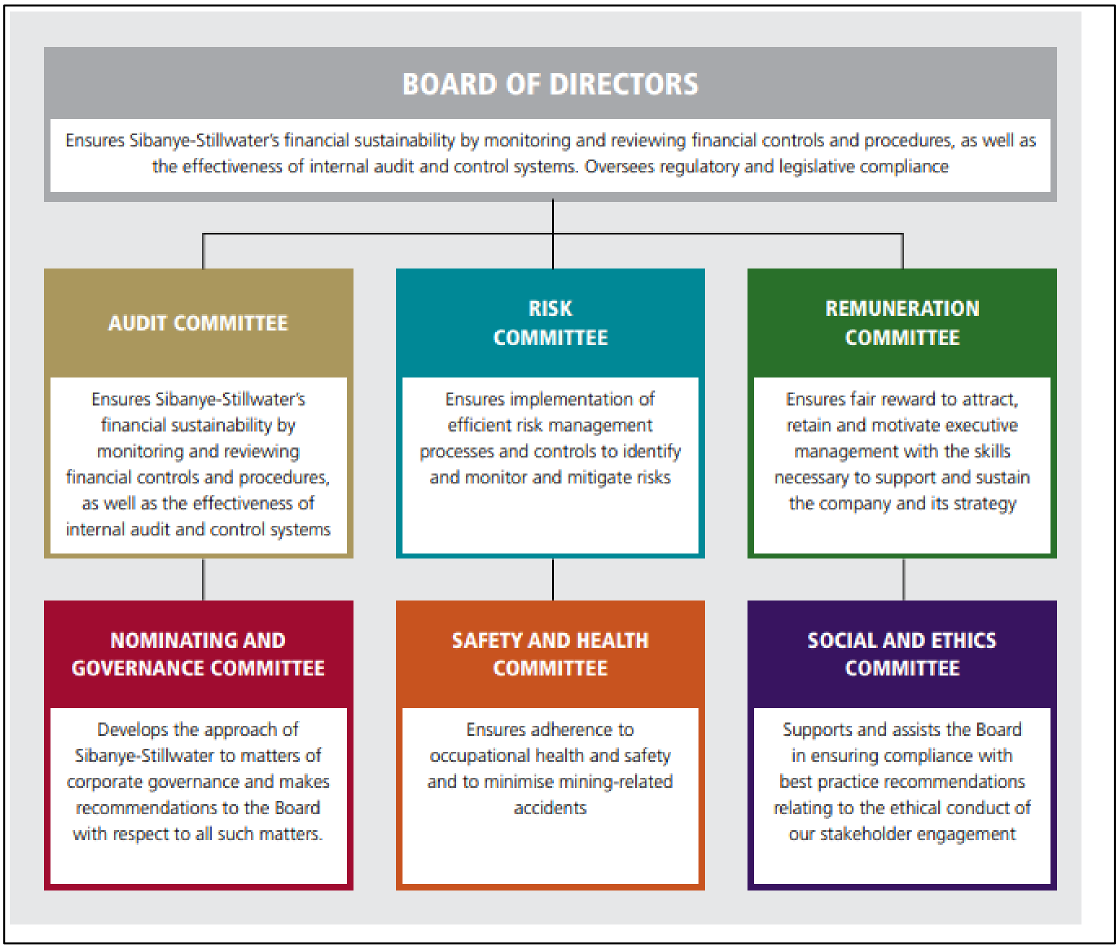


Figure 2.1: Mine Organisational Structure

2.8 Business and Corporate Policies

2.8.1 Environmental Policy

Sibanye commits to undertake its mining and related business activities in a manner that strives to minimise the adverse impacts on the natural environment. Sibanye will achieve their stated environmental goals and objectives by continuously aligning environmental considerations and social responsibility with their business objectives. They are committed to responsible stewardship of our natural resources and the ecological environment for present and future generations. The Sibanye Environmental Vision can be described as 'creating value for all our stakeholders through responsible environmental management practices that include inter alia verifiable compliance, risk management and environmental footprint management in anticipation of post closure socio-economic and environmental impacts.'

Sibanye is committed to achieving its Environmental Management vision through:

- Responsible compliance to all legal, regulatory and generally accepted standards applicable to their mining operations in different jurisdictions;
- Proactive environmental incident management supported by enabling technologies and comprehensive reporting, in order to minimise or prevent pollution;
- Implementation of sound environmental management practices and systems, and the development of fit-for-purpose environmental standards and procedures that promote continual improvement;
- Proactive air quality management using nationally prescribed methodologies;
- Efficient and responsible use of natural resources including water and energy, and the responsible management of all waste and effluent streams emanating from their mining operations;
- Implementation of a sustainable closure strategy, and concurrent rehabilitation for the environmentally responsible and effective socio-economic closure of their mining operations;
- Continual assessment of their water, land and carbon footprint - developing resource conservation programmes to effectively manage and reduce their footprint;
- Developing environmental training and awareness programmes for employees and communities; and
- Communicating openly and transparently with all their stakeholders insofar as their environmental impacts and environmental management programmes are concerned.

2.8.2 Health and Safety Policy

Sibanye strives for zero harm at its operations and aims to eliminate the potential for accidents and injury at the workplace. Sibanye strives to minimise hazards inherent in the working environment in a reasonably practicable manner through implementation of the Health, Safety and Wellbeing strategy and embracing the CARES values. Sibanye is committed to:

- Fostering a strong safety culture by providing solid safety leadership;
- Continually improving occupational health and safety performance through the setting and assessment of goals and taking into account evolving stakeholder expectations, best practices, scientific knowledge and available new technology;
- Providing a workplace that is conducive to health and safety;
- Risk management in the workplace and surveillance of workplaces and employees;
- Complying with applicable legal requirements and with other requirements to which the organization subscribes;
- Ensuring that appropriate resources, training and personal protective equipment are provided to improve occupational health and safety;

- Ensuring that employees and contractors have the relevant skills to perform work related tasks in a safe manner and that they are aware of their individual occupational health and safety obligations and rights;
- Applying a consultative and constructive approach in interactions with stakeholders; and
- Making this policy and its revisions, objectives and targets available to employees, contractors and other stakeholders.

2.8.3 Community and Indigenous Peoples Policy

In line with Sibanye's purpose of improving lives through mining, they recognise the important role they can play in enabling the transformation of the economy and delivering employment and value to its host communities. Sibanye seeks to develop mutually beneficial relationships with host communities and governments. In part, this will be satisfied through open engagement but more critical, is active involvement in the support and development of the communities in which they operate. To attain the vision of creating superior value for all its stakeholders, Sibanye is committed to:

- Contributing to the local economic development of their communities;
- Actively engaging with their stakeholders through robust systems that provide the platform for open, honest and constructive dialogue;
- Respecting local customs, traditions and cultures;
- Pursuing formalised partnerships with governments, non-governmental organisations and donor organisations to ensure that community development programmes are well designed, effectively delivered and capitalise on any synergies that may exist;
- Ensuring that any resettlement that cannot be avoided is undertaken such that resettled parties are constructively engaged and treated fairly;
- Embracing sound principles of local procurement and employment that contribute to local economic development;
- Designing and developing appropriate mine closure processes through constructive engagement with stakeholders; and
- Encouraging, where practical, their suppliers and contractors to adopt similar practices.

3 REGULATORY WATER AND WASTE MANAGEMENT FRAMEWORK

3.1 Summary of all Water Uses

Refer to Section 2.6.1 for the summary of water uses triggered in terms of Section 21 of the NWA that are applicable at Burnstone gold mine.

3.2 Existing Lawful Water Use

Existing Lawful Water Use (ELWU) is defined in Section 32 of the National Water Act 1998, (Act No. 36 of 1998) (NWA) as any water use which has taken place at any time during a period of two years immediately before the date of commencement of the NWA or which has been declared an existing lawful water use under Section 33 and which was authorised by or under any law which was in force immediately before the date of commencement of the NWA.

There are no existing lawful water use taking place on the property. All water uses triggered are being applied for as part of the IWULA and will be authorised in terms of a Water Use License issued by the Department of Water and Sanitation (DWS).

3.3 Relevant Exemptions

The Minister of the Department of Water and Sanitation (DWS) is responsible for the protection, use, development, conservation, management and control of the water resources of South Africa on a sustainable basis. The requirements prescribed in terms of the regulations must be seen as minimum requirements to fulfil this goal.

In order for the Burnstone operations to meet the requirements of sustainable water use, the following exemptions are requested as part of the Integrated Water Use License Application (IWULA):

- Exemption from Government Notice No. 704 (GN 704), Regulation 4 (Restriction on locality) which is required in terms of mining within 100 meter horizontal distance from a watercourse which requires an exemption in terms of regulation (a) (Table 2.1).

Table 3.1: Regulation 704 compliance

GN704	Condition	Sibanye-Stillwater
1	Definitions	Will Comply
2 (1)	Notify DWS of the intention to operate a new mine or conduct any new activity at least 14 days prior to start of operation or activity	Will Comply
2 (2) a	Submit to DWS a copy of all EMPR amendments	Will Comply
2 (2) b	Notify DWS in writing 14 days prior to temporary or permanent cessation of operation, or resumption of operation	Will Comply
2 (2) c	Notify DWS by fastest means possible of any emergency incident or potential emergency incident involving a water resource by providing the following information: date/time, description, source of pollution and impact on water resource and relevant users, and remedial action taken. Notification on new mine or new activity ; "Activity" includes --	Will Comply
2(2)(c)(a)	any mining related process on the mine including the operation of washing plants, mineral processing facilities, mineral refineries and extraction plants, and	Will Comply
2(2)(c)(b)	the operation and the use of mineral loading and off-loading zones, transport facilities and mineral storage yards, whether situated at the mine or not;	Will Comply
2(2)(c)(b)(i)	in which any substance is stockpiled, stored, accumulated or transported for use in such process; or	Will Comply
2(2)(c)(b)(ii)	out of which process any residue is derived, stored, stockpiled, accumulated, dumped, disposed of or transported,	Will Comply
2 (2) d	Within 14 days of such incident report in writing to DWA measures taken to correct and prevent recurrence of such incident (notify of emergency incidents)	Will Comply
4	Minister may authorise exemption from requirements of Regulations 4, 5, 6, 7, 8, 10 or 11	Will Comply
4 a	**Locate or place any residue deposit, dam, reservoir, together with any associated structure within 1:100 year flood-line or within a horizontal distance of 100m of a watercourse or borehole, excluding boreholes drilled specifically to monitor the pollution of ground water, or on ground likely to become water-logged, undermined, unstable or cracked**	**Exemption Requested**
4 b	**No opencast mining, prospecting or any other operation or activity under or within the 1:50 year flood-line or within a horizontal distance of 100m from any watercourse**	**Exemption Requested**
4 c	No placement or disposal of any residue or substance which causes or is likely to cause pollution of a water resource, in the underground workings or opencast excavation.	Will Comply

GN704	Condition	Sibanye-Stillwater
4 d	Locate any sanitary convenience, fuel depots, reservoir or depots for any substance which causes or is likely to cause pollution within the 1:50 year flood line of any watercourse	Will comply
5	May not use any residue or substance which causes or is likely to cause pollution of water resource for the construction of any dam or other impoundment or any embankment, road or railway or for any other purpose which is likely to cause pollution of a water resource	Will comply
6 a	Any unpolluted water must be confined to a clean water system, away from any dirty area	Will Comply
6 b	Clean water systems must be designed, constructed, maintained and operated so that it is not likely to spill into any dirty water system more than once in 50 years	Will Comply
6 c	Water arising within any dirty area must be collected, including water seeping from mining operations, outcrops or any other activity, into a dirty water system	Will Comply
6 d	Any dirty water systems must be designed, constructed, maintained and operated so that it is not likely to spill into any clean water system more than once in 50 years	Will Comply
6 e	Dams and tailings dams which form part of the dirty water system must be designed, constructed, maintained and operated with a minimum freeboard of 0.8 m above full supply level, unless otherwise agreed with DWS with respect to the dam safety regulations	Will Comply
6 f	Water systems shall be designed, constructed and maintained 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.	Will Comply
7 a	Prevent water containing waste or any substance which causes or is likely to cause pollution of water resource from entering any water resource, either by natural flow or by seepage and retain or collect such water for use, reuse, evaporation or for purification and disposal	Will Comply
7 b	Design, modify, locate, construct and maintain all water systems, including residue deposits, in any area so as to prevent the pollution of any water resource through the operation or use thereof	Will Comply
7 c	Cause effective measures to be taken to minimise the flow of any surface water or floodwater into mine workings	Will Comply
7 d	Design, modify, construct, maintain and use any dam or any residue deposit or stockpile used for the disposal or storage of mineral slimes, so that the water or waste therein will not result in the failure thereof or impair its stability	Will Comply

GN704	Condition	Sibanye-Stillwater
7 e	Prevent the erosion or leaching of materials from any residue deposit or stockpile and contain material or substances so eroded or leached in by providing suitable barrier dams, evaporation dams or any other effective measures to prevent this material or substance from entering and polluting any water resources	Will Comply
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	Will Comply
7 g	Keep any water system free from any matter or obstruction which may affect the efficiency thereof	Will Comply
7 h	Cause all domestic waste which cannot be disposed of in a municipal system to be disposed of in terms of the Act.	Will Comply
8 a	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	Will Comply
8 b	Access control in any area used for stockpiling or disposal of any residue or substance which causes, has caused or is likely to cause pollution of water resource is required to protect any measures taken in terms of this regulation	Will Comply
8 c	The mine shall 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	Will Comply
8 d	The mine must 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	Will Comply
9	On decommissioning, to ensure remediation of the affected water resource due to the mining activity	Will Comply
10	Winning sand and alluvial minerals from a watercourse	Not Applicable
11 a	To ensure all coal residue deposits are compacted to prevent spontaneous combustion and minimise infiltration of water	Not Applicable
11 b	To ensure rehabilitation of coal residue deposits concurrent with mining	Not Applicable
12 (1)	DWS may, after consultation with the DMR and DEAT, require a technical investigation or inspection of pollution prevention measures or any potential damage to the in stream or riparian habitat	Will Comply
12 (2)	Such investigation must be conducted and reported on as prescribed by DWA within a specified time period	Will Comply

GN704	Condition	Sibanye-Stillwater
12 (3)	The mine must inform DWA of the expertise and qualifications of the persons who are to conduct the investigation or inspection prior to commencement of the work	Will Comply
12 (4)	DWS may require a programme of implementation to prevent or rectify any pollution of a water resource of damage to in stream/riparian habitat as recommended in the above inspections/investigations	Will Comply
12 (5)	DWS may require a compliance monitoring network to monitor the programme of implementation in Regulation 12 (4)	Will Comply
12 (6)	Subject to Chapter 4 of the Act, the mine must submit plans, specifications and design reports by the approved professional person to DWS not later than 60 days prior to commencement of activities in relation to: surface dams for impounding waste, water containing waste or slurry; implementation of pollution control measures at residue deposits or stockpiles; and implementation of any water control measures at any residue deposit or stockpiles	Will Comply
13	The mining company must support the mine manager with the means and afford him/her every facility required to enable the mine manager to comply with these provisions	Will Comply
14	Offences and penalties	Not applicable
15	Repeal of regulations	Not applicable
16	Commencement	Not applicable

3.4 Generally Authorised Water Uses

Burnstone mine is a gold mining operation. In terms of the General Authorisations (GA), Burnstone is classified as a Category A mine which excluded the mine from applying for water uses in terms of the GA. All water uses triggered by the mine are therefore being applied for as a WUL.

3.5 New Water Uses to be Licensed

Mining at Burnstone ceased in 2012. Sibanye propose to reopen the mine and commence with mining in 2019, with development and equipping of the mine currently occurring. Several water uses were previously authorised by the issuance of a Water Use License (WUL) dated 23rd July 2010 (License No. 27/2/2C221/103/9) by the DWS. The following water uses were authorised in terms of Section 21 of the NWA:

- Section 21(a) – Taking water from a water resource:
  - Abstraction of 762 527m^3 of water from underground mining operation; and
  - Abstraction of 7 358m3 for water from a borehole.
- Section 21(e) – Engaging in a controlled activity (irrigation of land with waster or water containing waste):
  - Irrigation of land with 315 041m^3 of water containing waste.
- Section 21(g) – Disposing of waste in a manner that may detrimentally impact on a water resource:
  - Disposal of 10 368m^3 of waste water into settling dams at the decline shaft, the farm dam at the decline and the clear water dam;
  - Disposal of 10 368m^3 of waste water into settling dams at the vertical shaft;
  - Disposal of 315 041m^3 of waste water for dust suppression;
  - Disposal of 6 600m^3 of waste water into the contaminated water collection dam;
  - Disposal of 2 100 000m^2 of mine residue into the Tailings Storage Facility (TSF); and
  - Disposal of 600 000 tonnes of waste rock from underground onto the Waste Rocks Dump (WRD).
- Section 21(j) – Removing of water found underground:
  - Removal of 1 224 000 of groundwater per year.

As a result of the reopening of the mine, some of the previously licensed water uses are no longer applicable and need to be removed from the WUL. In addition, some of the authorised water uses require amendments and new water uses need to be included in the existing WUL. Refer to Table 3.2 for a summary of all of the water uses being applied for as part of this application and Figure 3.1 for the water use localities. Refer to Figure 3.2 for the water process flow diagram and Table 3.3 for the average annual water balance compiled for Burnstone.

Table 3.2 details the water uses that are being applied for as part of this IWULA. The yellow sections within the table describes the water uses that need to be amended in terms of the previous WUL. The green sections describe the new water uses that are being applied for. The red sections describe the water uses that need to be removed from the existing WUL.

Table 3.2: Burnstone Water Use Summary

Map No	Burnstone Water Uses					
	Section 21(a) Water Uses					
	Amendment /New Water use	Description	Site Name	Co-ordinates	Property	Volume (m^3/a)
1	Amendment requested	Dewatering of underground workings (Water pumped to the Blue Tank for use in the Plant, Dam 3, Dam 4 and into the underground).	Dewatering of underground workings and use of water	26°39'19.67"S 28°39'26.82"E And 26°39'10.00"S 28°40'15.70"E	Brakfontein 513 IR remaining extent of ptn 2 & Vlakfontein 556 IR ptn 15	762 527 m^3/a Amend to: 813 950m^3/a
2	New Water Use	Farm house borehole	Farm House Borehole (BG3D)	26°38'4.88"S 28°39'52.45"E	Brakfontein 513 IR remaining extent of ptn 10	3 650 m^3/a
3	Amendment requested	Use of borehole water in Reverse Osmosis (RO) Plant for domestic use	RO Borehole (BSB2)	26°39'7.09"S 28°40'12.44"E	Brakfontein 513 IR Amend to: Brakfontein 513 IR ptn 13	7 359/ 7 358 m^3/a Amend to: 3 650 m^3/a
	Section 21(c) & (i) Water Uses					
	Amendment /New Water use	Description	Site Name	Co-ordinates		Property
4	New Water Use	Location of Gold Plant, Vertical Shaft and associated infrastructure within the 500m radius of a wetland	Vertical Shaft & Plant areas	Top Left Corner: 26°39'15.25"S 28°39'21.03"E Bottom Left Corner: 26°39'29.11"S 28°39'35.16"E	Top Right Corner: 26°39'0.61"S 28°40'42.68"E Bottom Right Corner: 26°39'15.17"S 28°39'56.07"E	Vlakfontein 556 IR ptn 15
5	New Water Use	Slurry Pipeline and associated infrastructure within 500m of the wetland	Surface Tailings Pipeline	Start 26°39'9.08"S 28°39'43.84"E	End 26°37'34.91"S 28°40'10.30"E	Vlakfontein 556 IR ptn 15
6	New Water Use	Return Water Pipeline and associated infrastructure within 500m of the wetland	Surface Return Water Pipeline	Start 26°39'9.08"S 28°39'43.84"E	End 26°37'34.91"S 28°40'10.30"E	Brakfontein 513 IR ptn 11
7	New Water Use	Location of decline shaft, WWTW, RO Plant, Dams 1 to 4, offices, workshops and associated infrastructure within the 500 m radius of a wetland	Decline Shaft & WWTW Areas	Top Left Corner: 26°39'2.40" 28°40'9.51"E Bottom Left Corner: 26°39'15.64"S 28°40'9.94"E	Top Right Corner: 26°38'52.78"S 28°40'33.54"E Bottom Right Corner: 26°39'23.97"S 28°40'23.06"E	Brakfontein 513 IR remaining extent of ptn 2

8	New Water Use	Location of Tailings Storage Facility, discharge point for underground & treated sewage water, emergency containment area, Return Water Dam Complex and associated infrastructure within the 500m radius of a wetland and floodline	TSF and RWD complex areas	Top Left Corner: 26°36'48.00"S 28°40'35.62"E Bottom Left Corner: 26°37'35.39"S 28°40'9.83"E	Top Right Corner: 26°37'14.70"S 28°41'17.83"E Bottom Right Corner: 26°37'40.30"S 28°40'47.97"E	Brakfontein 513 IR ptn 11
9	New Water Use	Location of the Waste Rock Dump and Waste Rock Dump SWD and associated infrastructure within the 500m radius of a wetland	Waste Rock Dump area	Top Left Corner: 26°39'18.67"S 28°39'42.51"E Bottom Left Corner: 26°39'42.84"S 28°39'50.87"E	Top Right Corner: 26°39'16.58"S 28°39'53.05"E Bottom Right Corner: 26°39'43.04"S 28°40'0.34"E	Vlakfontein 556 IR ptn 15
10	New Water Use	Location of access road West to East within the 500m radius of a wetland	Access Road area	Start: 26°39'23.35"S 28°39'29.89"E	End: 26°38'56.60"S 28°40'24.36"E	Vlakfontein 556 IR ptn 15 & Brakfontein 513 IR remaining extent of ptn 2
11	New Water Use	Location of access road North to South within the 500m radius of a wetland	Access Road area	Start: 26°38'27.86"S 28°39'44.67"E	End: 26°39'15.69"S 28°39'56.55"E	Brakfontein 513 IR ptn 13 & Brakfontein 513 IR remaining extent of ptn 2
	Section 21(e) Water Uses					
	Amendment /New Water use	**Description**	**Site Name**	**Co-ordinates**	**Property**	**Volume (m^3/a)**
	Request to be removed from license	Irrigation of land with water containing waste. Total surface area of 3.7 ha of lawns on properties according to agreement to be irrigated.	Irrigation with water containing waste	Not licensed	Brakfontein 513 IR	315 041 m^3/a
	Section 21(f) Water Uses					
	Amendment /New Water use	**Description**	**Site Name**	**Co-ordinates**	**Property**	**Volume Applied for (m^3/a)**
12	New Water Use	Discharge of water from underground workings pumped to the Blue Tank into the TSF Stormwater Dam and discharge into the wetland system and unnamed tributary of the Suikerbosrant River (which flows into the Blesbokspruit).	Wetland system and unnamed tributary of Suikerbosrant River	26°37'3.57"S 28°40'57.38"E	Brakfontein 513 IR remaining extent	2 193 650 m^3/a
	Section 21(g) Water Uses					

	Amendment /New Water use	Description	Site Name	Co-ordinates	Property	Capacity (m³)	Volume (m³/a)
	Request to be removed from license	Disposal of waste water into settling dams at the decline shaft, farm dam at decline shaft and clear water dam	settling dams at the decline shaft, farm dam at decline shaft and clear water dam Amend to: Settling Dams at decline shaft (Dams 1 and 2) to be removed	Settling Dams at decline shaft: S-26.65358 E28.67237 Farm Dam: Y 2949 056 X 32 847	Brakfontein 513 IR	N/A	10 368 m^3/a
13	Amendment requested	Disposal of waste water into settling dams at vertical shaft. Amend to: Disposal of waste water into overflow PCD at Vertical Shaft.	settling dams at vertical shaft Amend to: Overflow PCD	Y 2949 392 X 34 033 Amend to: 26°39'14.90"S 28°39'32.48"E	Brakfontein 513 IR Amend to: Vlakfontein 556 IR ptn 15	1 600 m^3	10368 m^3/a Amend to: 1 042 m^3/a
14	Amendment requested	Use of waste water for dust suppression	Dust suppression	N/A	Burnstone 684 IR remaining extent, Brakfontein 513 IR ptn 2	N/A	315 041 m^3/a Amend to: 33 288 m^3/a
15	Amendment requested	Disposal of waste water into contaminated water collection dam. Amend to: Disposal of waste water into Return Water Dam Complex at TSF. Return Water Dam Complex consists of Mine Excess Water Dam, TSF Storm Water Dam (SWD) and TSF Return Water Dam (RWD). Water pumped from underground and discharge from WWTWs into Dam 3 to Dam 4 and into RWD Complex at TSF	Contaminated water collection dam Amend to: Return Water Dam Complex at TSF	S-26.6593 E28.6623 Amend to: Mine Excess Dam: 26°36'59.63"S 28°40'38.55"E TSF RWD: 26°37'5.01"S 28°40'50.81"E TSF SWD: 26°37'11.17"S 28°41'3.95"E	Brakfontein 513 IR Amend to: Brakfontein 513 IR ptn 11	Mine Excess Dam: 270 000 m^3 TSF RWD: 278 000 m^3 TSF SWD: 52 000 m^3	6 600 m^3/a Amend to: Mine Excess Dam: 80 836 m^3/a TSF SWD: 43 005 m^3/a TSF RWD: 904 926 m^3/a Dam3&4: 95 679 m^3/a Total: 1 124 446 m^3/a
16	Amendment requested	Disposal of mine residue (slurry) into Tailings Storage Facility	Tailings Storage Facility	26°37'18.48"S 28°40'40.53"E	Brakfontein 513 IR ptn 11	29.2 million tonnes	2 100 000 m^3/a Amend to: 1 503 069 m^3/a
17	Amendment requested	Disposal of waste rock onto Waste Rock Dump	Waste Rock Dump	26°39'22.09"S 28°39'49.71"E	Vlakfontein 556 IR ptn 15	Footprint of 28.1 Ha	600 000 tonnes / annum

18	New Water Use	Collection of runoff from the waste rock dump area into Waste Rock Dump (WRD) dirty Storm Water Dam (SWD)	WRD SWD	26°39'41.89"S 28°39'52.75"E	Vlakfontein 556 IR ptn 15	36 600 m^3	11 628 m^3/a
19	New Water Use	Collection of waste water from the TSF RWD pumped to the Plant RWD for re-use in the plant	Plant Return Water Dam	26°39'8.53"S 28°39'42.94"E	Vlakfontein 556 IR ptn 15	8400 m^3	622 390 m^3/a
20	New Water Use	Collection of runoff and rainfall from plant area	Plant PCD	26°39'8.66"S 28°39'39.54"E	Vlakfontein 556 IR ptn 15	7 500 m^3	24 115 m3/a
21	New Water Use	Collection of storm water runoff from site at the Vertical Shaft into PCD 1	PCD 1	26°39'11.91"S 28°39'30.93"E	Brakfontein 513 IR remaining extent of ptn 2	9 000 m^3	24 100 m^3/a
22	New Water Use	Collection of storm water runoff from site at the Vertical Shaft into PCD 2	PCD 2	26°39'22.67"S 28°39'35.23"E	Brakfontein 513 IR remaining extent of ptn 2	5 060 m^3	34 600 m^3/a
23	New Water Use	Collection of storm water runoff from site at the Decline Shaft into PCD 3	PCD 3	26°39'19.14"S 28°40'22.53"E	Brakfontein 513 IR remaining extent of ptn 2	8 400 m^3	38 782 m^3/a
24	New Water Use	Collection of storm water runoff from site at the Decline Shaft into PCD 4	PCD 4	26°39'10.11"S 28°40'30.98"E	Brakfontein 513 IR ptn 13	9 200 m^3	25 283 m^3/a
25	New Water Use	Runoff from the stockpiles at the Vertical Shaft are collected in the overflow PCD.	Stockpile	26°39'17.60"S 28°39'35.91"E	Vlakfontein 556 IR ptn 15	N/A	1 042 m^3/a
26	New Water Use	Collection of rainwater, potential use in future if required	Dam 1	26°39'12.74"S 28°40'15.18"E	Brakfontein 513 IR remaining extent of ptn 2	1 250 m^3	844 m^3/a
27	New Water Use	Collection of rainwater, potential use in future if required	Dam 2	26°39'12.83"S 28°40'16.53"E	Brakfontein 513 IR remaining extent of ptn 2	1 250 m^3	844 m^3/a
	Amendment /New Water use	**Description**	**Site Name**	**Co-ordinates**	**Property**	**Volume Applied for (m^3/a)**	
28	Amendment requested	Removal of groundwater from underground	Groundwater	26°39'19.67"S28°39'26.82"EAnd26°39'10.00"S28°40'15.70"E	Vlakfontein 556 IR ptn 15 & Brakfontein 513 IR remaining extent of ptn 2	1224000 m^3/a Amend to: 3 007 600 m^3/a	

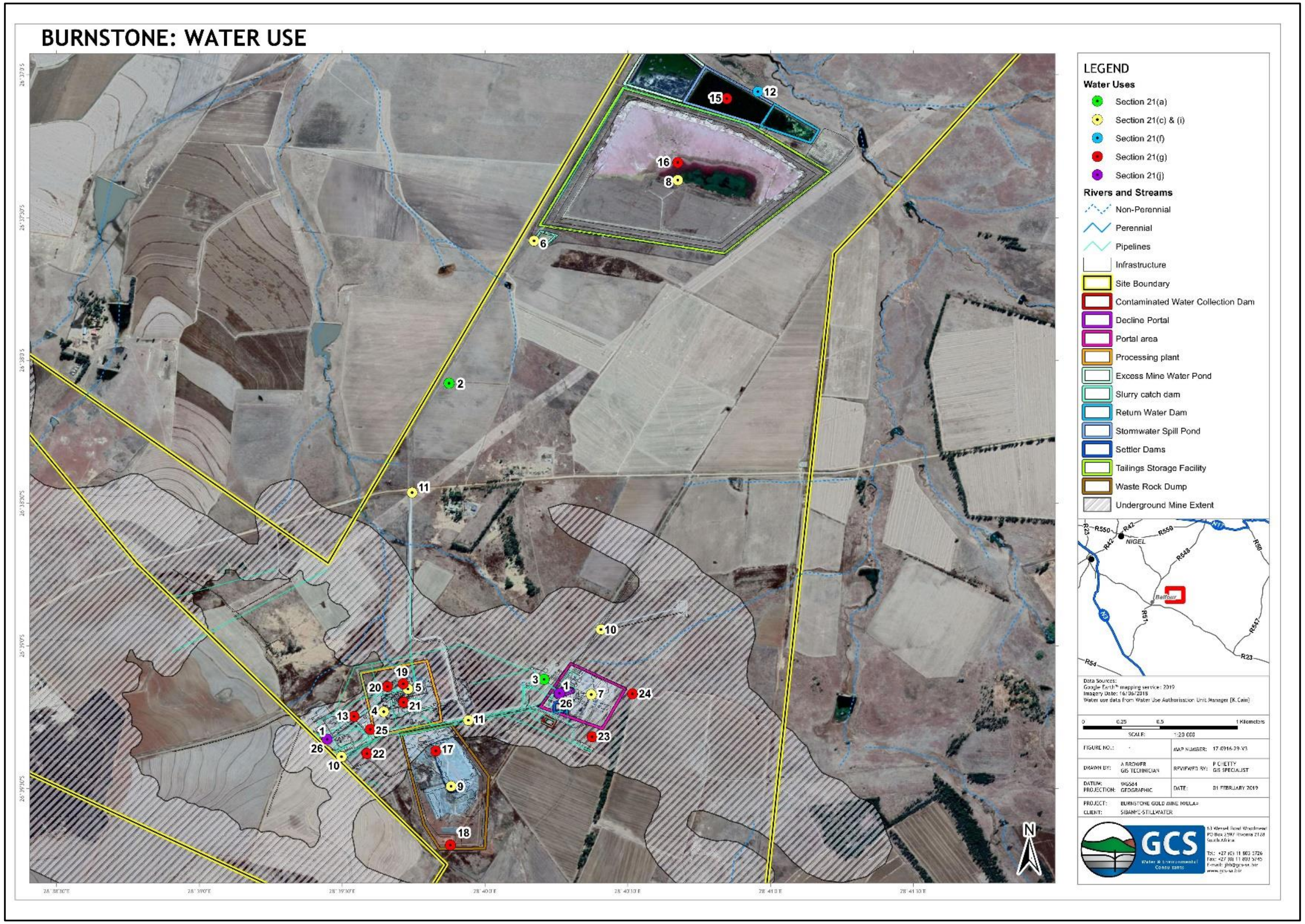


Figure 3.1: Burnstone's water use localities

3.5.1 Section 21(a)

3.5.1.1 Dewatering of the underground workings

Water removed from underground for use was previously authorised in the 2010 WUL. The volume authorised however needs to be increased from 762 527m^3/ to 813 950m^3/a. This is therefore being applied for as part of this application. The water removed from underground is pumped into the Blue Tank for use in the Plant, Dam 3, Dam 4 and for mining purposes.

3.5.1.2 Boreholes

Water is being applied to be abstracted from two boreholes located within the mining area. A volume of 3 650m^3/a is required from both boreholes and is being applied for as such. This water will be used for domestic purposes.

3.5.2 Section 21(c) and (i)

Section 21(c) and (i) water uses are required to be applied for to authorise the location of the mine and its associated infrastructure within the 500m radius of a wetland or within 100m of a floodline. The following is being applied for as part of this application:

- Location of Gold Plant, Vertical Shaft and associated infrastructure within the 500m radius of a wetland;
- Slurry Pipeline and associated infrastructure within 500m of the wetland;
- Return Water Pipeline and associated infrastructure within 500m of the wetland;
- Location of decline shaft, WWTW, RO Plant, Dam 4, offices, workshops and associated infrastructure within the 500 m radius of a wetland;
- Location of TSF, emergency containment area, Return Water Dam Complex and associated infrastructure within the 500m radius of a wetland and floodline;
- Location of the SWD and associated infrastructure within the 500m radius of a wetland;
- Location of access road West to East within the 500m radius of a wetland; and
- Location of access road North to South within the 500m radius of a wetland.

3.5.3 Section 21(e)

Irrigation of land with water containing waste was authorised in the 2010 WUL. No irrigation is proposed to take place when mining commences at Burnstone. This water use is therefore not required and is being requested to be removed from the WUL.

3.5.4 Section 21(f)

Due to the large volume of water abstracted from underground, water is required to be discharged into the receiving watercourse. Discharge of water from underground workings is pumped from the Blue Tank into the TSF Stormwater Dam and discharged into the wetland system and unnamed tributary of the Suikerbosrant River (which flows into the Blesbokspruit).

3.5.5 Section 21(g)

The following amendment are being applied for to the Section 21(g) water uses authorised as part of the 2010 WUL:

- Removal of water use:
  - Disposal of waste water into settling dams at the decline shaft and clear water dam - this use is no longer applicable as is requested to be removed from the WUL;
- Change of name and volume:
  - Disposal of wastewater into settling dams at vertical shaft is requested to be amended to the **Disposal of wastewater into overflow PCD at Vertical Shaft**. The volume is also to be amended from 10 368m^3/a to 1 042m^3/a.
- Change of volume:
  - Use of wastewater for dust suppression needs to be amended from 315 041m^3/a to 33 288m^3/a.
- Change of name and volume:
  - Disposal of waste water into contaminated water collection dam is requested to be amended to the **Disposal of wastewater into Return Water Dam Complex at TSF**. The Return Water Dam Complex consists of Mine Excess Water Dam, TSF Storm Water Dam (SWD) and TSF Return Water Dam (RWD). Water pumped from underground and discharge from WWTWs into Dam 3 to Dam 4 and into RWD Complex at TSF. The volume is requested to be increased from 6 600m^3/a to 1 124 446m^3/a.
- Change of volume:
  - Disposal of mine residue (slurry) into Tailings Storage Facility needs to be amended from 2 1000 000m^3/a to 1 503 069m^3/a.
- Change of footprint area:
  - Disposal of waste rock onto Waste Rock Dump to an area of 28.1Ha.

The following new Section 21(g) water uses are being applied for as part of this application:

- **WRD SWD** - Collection of runoff from the waste rock dump area into Waste Rock Dump (WRD) dirty Storm Water Dam (SWD);
- **Plant return Water Dam** - Collection of waste water from the TSF RWD pumped to the Plant RWD for re-use in the plant;
- **Plant PCD** - Collection of runoff and rainfall from plant area;

- **PCD 1** - Collection of storm water runoff from site at the Vertical Shaft into PCD 1;
- **PCD 2** - Collection of storm water runoff from site at the Vertical Shaft into PCD 2;
- **PCD 3** - Collection of storm water runoff from site at the Decline Shaft into PCD 3;
- **PCD 4** - Collection of storm water runoff from site at the Decline Shaft into PCD 4; and
- **Stockpile** - Runoff from the stockpiles at the Vertical Shaft are collected in the overflow PCD.

3.5.6 Section 21(j)

While the removal of water from underground water licensed as part of the 2010 WUL, the volume authorised needs to be increased from 1 224 000m^3/a to 3 007 600m^3/a. The water removed from underground is pumped to the Blue Tank for use in the Plant, Dam 3, Dam 4 and use underground. Excess water that cannot be used by the processing is discharged.

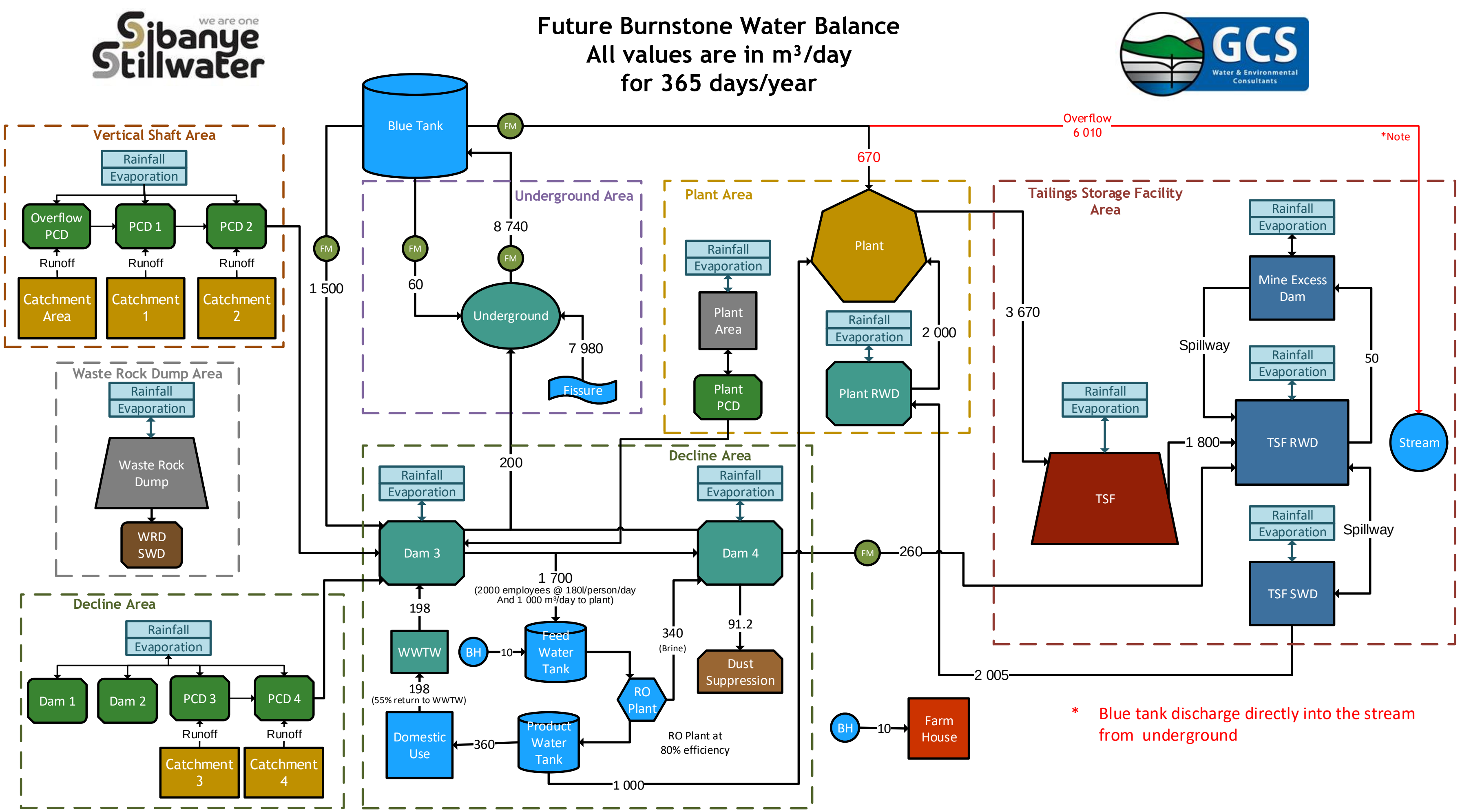


Figure 3.2: Process Flow Diagram

Table 3.3: Average Annual Water Balance

Facility Name	Water In		Water Out		Balance
	Water Circuit/stream	**Quantity (m3/a)**	**Water Circuit/stream**	**Quantity (m3/a)**	
Underground Area	Fissure water from underground mine workings	2 912 700	Blue Tank	3 007 600	
	Dam 3	73 000			
	Blue Tank	21 900			
	Total	**3 007 600**		**3 007 600**	-
Blue Tank	Underground	3 007 600	Overflow into Blesbokspruit	2 193 650	
			Dam 3 (decline area)	547 500	
			Processing Plant	244 550	
			Into underground	21 900	
		3 007 600		**3 007 600**	-
Vertical Shaft Area (Overflow PCD)	Runoff	739	Vertical Shaft Area (PCD 1)	322	
	Direct Rainfall	304	Evaporation	720	
		1 042		**1 042**	-
Vertical Shaft Area (PCD 1)	Runoff	20 740	Vertical Shaft Area (PCD 2)	16 900	
	Direct Rainfall	3 038	Evaporation	7 200	
	Vertical Shaft Area (Overflow PCD)	322			
		24 100		**24 100**	-
Vertical Shaft Area (PCD 2)	Runoff	15 810	Dam 3 (decline area)	30 120	
	Direct Rainfall	1 890	Evaporation	4 480	
	Vertical Shaft Area (PCD 1)	16 900			
		34 600		**34 600**	-
Plant Area (Plant)	RWD at the Plant	616 850	Water in slurry to TSF	1 339 550	
	RO (Product Water Tank)	365 000			
	Blue tank	357 700			
		1 339 550		**1 339 550**	-
Plant Area (RWD)	TSF RWD	731 825	Plant	730 000	
	Direct Rainfall	1 890	Evaporation	3 715	
		733 715		**733 715**	-
Plant Area (Plant PCD)	Runoff	22 225	Dam 3 (decline area)	19 635	
	Direct Rainfall	1 890	Evaporation	4 480	
		24 115		**24 115**	-
Waste Rock Dump Area	Runoff	11 628	Seepage	13 589	
	Direct Rainfall	42 728	Evaporation	40 766.45	
		54 355		**54 355**	-
Decline Area (Dam 3)	Blue Tank	547 500	RO Plant	620 500	
	WWTW	72 270	Underground	73 000	
	Vertical Shaft Area (PCD 2)	30 120	Dam 4 (decline area)	5 058	
	Vertical Shaft Area (PCD 3)	30 782	Evaporation	3 027	
	Plant Area (Plant PCD)	19 635			

	Direct Rainwater	1 277			
	Total	**701 585**		**701 585**	**-**
Decline Area (Dam 4)	Dam 3 (decline area)	5 058	Dust Suppression	33 288	
	Brine from RO Plant	124 100	Overflow to TSF RWD	95 679	
	Direct Rainwater	139	Evaporation	330	
	Total	**129 297**		**129 297**	**-**
RO Plant	Supply from Dam3	620 500	Plant	365 000	
			Domestic Use	131 400	
			Brine (Dam 4)	124 100	
	Total	**620 500**		**620 500**	**-**
Domestic Use	Decline Area	131 400	Consumption	62 780	
	Farmhouse from borehole	3 650	WWTW	72 270	
		135 050		**135 050**	**-**
Decline Area (Dam 1)	Direct Rainfall	844	Evaporation	844	
		844		**844**	**-**
Decline Area (Dam 2)	Rainfall	844	Evaporation	844	
		844		**844**	**-**
Decline Area (PCD 3)	Runoff	18 253	Dam 3 (decline area)	30 782	
	Direct Rainfall	3 375	Evaporation	8 000	
	Vertical Shaft Area (PCD 4)	17 155			
		38 782		**38 782**	**-**
Decline Area (PCD 4)	Runoff	21 854	Decline Area (PCD 3)	17 155	
	Direct Rainfall	3 429	Evaporation	8 128	
		25 283		**25 283**	**-**
Tailings Storage Facility Area (TSF)	Water in Slurry (Plant)	1 339 550	TSF RWD	751 534	
	Direct Rainwater	163 519	Seepage/Entrainment	635 254	
			Evaporation	116 280	
	Total	**1 503 069**		**1 503 069**	**-**
Tailings Storage Facility Area (RWD)	TSF Runoff	751 534	Plant RWD	731 825	
	Direct Rainfall	19 352	SWD at TSF	23 653	
	Overflow Dam 4	95 679	Mine Excess Dam	12 648	
			Evaporation	136 800	
	Total	904 926		904 926	**-**
Tailings Storage Facility Area (SWD)	Direct Rainfall	19 352	Evaporation	43 005	
	TSF RWD	23 653			
	Total	43 005		43 005	**-**
Mine Excess Dam	TSF SWD	12 648	Evaporation	75 153	
	Direct Rainfall	62 505			
		75 153		75 153	**-**
Total Water Balance		12 405 014		12 405 014	-

3.6 Waste Management Activities (NEM: WA)

The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA) fundamentally reformed the law regulating waste management, and for the first time provides a coherent and integrated legislative framework addressing all the steps in the waste management hierarchy. The objectives of the NEM:WA are to protect health, well-being and the environment by providing reasonable measures for, inter alia, remediating land where contamination presents, or may present, a significant risk of harm to health or the environment. The objectives of the NEM: WA are structured around the steps in the waste management hierarchy, which is the overall approach that informs waste management in South Africa. The waste management hierarchy consists of options for waste management during the lifecycle of waste, arranged in descending order of priority; i.e. waste avoidance, reduction, re-use, recycling, recovery, treatment, and safe disposal as a last resort.

NEMA, as previously mentioned, introduced a number of additional guiding principles into South African environmental legislation, including the life-cycle approach to waste management, producer responsibility, the precautionary principle and the polluter pays principle (i.e. the sustainability principles as contained in Section 2 of NEMA). Section 5(2) of the NEM: WA stipulates that the Act should be interpreted and guided in accordance with these sustainability principles. The NEM: WA, furthermore, echoes the duty of care provision, in terms of Section 28 of NEMA, by obliging holders of waste to take reasonable measures to implement the waste management hierarchy. Section 16(1) of the NEM: WA provides that:
"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 an unauthorised purpose."

While the NEM: WA creates a comprehensive legal framework for waste management, its provisions will be meaningless without measures to monitor and, where necessary, enforce compliance. Compliance monitoring is supported by a range of reporting provisions contained in the NEM:WA. In addition to compliance reports for waste management licences and norms and standards, the NEM: WA has provisions for annual performance reports on the implementation of provincial and local Integrated Waste Management Plans. Industry Waste Management Plans are subject to review at intervals to be determined by the authority that mandated the plan, which in the case of mines would be the DMR. Furthermore, Environmental Management Inspectors and Waste Management Officers can request a Waste

Impact Report where they suspect a contravention of the Act, licence conditions or exemption conditions.

The NEM: WA provides for a licensing regime specific to waste management activities. It replaces the historical system of permits issued in terms of the repealed Section 20 of the ECA. Transitional arrangements allow existing permits granted in terms of ECA to be regarded as licences in terms of the NEM: WA until the Minister requires a licence application as per the NEM: WA category of the waste management activity (i.e. category A or B). The NEM: WA waste management categories determine the environmental assessment procedure (which is the equivalent of the NEMA EIA regulations' requirements) required to obtain a licence.

Category A activities require a Basic Assessment (BA) process to be undertaken, whilst Category B activities require a Scoping and Environmental Impact Report (S&EIR) process to be undertaken.

The recently amended legislation concerning EIAs makes reference to the development of norms and standards which may guide EIA applications and Environmental Authorisations in the future. The production of appropriate norms and standards for specific forms of developments is ongoing and it is anticipated that this will eventually provide the opportunity to further streamline the EIA procedures in relation to particular forms of developments. Depending on the location of developments, it is important to note that applicable Norms and Standards are no different from regulations in law in that they are both equally binding.

There are several waste sources that have been identified as part of the mining activities at Burnstone mining operations. These waste sources include:

- Solid Waste;
- Industrial Waste (e.g. waste from the processing plant);
- General and Non-hazardous Waste;
- Sewage; and
- Hazardous Waste.

3.7 Waste Related Authorisations

There are currently no waste related authorisations for the Burnstone mine operations.

3.8 Other Authorisations (EIAs, EMPs, RODs, Regulations)

Burnstone completed an Environmental Management Plan (EMP) in February 2008 and an Environmental Impact Assessment (EIA) in March 2011. In addition, the Department of Mineral and Energy (DME) [now the Department of Mineral Resources (DMR)] issued a letter of acceptance of an application for a mining right (MP 30/5/1/2/2/248 MR). In October 2008, 'Southgold' was granted a mining right from the DMR for Areas 1 - 4.

3.9 Legislation

3.9.1 Constitution of South Africa, 1996 (Act No.108 of 1996)

The Constitution of the Republic of South Africa, 1996 (Act No.108 of 1996) compels all to ensure the fundamental rights of all citizens. Section 24 of the act states the following:

Everyone has the right:

a) *To an environment that is not harmful to their health or wellbeing, and*
b) *To have an environment protected for the benefit of present and future generations through reasonable legislative and other measures that-*
   I. *Prevent pollution and ecological degradation;*
   I. *Promote conservation; and*
   II. *Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.*

The environmental legislation promulgated since the constitution has given legal effect to this section of the Constitution.

3.9.2 National Environmental Management Act, 1998 (Act No. 107 of 1998)

The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) is South Africa's overarching framework for environmental legislation. The NEMA sets out the principles of Integrated Environmental Management (IEM). The NEMA aims to promote sustainable development, with wide-ranging implications for national, provincial, and local government. Included amongst the key principles is that all development must be environmentally, economically and socially sustainable and that environmental management must place people and their needs at the forefront, and equitably serve their physical, developmental, psychological, cultural and social interest.

The NEMA is the environmental framework legislation promulgated to replace the Environmental Conservation Act, 1989 (Act No. 73 of 1989), and ensure that the environmental rights contemplated in Section 24 of the Constitution are realised. NEMA sets out:

- the fundamental principles that need to be incorporated in the environmental decision making process;
- the principles that are necessary to achieve sustainable development;
- provides for duty of care to prevent, control and rehabilitate the effect of significant pollution and environmental degradation; and

- it allows for the prosecution of environmental crimes.

The NEMA provides for the identification of activities which will impact the environment. These activities were promulgated in terms of Regulations 982, 983, 984 and 985, published 4 December 2014 and require environmental authorisation.

The impacts of the listed activities must be investigated, assessed and reported to the competent authority before authorisation to commence with such listed activities can be granted.

3.9.3 The Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)

Granting of permission to mine or prospect, among others, is conditional on an environmental management programme and plan being submitted and accepted by the relevant government authority. Section 43 is one of the most important provisions as it deals with the responsibility for any environmental liability, pollution or ecological degradation until the issue of the closure certificate. In terms of Section 43 of the Minerals and Petroleum Resources Development Act (MPRDA), the holder of a prospecting, mining right or permit remains responsible for any environmental liability, until a closure certificate has been issued. Section 43(1) states:

"The holder of a prospecting right, mining right, retention permit, mining permit, or previous holder of an old order right or previous owner of works that has ceased to exist, remains responsible for any environmental liability, pollution, ecological degradation, the pumping and treatment of extraneous water, compliance to the conditions of the environmental authorisation and the management and sustainable closure thereof…"

These holders will remain responsible "...***until the Minister has issued a closure certificate in terms of this Act to the holder or owner concerned."***

However, in terms of NEMA, Section 24R, the abovementioned holders will remain liable even if a closure certificate was issued in terms of the MPRDA. Section 24R(1) states that:

"... remain responsible for any environmental liability, pollution or ecological degradation, the pumping and treatment of polluted or extraneous water, the management and sustainable closure thereof notwithstanding the issuing of a closure

certificate by the Minister responsible for mineral resources in terms of the Mineral and Petroleum Resources Development Act, 2002, to the holder or owner concerned."

It is important to note, that environmental liability will not necessarily cease or fall away by the issuing of a closure certificate. In addition to the broader liability provisions above, Section 45 provides that the relevant authority may direct a mine to undertake remedial measures where:

"...any prospecting, mining, reconnaissance or production operations cause or results in ecological degradation, pollution or environmental damage which may be harmful to the health or well-being of anyone and requires urgent remedial measures."

Where the mine fails to take these measures, the relevant authority will act on its behalf and then recover costs incurred from the mine. If the mine fails to compensate the authority, the latter is empowered to seize and sell the mine's property to recover the costs. The mine will thus remain financially liable for the rehabilitation, even if it chooses to ignore the government directive.

3.9.4 The National Water Act, 1998 (Act No.36 of 1998)

The purpose of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled. Sections 40 and 42 of NWA provides for the responsible authority to request public participation and an assessment of the likely effect of the proposed licence the protection, use, development, conservation, management and control of the water resource.

The NWA defines 11 consumptive and non-consumptive water uses in terms of Section 21 of the NWA:

- **Section 21(a): Taking water from a water resource;**
- Section 21(b): Storing water;
- **Section 21(c): Impeding or diverting the flow of water in a watercourse;**
- Section 21(d): Engaging in a stream flow reduction activity;
- Section 21(e): Engaging in a controlled activity: irrigation of any land with waste or water containing waste;
- **Section 21(f): Discharging waste or water containing waste into a water resource through a pipe, canal, sewer or other conduit**
- **Section 21(g): Disposing of waste in a manner which may detrimentally impact on a water resource;**

- Section 21(h): Disposing in any manner of water which contains waste from, or which has been heated in any industrial or power generation process;
- **Section 21(i): Altering the bed, banks, course or characteristics of a watercourse;**
- **Section 21(j): Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people;**
- Section 21(k): Using water for recreational purposes.

Water uses that are not permissible in terms of Schedule 1 of the NWA need to be authorised under a tiered authorisation system as a General Authorisation in terms of the General Authorisations as published under section 39 of the NWA or as a water use licence, as provided for in terms of section 21 of the NWA.

The authorisation system allows for the "Reserve" and provides for public consultation processes in the establishment of strategies and decision making and guarantees the right to appeal against such decision.

Section 27 of the NWA specifies that the following factors regarding water use authorisation be taken into consideration:

- The efficient and beneficial use of water in the public interest;
- The socio-economic impact of the decision whether or not to issue a licence;
- Alignment with the catchment management strategy;
- The impact of the water use and possible resource directed measures; and
- Investments made by the applicant in respect of the water use in question.

Section 26(1) of the NWA states:

- Subject to subsection (4), the Minister may make regulations:
  - (a) limiting or restricting the purpose, manner or extent of water use;
  - (b)requiring that the use of water from a water resource be monitored, measured and recorded;
  - (c) requiring that any water use be registered with the responsible authority;
  - (d) prescribing the outcome or effect which must be achieved by the installation and operation of any water work;
  - (e) regulating the design, construction, installation, operation and maintenance of any water work, where it is necessary or desirable to monitor any water use or to protect a water resource;

- (f) requiring qualification for and registration of persons authorised to design, construct, install, operate and maintain any water work, in order to protect the public and to safeguard human life and property;
- (g) regulating or prohibiting any activity in order to protect a water resource or instream or riparian habitat;
- (h) prescribing waste standards which specify the quantity, quality and temperature of waste which may be discharged or deposited into or allowed to enter a water resource;
- (i) prescribing the outcome or effect which must be achieved through management practices for the treatment of waste, or any elements of waste, before it is discharged or deposited into or allowed to enter a water resource;
- (j) requiring the waste discharged or deposited into or allowed to enter a water resource be monitored and analysed, and prescribing methods for such monitoring and analysis;
- (k) prescribing procedural requirements for license applications;
- (l) relating to transactions in respect of authorisations to use water, including but not limited to:
    - (i) the circumstances under which a transaction may be permitted;
    - (ii)the conditions subject to which a transaction may take place; and
    - (iii) the procedure to deal with a transaction;
- (m) prescribing methods for making a volumetric determination of water to be ascribed to a stream flow reduction activity for the purpose of water use allocation and the imposition of charges;
- (n) prescribing procedures for the allocation of water by means of public tender or auction; and
- (o) prescribing:
    - (i) procedures for obtaining; and
    - (ii) the required contents of, assessments of the likely effect which any proposed licence may have on the quality of the water resource in question.

4 PRESENT ENVIRONMENTAL SITUATION

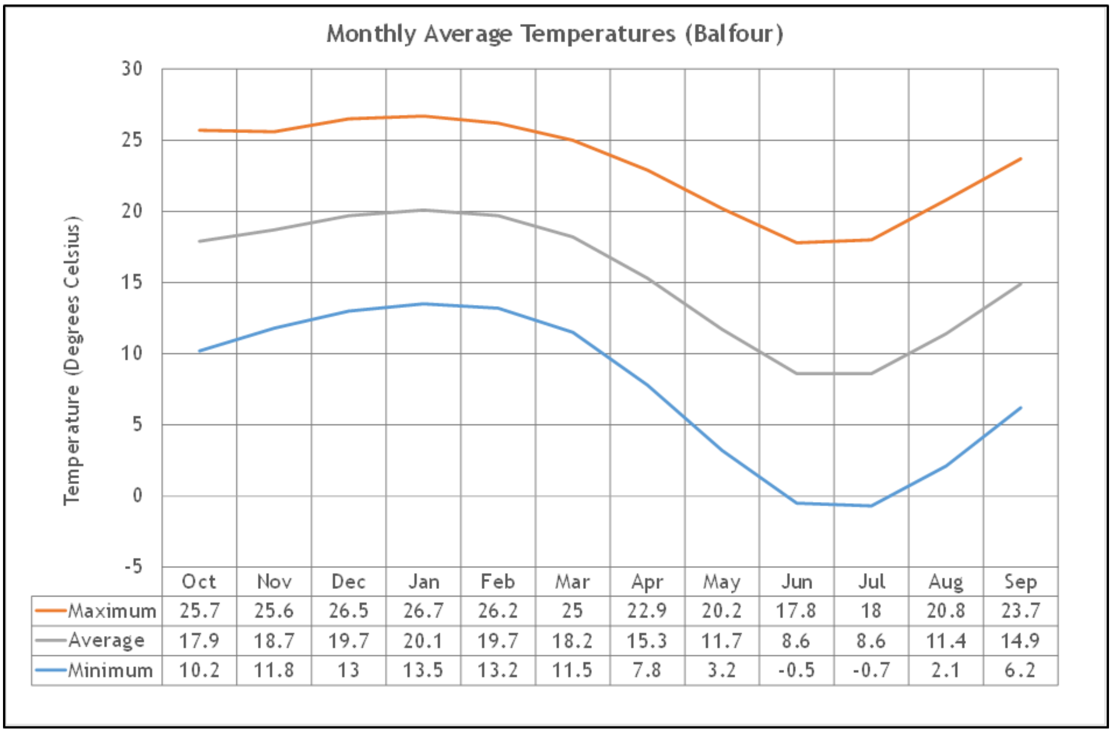
4.1 Climate

The information contained in this section is sourced from the Hydrological Assessment compiled by GCS (dated 2018).

4.1.1 Regional Climate

Burnstone lies within the summer rainfall region of South Africa, which is characterised by showers and thunderstorms. The climate is typical of the Highveld regions of the Upper Vaal River Catchment. The area experiences warm and humid summers, with cold and dry winter seasons. The Köppen-Geiger classification indicates that the study site falls under the Temperate or C-climate category, denoted as Cwb (Kottek, et al., 2006).

Temperatures for the site are likely to be similar to those recorded for the town of Balfour (Climate-data.org, 2012) and are expected to be distributed as presented in Figure 4.1. IPCC5 projections (Flato, et al., 2013), however, indicate a likely increase in average temperature between 1970 and 2020 of between 2 and 2.5°C, for each season in the year.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Maximum	25.7	25.6	26.5	26.7	26.2	25	22.9	20.2	17.8	18	20.8	23.7
Average	17.9	18.7	19.7	20.1	19.7	18.2	15.3	11.7	8.6	8.6	11.4	14.9
Minimum	10.2	11.8	13	13.5	13.2	11.5	7.8	3.2	-0.5	-0.7	2.1	6.2

Figure 4.1: Time period graph defines temperature variability at Burnstone Mine

4.1.2 Rainfall

Rainfall for the site is based on 100 years of record at Balfour (Balfour - 0440129 W (1901-2000)) and historical records indicate a long-term average of approximately 698mm/yr (Figure 4.2). There are, however, strong trends of change over time, both in terms of the temporal distribution of rainfall and in terms of the anticipated total annual rainfall. IPPC5 climate projections from global climate models (GCMs) for representative concentration pathways (RCPs) 4.5 were obtained from WorldClim 1.4 data (Hijmans, Cameron, Parra, Jones, & Jarvis, 2005). Future rainfall (MAP of 660mm) can be represented as indicated in Figure 4.3.

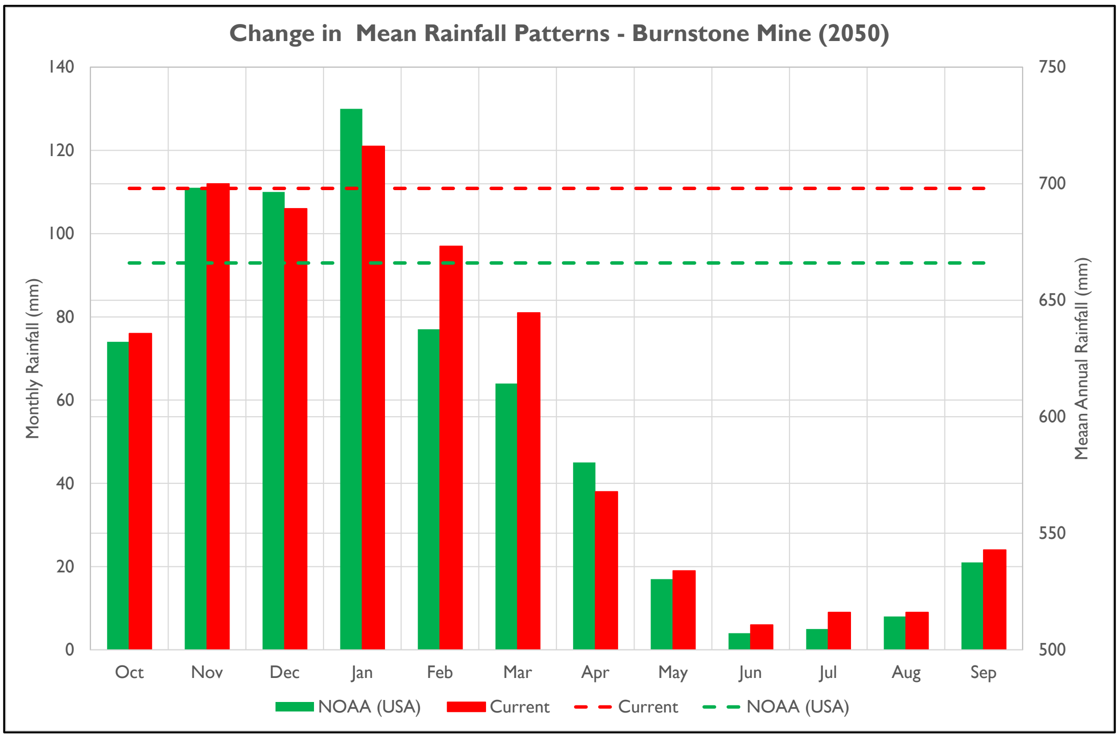
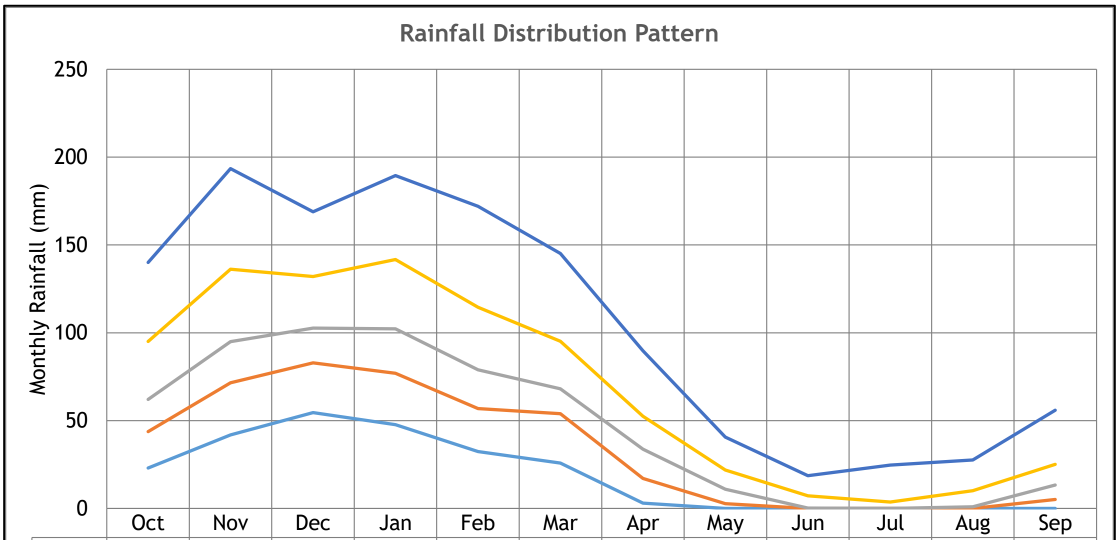


Figure 4.2: Mean rainfall trends at Burnstone



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
E90	23	42	55	48	32	26	3	0	0	0	0	0
E70	44	72	83	77	57	54	17	3	0	0	0	5
E50	62	95	103	102	79	68	34	11	0	0	1	13
E30	95	136	132	142	115	95	52	22	7	4	10	25
E10	140	194	169	190	172	145	90	41	19	25	28	56

Note: E30 represents a value that is likely to be exceeded in 30% of years

Figure 4.3: Rainfall distribution at Burnstone

4.1.2.1 Design Rainfall Depth

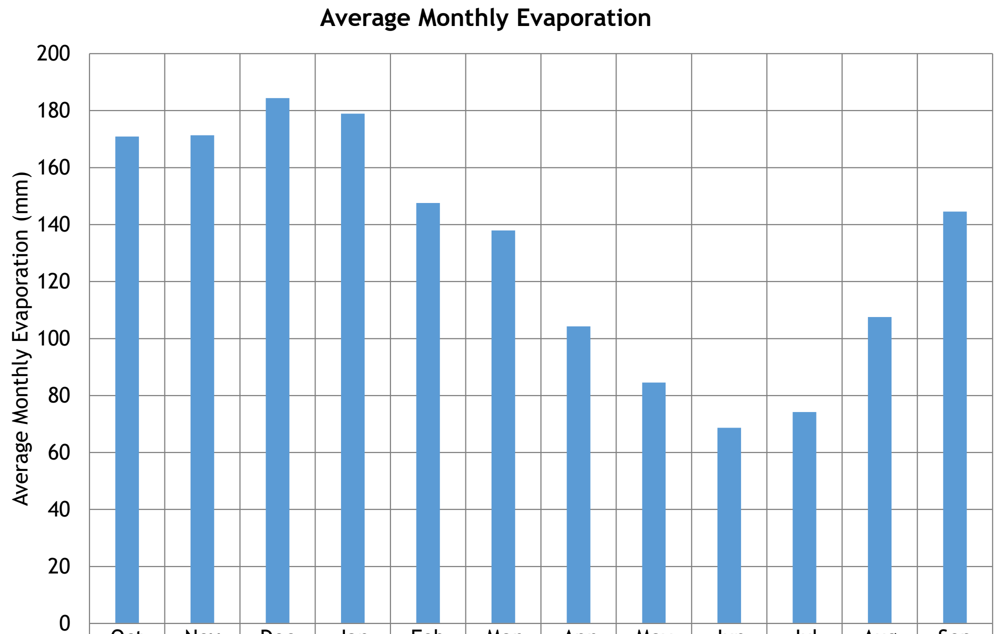
Design rainfall depths for the Burnstone Mine were calculated using the Design Rainfall software for South Africa (Smithers and Schulze, 2000). The design rainfall depths for the 1:2-year to 1:200-year return periods can be seen in Table 4.1. These rainfall depths were used as input in calculating flood peak flows for the project site using South African SCS type 3 curve method in PCSWMM.

Table 4.1: Design rainfall depths for Burnstone

	Return Period (Years)						
Duration	**2**	**5**	**10**	**20**	**50**	**100**	**200**
5 min	10.3	14.2	17.2	20.4	25.2	29.2	33.7
10 min	15.1	20.8	25.1	29.8	36.7	42.6	49.2
15 min	18.8	25.9	31.4	37.2	45.8	53.2	61.4
30 min	23.8	32.8	39.7	47.1	58.0	67.3	77.6
45 min	27.3	37.6	45.5	54.0	66.5	77.2	89.0
1 h	30.0	41.5	50.2	59.6	73.3	85.1	98.1
1.5 h	34.5	47.6	57.5	68.3	84.1	97.6	112.6
2 h	38.0	52.5	63.4	75.3	92.7	107.6	124.1
4 h	44.4	61.3	74.1	88.0	108.3	125.8	145.1
6 h	48.7	67.2	81.2	96.4	118.7	137.8	158.9
8 h	51.9	71.7	86.7	102.9	126.6	147.0	169.6
10 h	54.6	75.4	91.1	108.2	133.1	154.6	178.3
12 h	56.9	78.5	94.9	112.7	138.7	161.1	185.8
16 h	60.7	83.8	101.3	120.3	148.0	171.9	198.2
20 h	63.8	88.1	106.5	126.5	155.6	180.7	208.4
24 h	66.5	91.8	111	131.8	162.2	188.3	217.1

4.1.3 Evaporation

Evaporation data used for this site is based on the 1 600mm/yr S-Pan evaporation reported in WR 2005 and Evaporation Zone 12A (WRC, 2012). It does, however appear that the average annual number of rain days (when evaporation decreases due to humidity and cloud cover) has reduced from 67 to 60 days per year. Taken together with projected changes in temperature, it seems likely that slightly higher evaporative losses will occur. Evaporation of 1 650mm/yr is likely to be distributed as presented in Figure 4.4.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
S-Pan Evap	170.9	171.4	184.4	178.9	147.6	138.0	104.3	84.6	68.7	74.2	107.6	144.6

Figure 4.4: Estimated S-pan evaporation for Burnstone

4.2 Surface Water

A hydrological investigation was undertaken by GCS in 2018. Refer to Annexure 8 for the full hydrological report.

4.2.1 Water Management Area (WMA)

Burnstone is situated in the Upper Vaal Water Management Area (WMA) 8 within the C21B and C12G quaternary catchments (Figure 4.5). The greater region, in which the Burnstone Mine is located, is drained by the Suikerbosrand River, which is a secondary perennial channel, being fed by non-perennial tertiary streams (Figure 4.5). Burnstone Mine is currently discharging into an unnamed stream (stream) which is a tributary of the Suikerbosrand River.

4.2.2 Surface Water Hydrology

Various small, non-perennial streams traverse the site, mainly along the north-south alignment. The stream to the north of the site flows in a westerly direction and into the Suikerbosrand River, which in turn eventually flows into the Vaal River. Most of these rivers are dry for most of the year.

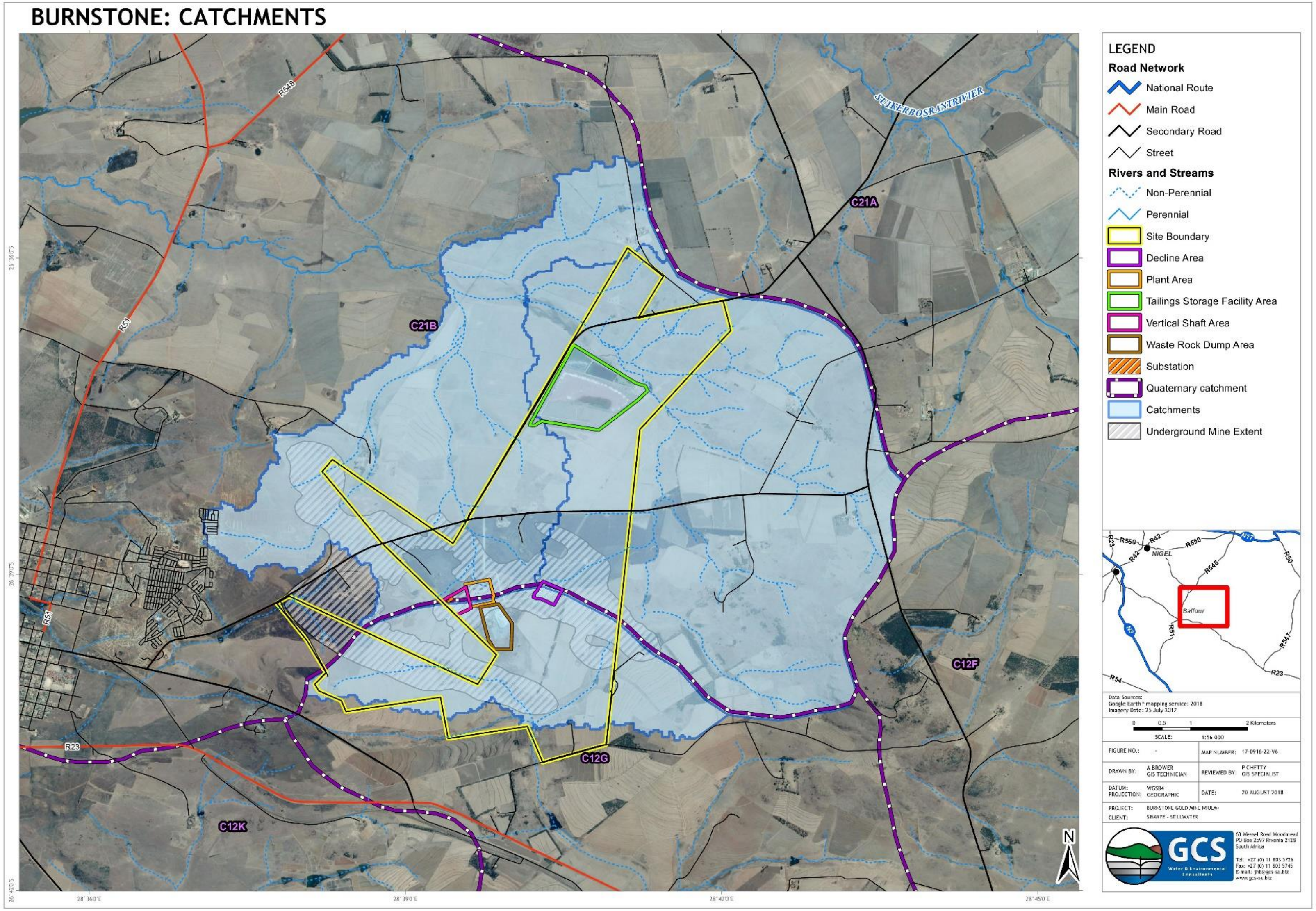


Figure 4.5: Burnstone Catchments

4.2.3 Surface Water Quality

All surface water quality data was received from Sibanye and monitoring localities are listed in Table 4.2. The laboratories used by Sibanye are not accredited, however, these laboratories use SANAS accredited methods and participate and perform very well in the SABS Water Check Proficiency Testing. In total eight (8) surface water localities are included in the monitoring programme. Surface water sampling is done on a monthly basis (Figure 4.6).

Table 4.2: Surface water monitoring localities

Locality	Latitude	Longitude	Type	Locality Description
SW5	26°38'23.52"S	28°41'21.27"E	Stream	Upstream of TSF
SW6	26°38'29.34"S	28°39'33.52"E	Stream	Instream water quality west of TSF complex
SW7	26°37'42.59"S	28°40'02.58"E	Stream	Upstream wetland of TSF
SW8	26°26'45.58"S	28°40'36.83"E	Stream	Downstream of TSF
SW9	26°36'35.39"S	28°39'33.21"E	Stream	Downstream of plant
SW10	26°35'44.81"S	28°36'49.06"E	Stream	Furthest downstream instream point
PCD 4	26°39'4.94"S	28°40'10.13"E	Containment Dam	Irrigation abstraction points
RWD	26°39'20.96"S	28°40'20.10"E	Containment Dam	Spill from RWD

Water quality was compared to the stipulated limits as set out in the WUL (licence no. 27/2/2C221/103/9) (Sibanye, 2010) for surface water. Additionally, the water quality is compared to the SANS 241-1:2015 for Drinking Water for comparative purposes.

For the purpose of this report, only the surface water quality was described. The most recent surface water quality compared to the relevant limits for data of October 2017 is shown in Table 4.3.

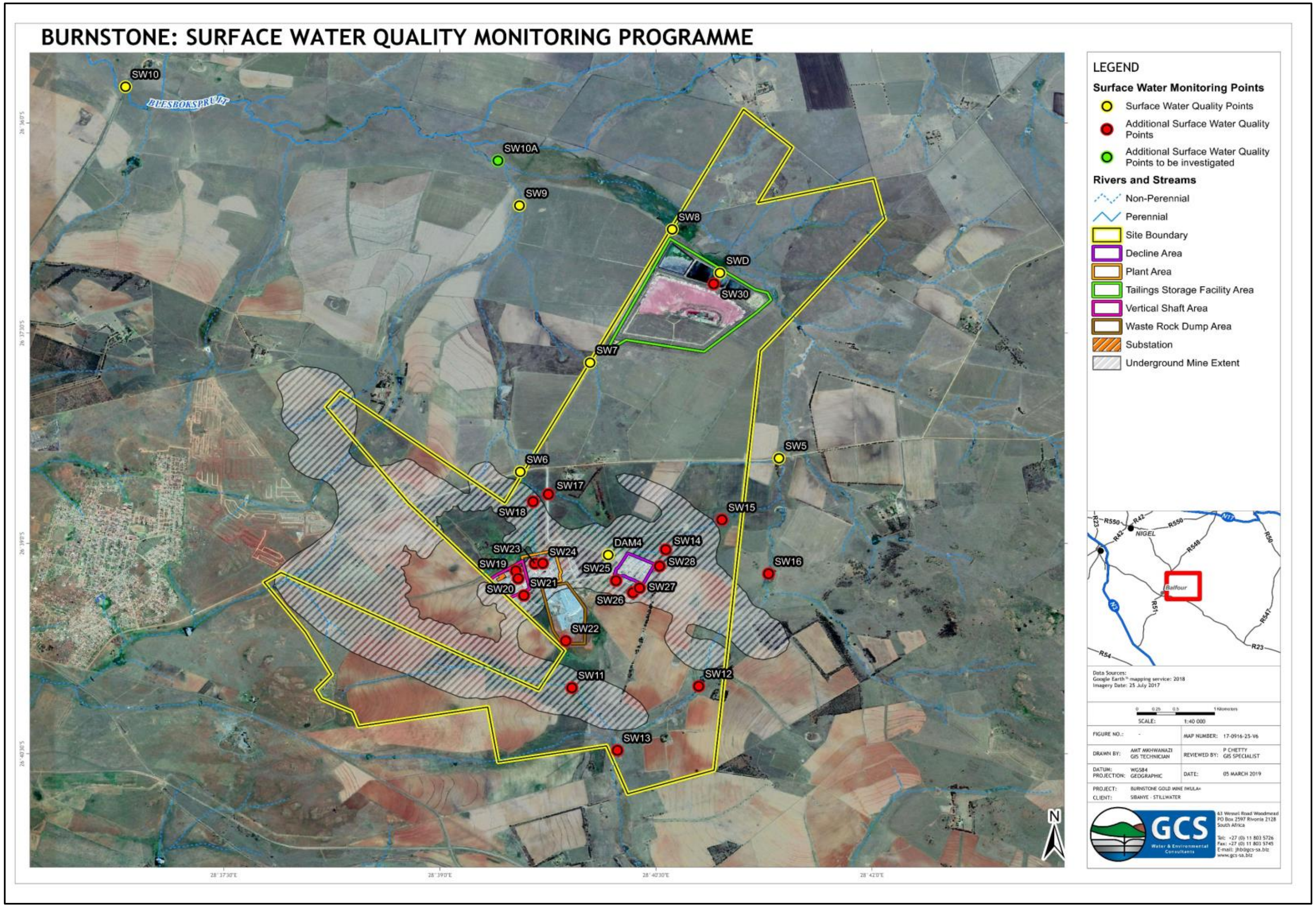


Figure 4.6: Current and proposed water quality monitoring programme

Table 4.3: Surface water quality results

Parameter	Units	WUL Requirements	SANS 241-1:2015 Drinking Water Standard	SW5	SW6	SW7	SW8	SW9	SW10	Dam 4	SWD
				Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017
pH	pH units	**6.5-8.5**	**5-9.7**	7.23	7.81	9.3	7.51	7.82	8.18	7.43	9.24
Electrical conductivity (EC)	mS/m	**65**	**170**	60.7	60.7	25	48.3	60.8	91.6	46.6	47.2
Total Dissolved Solids (TDS)	mg/L	**NS**	**1200**	264	282	96	158	294	490	176	188
Calcium, Ca	mg/L	**NS**	**NS**	44.5	36	22.8	15.3	35.7	29.3	17.5	14.4
Magnesium, Mg	mg/L	**30**	**NS**	22.74	23.56	8.7	9.11	23.73	18.83	4.62	8.33
Sodium, Na	mg/L	**100**	**200**	34.53	53.86	45.64	76.21	53.49	169.9	67.13	70.67
Potassium, K	mg/L	**NS**	**NS**	19.23	11.15	8.76	1.93	11.24	7.64	2.2	3.77
Chloride, Cl	mg/L	**140**	**300**	21.64	29.4	12.21	24.2	29.53	116.2	15.177	21.5
Sulphate, SO_4	mg/L	**200**	**500**	154.6	79.1727	10	34.63	79.83	19.56	18.91	35.59
Total Alkalinity as $CaCO_3$	mg/L	**NS**	**NS**	97.2	170.4	87.2	162.3	168.5	257.6	86.3	112.6
Nitrate (NO_3) as N	mg/L	**NS**	**11**	0.24	0.146	0.023	0.785	0.182	0.081	19.114	11.07
Ammonium (NH_4)as N	mg/L	**NS**	**NS**	0.26	0.17	0.72	0.08	0.18	0.68	0.078	0.078
Manganese, Mn	mg/L	**0.5**	**0.4**	0.034	0.136	0.08	0.008	0.141	0.096	0.005	0.003
Fluoride, F	mg/L	**0.7**	**1.5**	0.236	0.6004	0.644	0.8189	0.611	0.641	0.881	0.769
Boron, B	mg/L	**NS**	**2.4**	0.05	0.034	0.024	0.259	0.035	0.042	0.31	0.237
Aluminium, Al	mg/L	**0.3**	**0.3**	0.028	5.488	0.226	0.028	6.385	0.7	0.028	0.028
Copper, Cu	mg/L	**NS**	**2**	0.005	0.005	0.005	0.005	0.006	0.007	0.005	0.005
Iron, Fe	mg/L	**0.5**	**2**	0.376	3.411	0.353	0.069	3.954	0.412	0.005	0.005
Lead, Pb	mg/L	**NS**	**0.01**	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	
Orthophosphate PO_4 as P	mg/L	**NS**	**NS**	0.098	0.173	0.178	0.098	0.172	0.098	0.098	0.098
Chromium, Cr	mg/L	**NS**	**0.05**	-	0.014	-	0.007	-	-	-	-
Uranium, U	mg/L	**NS**	**0.03**	0.001	0.023	0.001	0.003	0.022	0.006	0.001	0.005
Nickel, Ni	mg/L	**NS**	**0.07**	0.015	0.015	0.015	0.015	0.016	0.015	0.015	0.015
Cadmium, Cd	mg/L	**NS**	**0.003**	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Zinc, Zn	mg/L	**NS**	**5**	0.002	0.008	0.002	0.002	0.008	0.002	0.002	0.002
Total cyanide, CN	mg/L	**NS**	**0.2**	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Hardness as $CaCO_3$	mg/L	**NS**	**NS**	204.75	186.91	92.75	75.71	186.86	150.70	62.72	70.25
Calcium Hardness as $CaCO_3$	mg/L	**NS**	**NS**	111.11	89.892	56.93	38.20	89.14	73.16	43.69	35.95
Magnesium Hardness as $CaCO_3$	mg/L	**NS**	**NS**	93.64	97.02	35.82	37.51	97.72	77.54	19.02	34.30
Turbidity	NTU	**NS**	**5**	4.25	254	19.62	0.9	274	16.82	1.89	0.98
Suspended solids	mg/L	**30**	**NS**	3	190	20	1	178	44	12	1

4.2.3.1 Up-stream Water Quality

Locality SW5 represents the stream water quality upstream before entering the Burnstone Mine boundary and is located upstream of the TSF (Figure 4.6). Variations in metal concentrations (iron, aluminium and manganese) are observed in locality SW5 (Figure 4.7). Improved water quality is observed during October 2017 as analysed parameters were below the relevant limits.

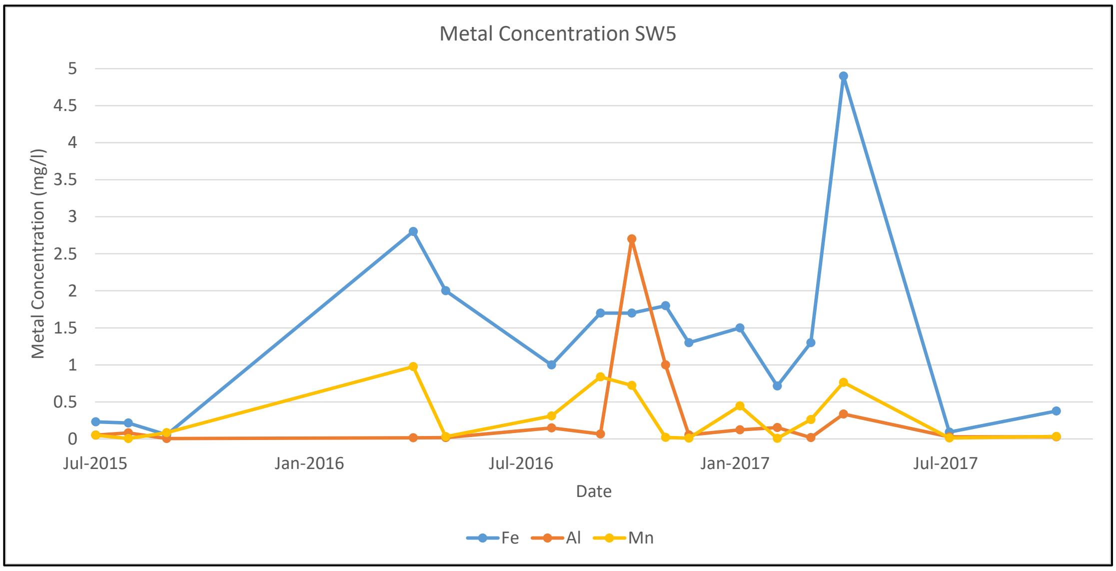


Figure 4.7: Time-series of metal concentration observed in SW5

4.2.3.2 Processing Plant and Vertical Shaft area

Locality SW6 is located downstream of the processing plant. The processing plant has not been in operation since mid-2012. During October 2017, SW6 indicated turbidity and aluminium concentrations exceeding the SANS 241 Drinking Water Standard and suspended solids and iron concentrations exceeding the WUL 2010 requirements (Table 4.3). Elevated iron and aluminium concentrations are also found in the surrounding soils of Burnstone Mine as investigated in the soil specialist study of GCS (2018). Based on the overall water quality database, however, no clear trends could be indicated, and more investigation is required to confirm this. It is likely that there is currently no impact of the processing plant area on downstream surface water quality as the plant is not operational at this stage. Water quality should still be continued to be monitored as proposed in Section 5.4.1 for a more in depth analysis.

4.2.3.3 Tributary Water Quality

Locality SW7 and SW9 are located within the stream up and down-gradient of the tributary stream respectively. SW7 represents surface water quality upstream of the tributary whereas SW9 represents surface water quality downstream of the tributary.

SW7 indicated pH not meeting the WUL 2010 requirements and turbidity exceeding the SANS 241 Drinking Water Standard. SW9 indicated iron concentration and suspended solids not meeting the WUL 2010 requirements and turbidity and iron concentrations exceeding the SANS 241 Drinking Water Standard. As shown in Figure 4.8 and Figure 4.9, higher aluminium and iron concentrations are observed in SW9 when compared to SW7. When comparing the water quality in SW7 and SW9, a potential small down-gradient impact from SW6 is observed in SW9. However, from received water quality data of Burnstone Mine, there was no clear impact from any activity at SW 9. It is likely that there is currently no impact of the processing plant area on downstream surface water quality as the plant is not operational at this stage.

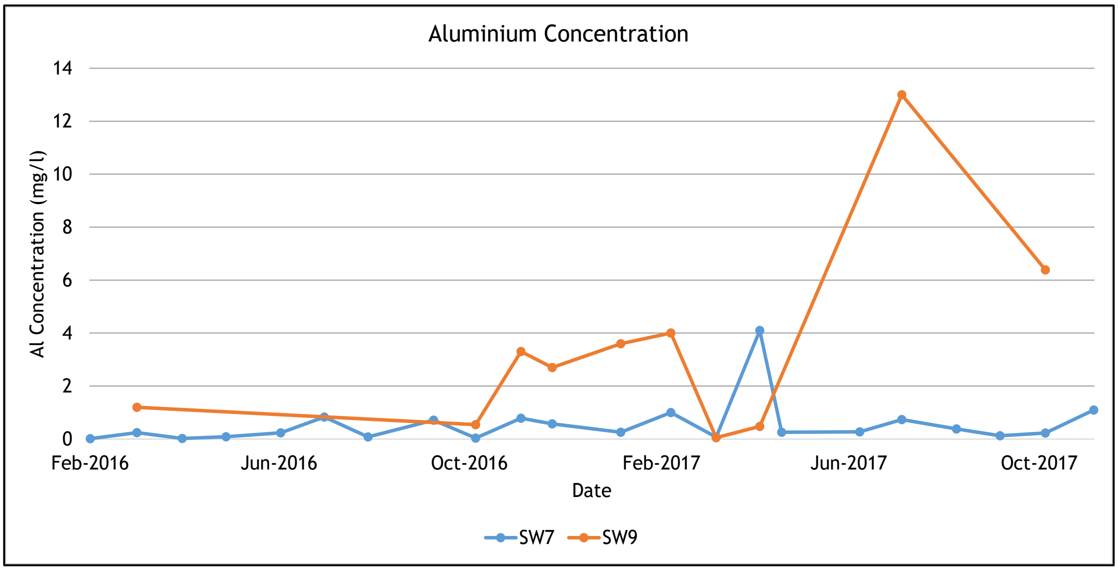


Figure 4.8: Time-series of aluminium concentration observed in SW7 and SW9

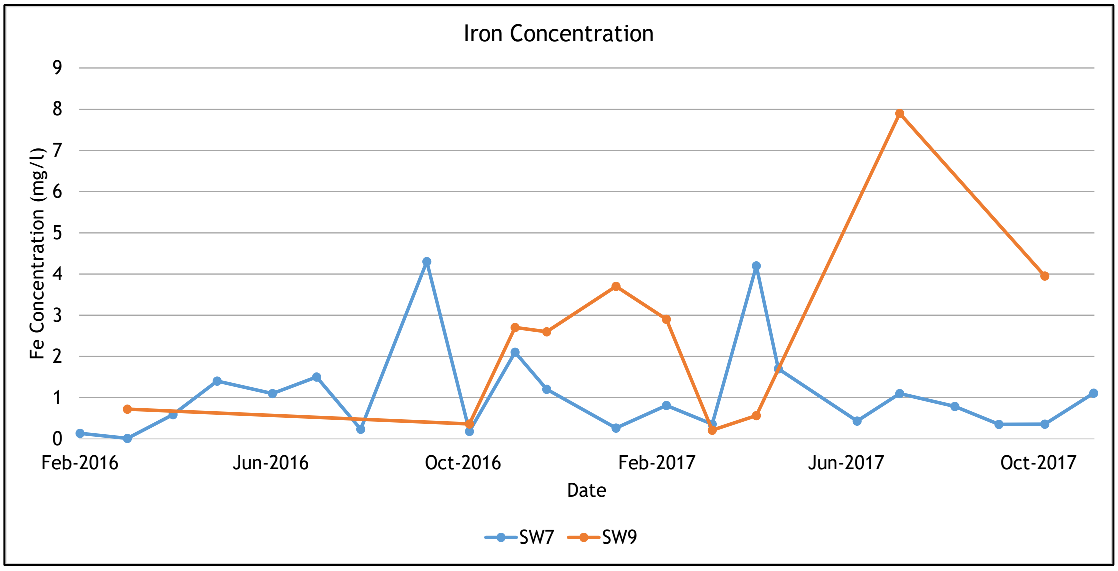


Figure 4.9: Time-series of iron concentration observed in SW7 and SW9

4.2.3.4 Operational Water

Groundwater mixed with process water from the underground workings, brine form the reverse osmosis (RO) plant and treated sewage effluent is pumped into Dam 4. The operational water is then pumped to the TSF RWD and has a spillway to the TSF SWD . Water from the TSF RWD is discharged into the stream. From Table 4.3, it is evident that Dam 4 and RWD indicate similar water quality. During October 2017, both Dam 4 and the RWD indicate fluoride concentration not meeting the WUL 2010 requirement, however, these concentrations were within the SANS 241 Drinking Water Standard as well as the Chronic Effect Value (CEV) (1.5 mg/l) for Aquatic Ecosystems (DWAF 1996). Nitrate as N exceeded the SANS 241 Drinking Water Standard but not the General Limit for Wastewater Discharges. Sources of nitrate can include the leaking of blasting residues from the underground workings. Variations in nitrate concentration within in Dam 4 and the RWD are shown in Figure 4.10. Additionally, the RWD indicates pH not meeting the WUL 2010 requirement, but does fall within the General Limit for treated wastewater discharges. From Figure 4.11 it is observed that the pH in the RWD consistently exceeds the WUL 2010 requirement of 8.5.

Two instances of elevated arsenic concentrations are observed in sampling localities Dam 4 and the RWD (Figure 4.12). Arsenic is a natural element commonly found as an impurity in gold bearing ores. Water quality in Dam 4 and the RWD are highly influenced by water from the underground workings and, in the future, by processing plant operations as well as the TSF operation. Therefore, arsenic should be included in the monitoring programme and should the quality be unacceptable, further mitigation measures should be put into place.

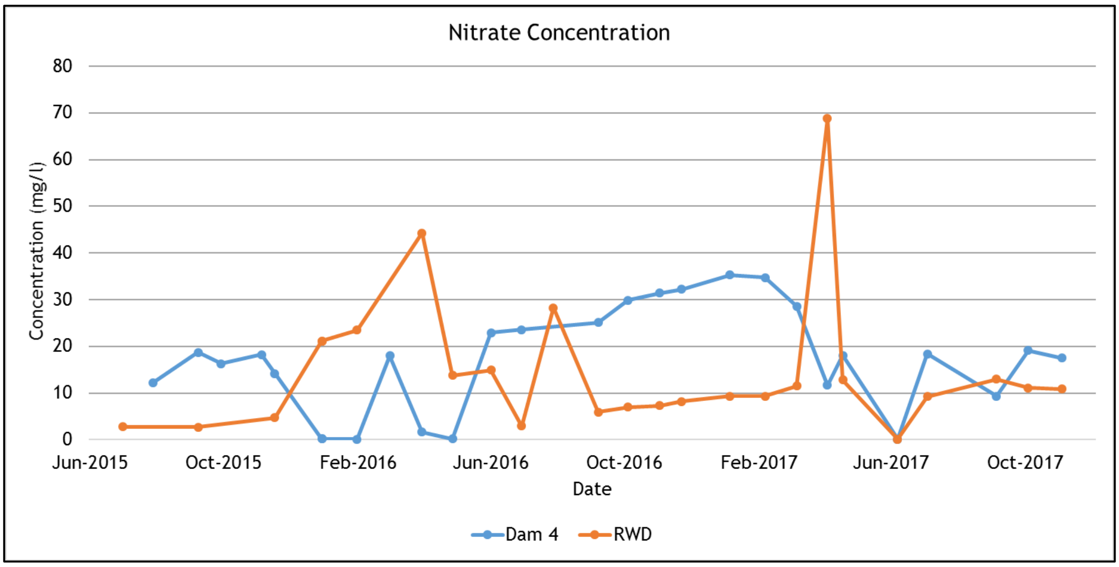


Figure 4.10: Nitrate concentration time-series observed in Dam 4 and RWD

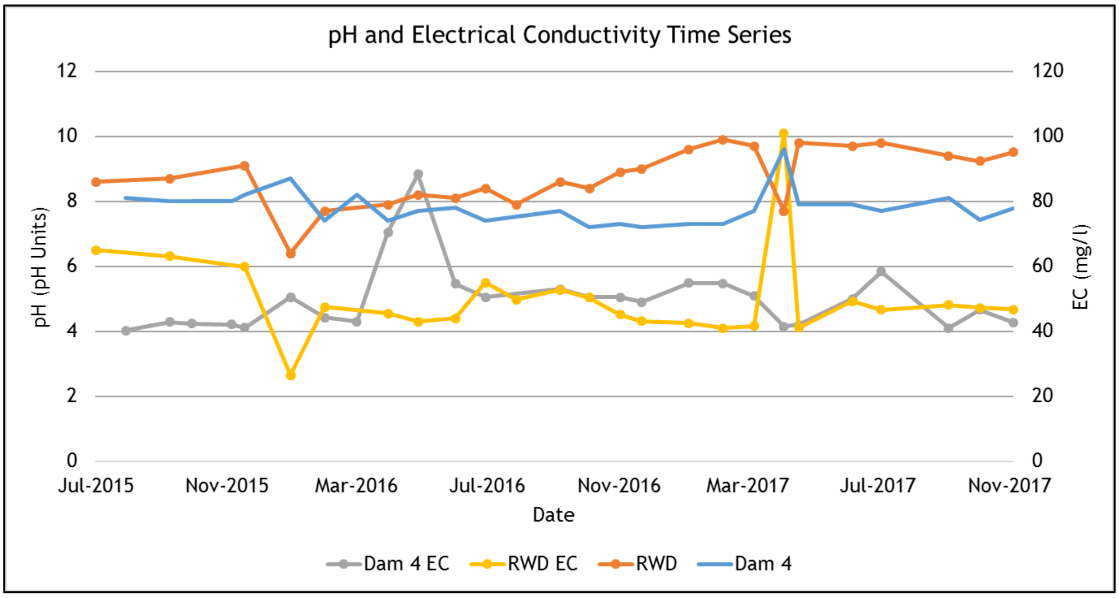


Figure 4.11: pH and electrical conductivity time-series

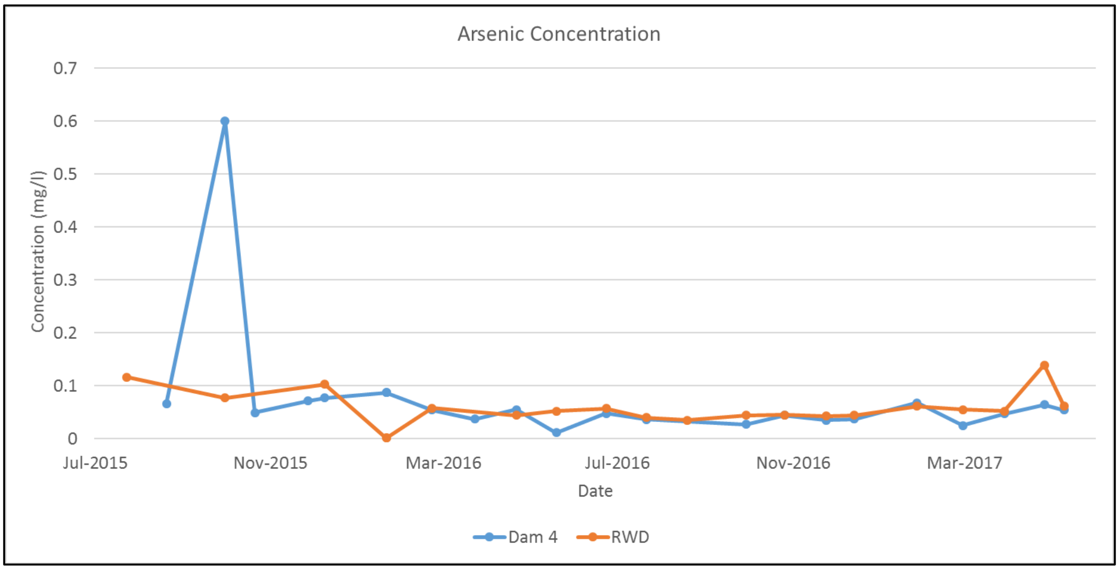


Figure 4.12: Arsenic concentration time-series

Locality SW8 is located in the stream downstream of the RWD discharge locality. SW8 indicates similar water quality to that found in the RWD. During October 2017, SW8 indicated fluoride concentration not meeting the WUL 2010 requirement. However, compliance to the instream pH WUL Limit is shown at this point indicating sufficient buffering capacity within the system.

4.2.3.5 Down-stream Water Quality

Locality SW10 is the furthest downstream monitoring locality situated within the stream. During October 2017, SW10 indicated electrical conductivity, sodium concentration (Figure 4.13) and turbidity not meeting the WUL 2010 requirements. Further downstream (at SW10) there are no exceedances with regards to pH, nitrates and fluoride. Additionally SW10 indicated turbidity and aluminium concentration (Figure 4.14) exceeding the SANS 241 Drinking Water Standard. When comparing the water quality of SW5 and SW10, a downstream impact is observed in SW10 (Aluminium, Sodium and Turbidity). However, water quality of SW10 can be influenced by natural soil conditions, agriculture impacts, Burnstone Mine and/or Balfour and it is recommended at this sampling point or an additional sampling point to be investigated further upstream (Section 5.4.1- sampling point SW10A).

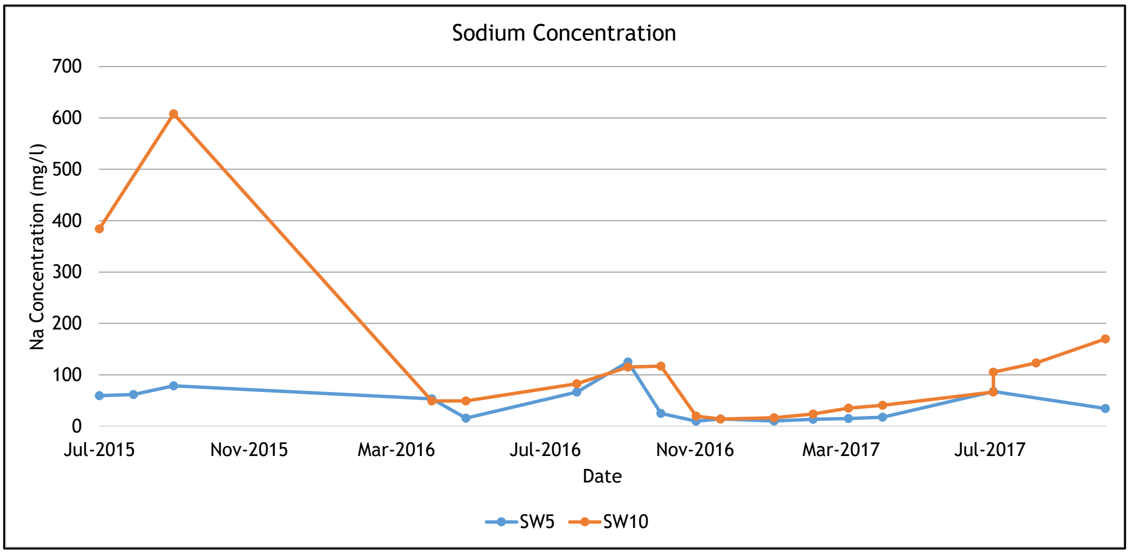


Figure 4.13: Sodium concentration time series observed in SW5 and SW10

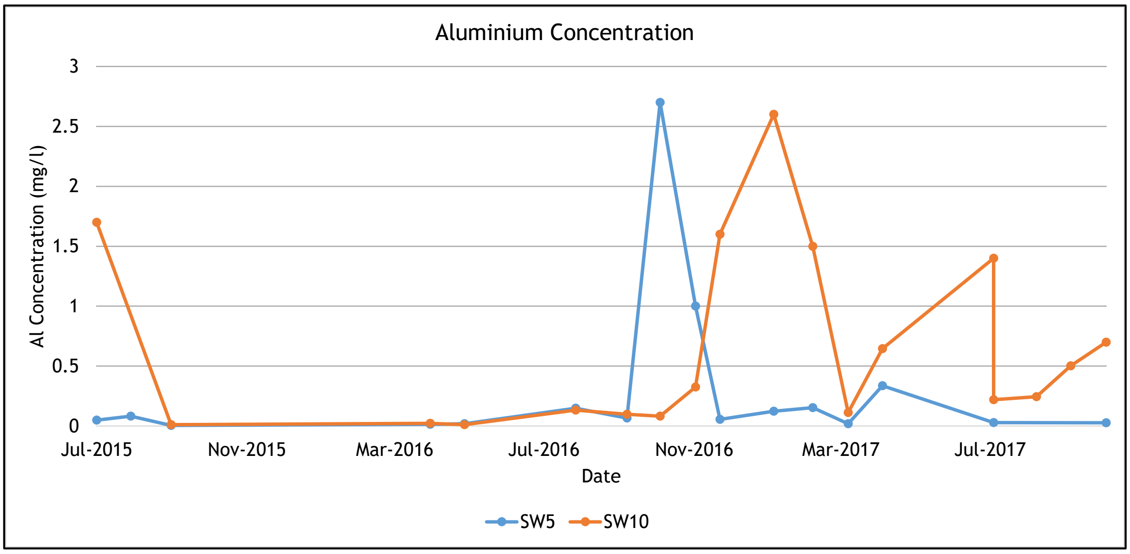


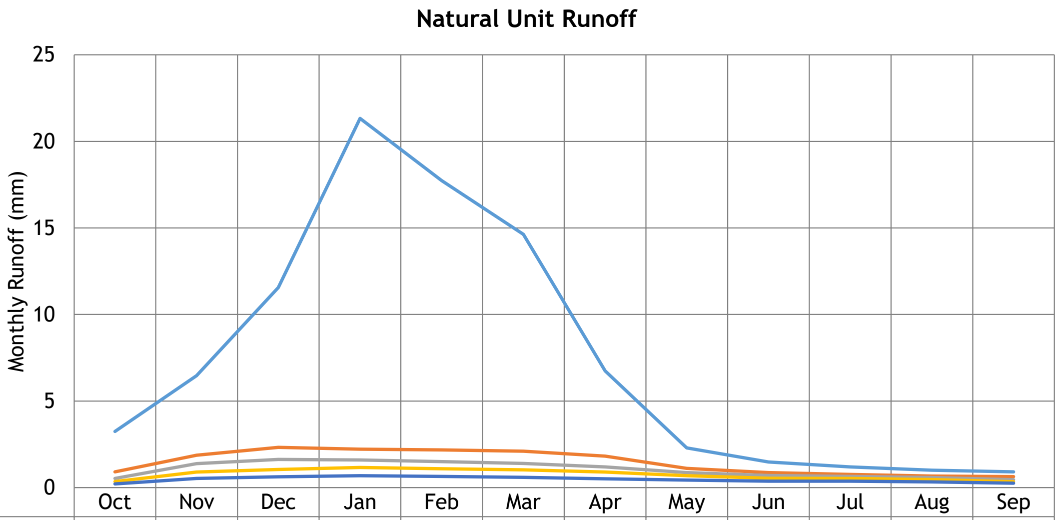
Figure 4.14: Aluminium concentration time series observed in SW5 and SW10

Table 4.4: Surface water quality results

Parameter	Units	WUL Requirements	SANS 241-1:2015 Drinking Water Standard	SW5	SW6	SW7	SW8	SW9	SW10	Dam 4	RWD
				Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017	Oct-2017
pH	pH units	**6.5-8.5**	**5-9.7**	7.23	7.81	9.3	7.51	7.82	8.18	7.43	9.24
Electrical conductivity (EC)	mS/m	**65**	**170**	60.7	60.7	25	48.3	60.8	91.6	46.6	47.2
Total Dissolved Solids (TDS)	mg/L	**NS**	**1200**	264	282	96	158	294	490	176	188
Calcium, Ca	mg/L	**NS**	**NS**	44.5	36	22.8	15.3	35.7	29.3	17.5	14.4
Magnesium, Mg	mg/L	**30**	**NS**	22.74	23.56	8.7	9.11	23.73	18.83	4.62	8.33
Sodium, Na	mg/L	**100**	**200**	34.53	53.86	45.64	76.21	53.49	169.9	67.13	70.67
Potassium, K	mg/L	**NS**	**NS**	19.23	11.15	8.76	1.93	11.24	7.64	2.2	3.77
Chloride, Cl	mg/L	**140**	**300**	21.64	29.4	12.21	24.2	29.53	116.2	15.177	21.5
Sulphate, SO_4	mg/L	**200**	**500**	154.6	79.1727	10	34.63	79.83	19.56	18.91	35.59
Total Alkalinity as $CaCO_3$	mg/L	**NS**	**NS**	97.2	170.4	87.2	162.3	168.5	257.6	86.3	112.6
Nitrate (NO_3) as N	mg/L	**NS**	**11**	0.24	0.146	0.023	0.785	0.182	0.081	19.114	11.07
Ammonium (NH_4)as N	mg/L	**NS**	**NS**	0.26	0.17	0.72	0.08	0.18	0.68	0.078	0.078
Manganese, Mn	mg/L	**0.5**	**0.4**	0.034	0.136	0.08	0.008	0.141	0.096	0.005	0.003
Fluoride, F	mg/L	**0.7**	**1.5**	0.236	0.6004	0.644	0.8189	0.611	0.641	0.881	0.769
Boron, B	mg/L	**NS**	**2.4**	0.05	0.034	0.024	0.259	0.035	0.042	0.31	0.237
Aluminium, Al	mg/L	**0.3**	**0.3**	0.028	5.488	0.226	0.028	6.385	0.7	0.028	0.028
Copper, Cu	mg/L	**NS**	**2**	0.005	0.005	0.005	0.005	0.006	0.007	0.005	0.005
Iron, Fe	mg/L	**0.5**	**2**	0.376	3.411	0.353	0.069	3.954	0.412	0.005	0.005
Lead, Pb	mg/L	**NS**	**0.01**	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	
Orthophosphate PO_4 as P	mg/L	**NS**	**NS**	0.098	0.173	0.178	0.098	0.172	0.098	0.098	0.098
Chromium, Cr	mg/L	**NS**	**0.05**	-	0.014	-	0.007	-	-	-	-
Uranium, U	mg/L	**NS**	**0.03**	0.001	0.023	0.001	0.003	0.022	0.006	0.001	0.005
Nickel, Ni	mg/L	**NS**	**0.07**	0.015	0.015	0.015	0.015	0.016	0.015	0.015	0.015
Cadmium, Cd	mg/L	**NS**	**0.003**	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Zinc, Zn	mg/L	**NS**	**5**	0.002	0.008	0.002	0.002	0.008	0.002	0.002	0.002
Total cyanide, CN	mg/L	**NS**	**0.2**	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Hardness as $CaCO_3$	mg/L	**NS**	**NS**	204.75	186.91	92.75	75.71	186.86	150.70	62.72	70.25
Calcium Hardness as $CaCO_3$	mg/L	**NS**	**NS**	111.11	89.892	56.93	38.20	89.14	73.16	43.69	35.95
Magnesium Hardness as $CaCO_3$	mg/L	**NS**	**NS**	93.64	97.02	35.82	37.51	97.72	77.54	19.02	34.30
Turbidity	NTU	**NS**	**5**	4.25	254	19.62	0.9	274	16.82	1.89	0.98
Suspended solids	mg/L	**30**	**NS**	3	190	20	1	178	44	12	1

4.2.4 Mean Annual Run-off

WR 2012 simulates runoff in the C21B catchment as being equivalent to a unit runoff of 42mm. Change of trends in annual rainfall, temperature and evaporation are likely to cause a reduction in runoff. Indirect and layered trend analysis of WR2012 flow data shows a minor reduction in MAR to 39.8mm, which is distributed in Figure 4.15.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
E10	3.2	6.5	11.6	21.3	17.7	14.6	6.7	2.3	1.5	1.2	1.0	0.9
E30	0.9	1.9	2.3	2.2	2.2	2.1	1.8	1.1	0.9	0.8	0.7	0.6
E50	0.5	1.4	1.6	1.6	1.5	1.4	1.2	0.9	0.7	0.6	0.6	0.5
E70	0.3	0.9	1.0	1.2	1.1	1.0	0.9	0.7	0.5	0.5	0.5	0.3
E90	0.2	0.5	0.6	0.7	0.6	0.6	0.5	0.4	0.4	0.4	0.3	0.3

E10 represents a value that is likely to be exceeded in 10% of years, etc.

Figure 4.15: Unit runoff for a local catchment near Burnstone

4.2.5 Resource Class and River Health

The following tables (Table 4.5 and Table 4.6) list the river class as well as the Resource Quality Objectives (RQO) for the Suikerbosrand River, into which the watercourse in whose catchment Burnstone Operation drains into (i.e. the RQOs are not directly applicable)

Table 4.5: Resource Quality Objectives for River Instream Habitat and Biota in the Upper Vaal (GN 468).

IUA	Class	River	RU	REC	RQO	Numerical Limits
UH. Suikerbosrand River	II	Suikerbosrand River	60	B/C	Instream habitat must be in a better than moderately modified condition to support the ecosystem.Instream biota must be in a better than moderately modified condition and at sustainable levels.Low and high flows must be suitable to maintain the river habitat for ecosystem condition. Low flows must the sufficient for users.Water quality: The nutrient concentrations must be decreased for ecosystem condition and other users. Temperature and oxygen	Instream Habitat Integrity category ≥ B/C (≥ 78)Fish ecological category: ≥ B/C (≥ 78)Macro-invertebrate ecological category: ≥ B/C (≥ 78)Instream Ecostatus category ≥ B/C (≥ 78)Hydrological category ≥ B/C (≥ 78)Water Quality category:≥ B/C (≥ 78)

Table 4.6: Resource Quality Objectives for River Riparian Zone Habitat in the Upper Vaal (GN 468).

IUA	Class	River	RU	REC	RQO	Numerical Limits
UH. Suikerbosrand River	II	Suikerbosrand River	60	B/C	The riparian zone must be in a better than moderately modified condition. Riparian vegetation must be in a better than moderately modified condition. The requirements of plant species of ecological importance must be provided for. Low and high flows must be suitable to maintain the riparian zone habitat for ecosystem condition.	Riparian Zone Habitat Integrity category ≥ B/C (≥ 78) Riparian ecostatus category:≥ B/C (≥ 78) Hydrological category≥ B/C (≥ 78)

4.2.6 Receiving Water Quality Objectives and Reserve

The issued WUL for Burnstone Mine (Sibanye, 2010) covered the water resource protection in the Blesbokspruit. However, the mine is currently discharging into an unnamed stream, which is a tributary of the Suikerbosrand River (Figure 1.1). The water quality objectives for Suikerbosrand cannot exceed limits presented in Table 4.7.

Table 4.7: Limits for the Suikerbosrand and Vaal River (NWA, 1998)

Parameters	Limit
F [mg/L]	3.0
Al [µg/L]	150
As [µg/L]	130
Cd hard [µg/L]	5.0
Cr (VI) [µg/L]	200
Cu hard [µg/L]	8.0
Hg [µg/L]	1.7
Mn [µg/L]	1300
Pb hard [µg/L]	13.00
Se [µg/L]	30
Zn [µg/L]	36
Chorine [µg/L]	5.0
Endosulfan [µg/L]	0.200
Atrazine [µg/L]	100

4.2.7 Surface Water User Survey

Land use in the WMA is characterised by sprawling urban and industrial areas, in the northern and western parts, together with mining of which much is now inactive. Large areas under dry land cultivation, occurring mainly in the central and south-western parts, where maize, wheat and other annual crops are grown (Upper Vaal WMA, 2003) also occur in the area. No afforestation occurs in the water management area, which mostly remains under natural vegetation for livestock farming. There are several large towns in the WMA, mainly to serve mining and agricultural development (Upper Vaal WMA, 2003).

4.2.8 Sensitive Areas Survey (Wetlands)

A wetland investigation was undertaken by GCS in 2018. Refer to Annexure 10 for the full wetland report.

4.2.8.1 Wetland Delineation

The wetlands present on site were delineated in the field. Figure 4.16 shows the delineation and the required buffers. It must be noted that the wetlands to the south of the mine were included in this assessment due to the fact that they fall within surface infrastructure and stormwater channels.

The wetland units were delineated and classified as follows:

- An Unchannelled Valley Bottom Wetland (Wetland Unit 1):
  - The upper reaches are located along the watershed between quaternary catchments C21B and C12G. The wetland unit cover 69.8ha onsite and flows out the northern boundary of the mine site boundary.
- A Channelled Valley Bottom Wetland (Wetland Unit 2):
  - The wetland unit tracks along the western to northern boundary of the site covering 95.6ha in extent. The Stormwater Dam is located within the 100 m buffer zone. While a large *Typha sp*. wetland is located along the northern boundary.
- A Unchannelled Valley Bottom Wetland (Wetland Unit 3):
  - Flows south from the upper reaches near the Vertical Shaft; between the eastern agricultural field; and the western WRD, into a larger wetland unit south of the site boundary.

The established Wetland Classification's for Wetland Units 1 and 2 are as per the 2017 Wetland Assessment Report compiled by GCS (refer to Annexure 10 for the full report).

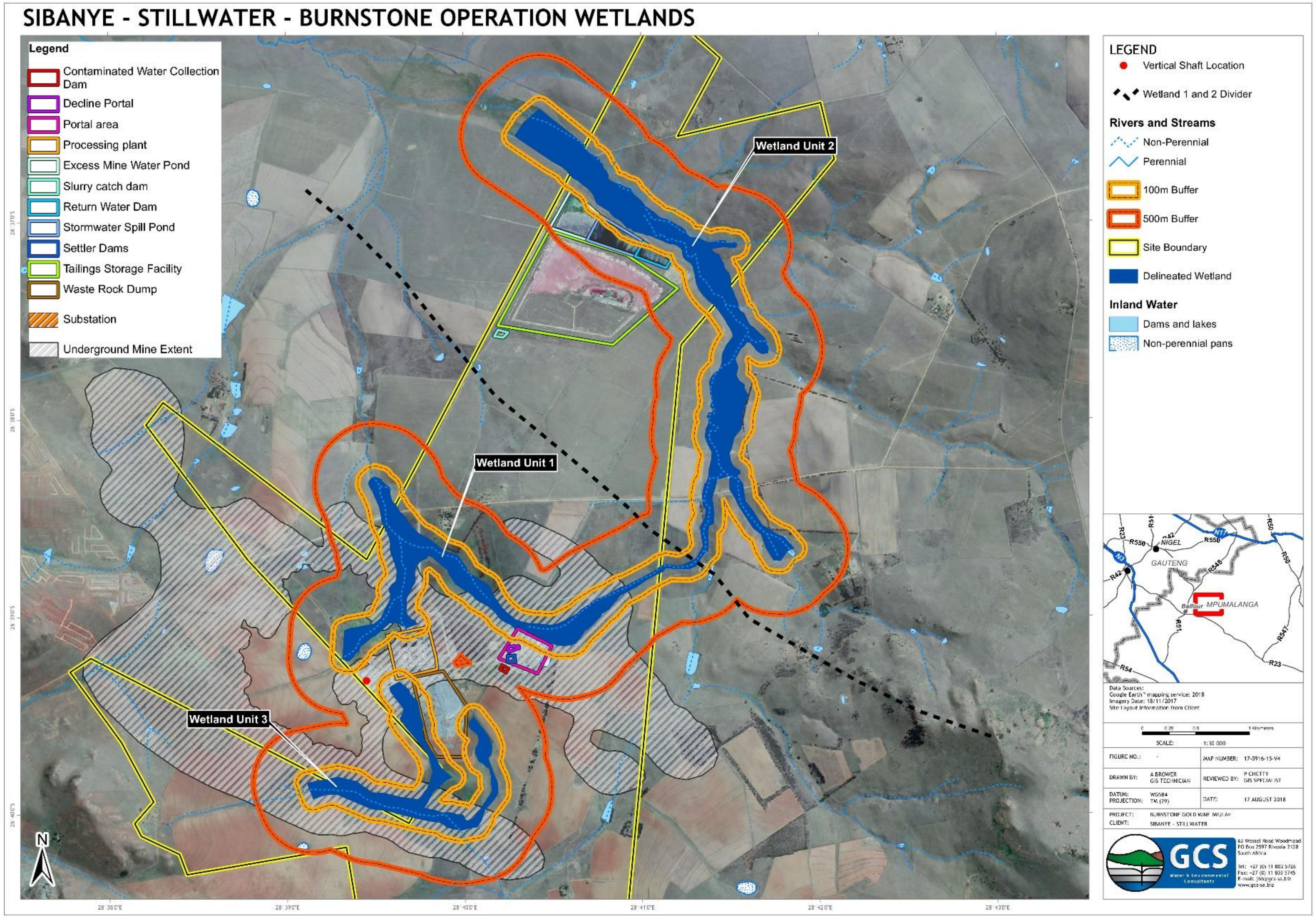


Figure 4.16: Delineated wetlands including 100m and 500m buffers

4.2.8.2 Wetland Unit 1 Classification

Refer to Table 4.8 for a summary of the classification done for Wetland Unit 1.

Table 4.8: Wetland Unit 1 Classification

SYSTEM	REGIONAL SETTING	LANDSCAPE UNIT	HYDROGEOMORPHIC UNIT
Inland	Highveld	Valley	Unchannelled Valley Bottom

Wetland IHI

The Wetland Habitat Integrity Index (Wetland-IHI) (DWAF, 2007) was designed for the rapid assessment of floodplain and channelled valley bottom wetlands. No Wetland IHI was conducted for Wetland Unit 1 or 3.

Wetland Unit 1 - PES

The Present Ecological State (PES) of Wetland Unit 1 is summarised in Table 4.9.

Table 4.9: PES Wetland Unit 1

DESCRIPTION OF ECOLOGICAL CATEGORY	ECOLOGICAL CATEGORY
Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	C

Wetland Unit 1 – EIS

The Environmental Importance and Sensitivity (EIS) of Wetland Unit 1 is summarised in Table 4.10.

Table 4.10: EIS Wetland Unit 1

RANGE OF MEDIAN	EIS CATEGORY	CATEGORY DESCRIPTION	RECOMMENDED ECOLOGICAL MANAGEMENT CLASS
>1 and <=2	Moderate	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	C

Wet-EcoServices - Wetland Unit 1

Wetland unit 1 received a high rating for indirect services and moderate rating for direct services (Table 4.11 and Table 4.12) (Figure 4.17). The higher indirect rating can be attributed to some erosion control provided by the wetland. This function can be attributed to the wetland vegetation, which assimilates nutrients, traps sediment and serves as a buffer during heavy flow events. A spike on the indirect services is observed on the trapping of phosphates.

Table 4.11: Class for the Overall Level of Indirect Services provided by Wetland Unit 1

CLASS BOUNDARIES	CLASS	CLASS DESCRIPTION
24 - 29.9	High	Largely natural with few modifications, but with some loss of natural habitats.

Table 4.12: Class for the Overall Level of Direct Services provided by Wetland Unit 1

CLASS BOUNDARIES	CLASS	CLASS DESCRIPTION
12 - 15.9	Moderate	Local people are moderately dependent on the wetland and benefit from it occasionally.

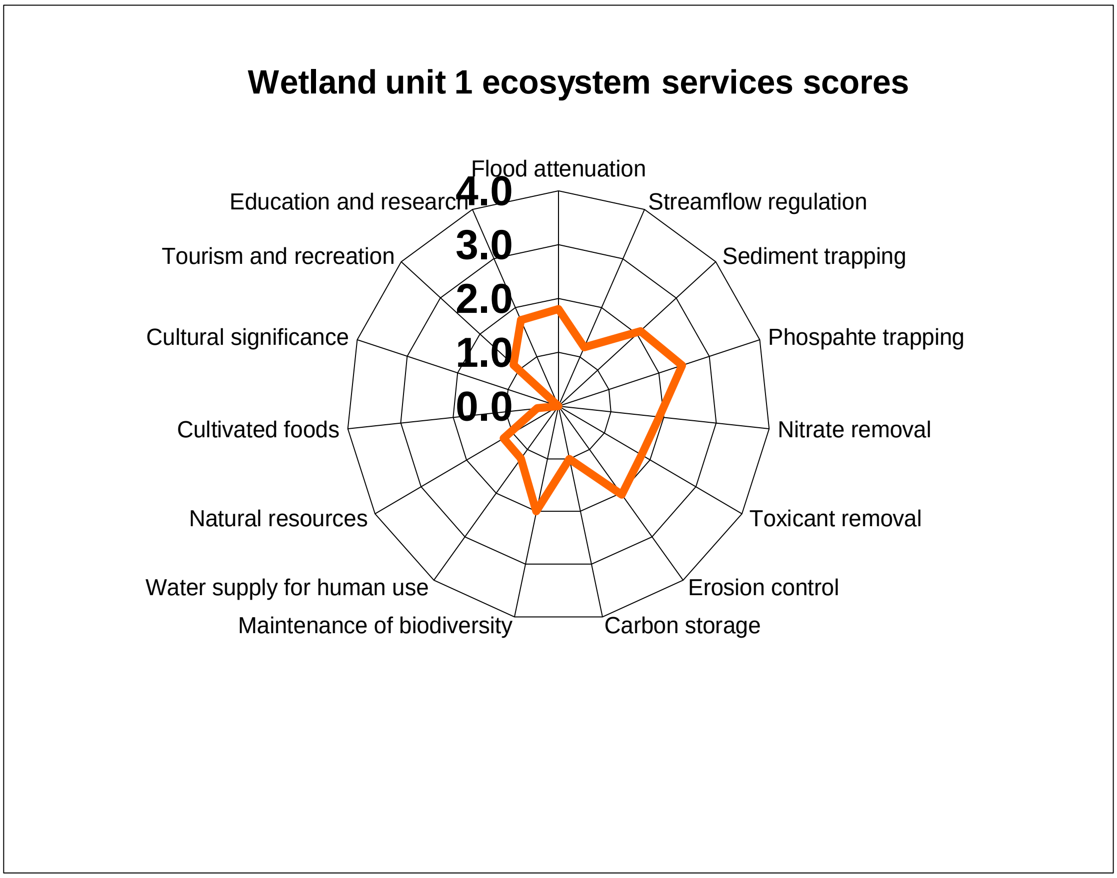


Figure 4.17: Summary Diagram of Wetland Unit 1

The wetland found on site was moderately impacted on by anthropogenic impacts. The mine was developed within the headwaters of the wetland. This has a detrimental effect on the amount of water flowing through the wetland. This in turn can have a negative effect on the functionality of the wetland. This resulted in the wetland boundaries being narrower than they used to be under more natural conditions, this was also impacted by the adjacent farming activities.

4.2.8.3 Wetland Unit 2 Classification

Refer to Table 4.13 for a summary of the classification done for Wetland Unit 2.

Table 4.13: Wetland Unit 2 Classification

SYSTEM	REGIONAL SETTING	LANDSCAPE UNIT	HYDROGEOMORPHIC UNIT
Inland	Highveld	Valley	Valley Bottom

Wetland IHI

The Wetland Habitat Integrity Index (Wetland-IHI) (DWAF, 2007) was designed for the rapid assessment of floodplain and channelled valley bottom wetlands. Refer to Table 4.14 to Table 4.16 for a summary of the vegetation, hydrology and geomorphology alternations.

Table 4.14: Vegetation Alteration

DESCRIPTION OF ECOLOGICAL CATEGORY	ECOLOGICAL CATEGORY
Vegetation composition has been moderately altered but introduced; alien and/or increased ruderal species are still clearly less abundant than characteristic indigenous wetland species.	C

Table 4.15: Hydrology Alteration

DESCRIPTION OF ECOLOGICAL CATEGORY	ECOLOGICAL CATEGORY
The impact of the modifications on the hydrological integrity is clearly identifiable, but limited.	C

Table 4.16: Geomorphology Alteration

DESCRIPTION OF ECOLOGICAL CATEGORY	ECOLOGICAL CATEGORY
Largely natural with few modifications. A slight change in geomorphic processes is discernible but the system remains largely intact	B

Wetland Unit 2 - PES

The Present Ecological State (PES) of Wetland Unit 2 is summarised in Table 4.17.

Table 4.17: PES Wetland Unit 2

DESCRIPTION OF ECOLOGICAL CATEGORY	ECOLOGICAL CATEGORY
Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	C

Wetland Unit 2 - EIS

The Environmental Importance and Sensitivity (EIS) of Wetland Unit 2 is summarised in Table 4.18.

Table 4.18: EIS Wetland Unit 2

RANGE OF MEDIAN	EIS CATEGORY	CATEGORY DESCRIPTION	RECOMMENDED ECOLOGICAL MANAGEMENT CLASS
>1 and <=2	Moderate	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	C

Wet-EcoServices - Unit 2

Wetland unit 2 received a high rating for indirect services and moderate rating for direct services (Table 4.19 and Table 4.20) (Figure 4.18). The higher indirect rating can be attributed to some erosion control provided by the wetland. This function can be attributed to the wetland vegetation which assimilates nutrients, traps sediment and serves as a buffer during heavy flow events. A spike on the indirect services is observed on the trapping of phosphates.

Table 4.19: Class for the Overall Level of Indirect Services provided by Wetland Unit 2

CLASS BOUNDARIES	CLASS	CLASS DESCRIPTION
24 - 29.9	High	Largely natural with few modifications, but with some loss of natural habitats.

Table 4.20: Class for the Overall Level of Direct Services provided by Wetland Unit 2

CLASS BOUNDARIES	CLASS	CLASS DESCRIPTION
12 - 15.9	Moderate	Local people are moderately dependent on the wetland and benefit from it from occasionally.

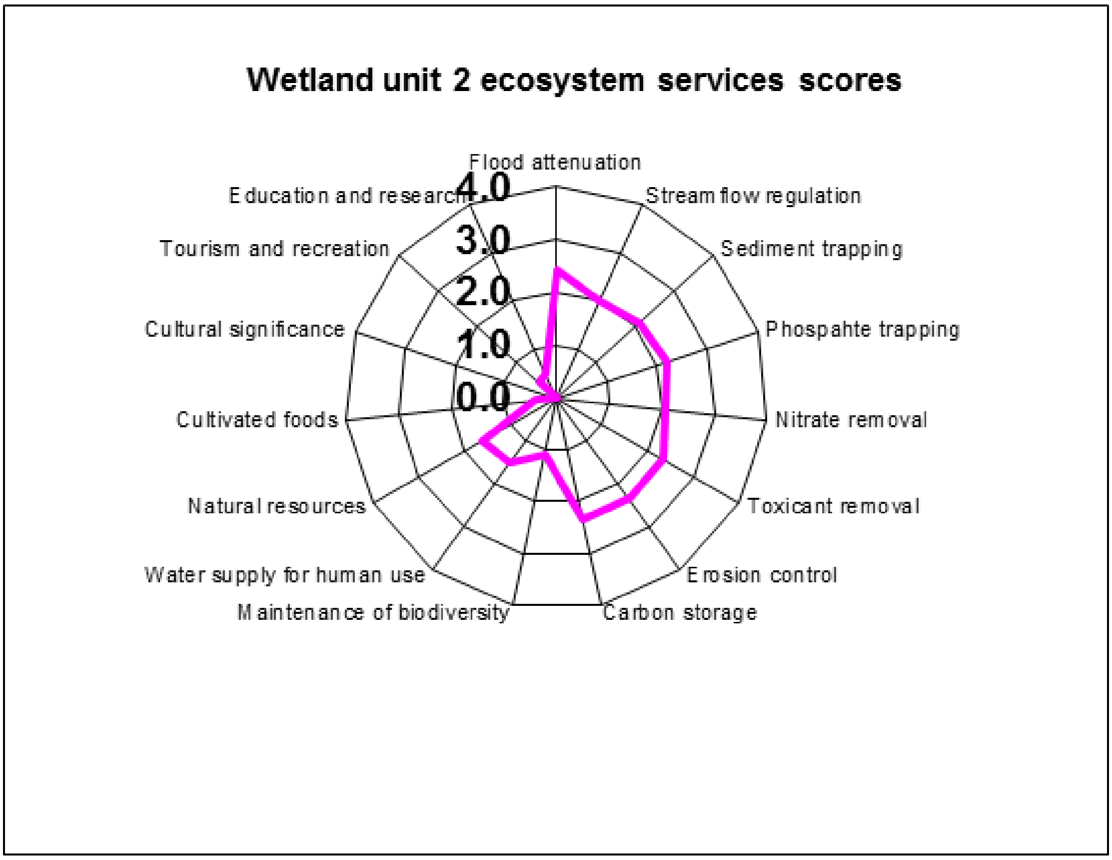


Figure 4.18: Summary diagram of Wetland Unit 2

Wetland Unit 2, situated northeast of the site was moderately impacted on by anthropogenic impacts. These impacts include a large number of farm dams constructed within the upper reaches of the wetland. Grazing activities and crop cultivation also form part of the land use associated with the upper reaches. The presence of dams, will result in a reduction of flow through the wetland system, negatively effecting the functionality of the wetland. Grazing and crop land activities occurring within and on the surrounding areas of the wetland will lead to a reduction in basal cover. This in turn might lead to an increase in water runoff velocity from the adjacent areas, resulting in erosion and sedimentation of the wetland system. A road also traverses the wetland system. This will lead to a decrease in flow velocity and damming of the wetland directly upstream of the road. Water flowing through the installed culvert system will lead to channel erosion due to the increase in velocity.

The Tailing Storage Facilities (TSF) in close proximity of the wetland system will also contribute to the moderately impacted state of the wetland. Water from the TSF may have a detrimental effect on the water quality of the wetland system. Discharge from the TSF also results in hydrological alteration of the wetland (due to increased flows), this will likely increase the overall wetland footprint.

4.2.8.4 Wetland Unit 3 Classification

Refer to Table 4.21 for a summary of the classification done for Wetland Unit 3.

Table 4.21: Wetland Unit 3 Classification

SYSTEM	REGIONAL SETTING	LANDSCAPE UNIT	HYDROGEOMORPHIC UNIT
Inland	Highveld	Valley	Unchannelled Valley Bottom

Wetland IHI

The Wetland Habitat Integrity Index (Wetland-IHI) (DWAF, 2007) was designed for the rapid assessment of floodplain and channelled valley bottom wetlands. No Wetland IHI was conducted for Wetland Unit 1 or 3.

Wetland Unit 3 - PES

The Present Ecological State (PES) of Wetland Unit 3 is summarised in Table 4.22.

Table 4.22: PES Wetland Unit 3

DESCRIPTION OF ECOLOGICAL CATEGORY	ECOLOGICAL CATEGORY
Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	D

Wetland Unit 3 - EIS

The Environmental Importance and Sensitivity (EIS) of Wetland Unit 3 is summarised in Table 4.23.

Table 4.23: EIS Wetland Unit 3

RANGE OF MEDIAN	EIS CATEGORY	CATEGORY DESCRIPTION	RECOMMENDED ECOLOGICAL MANAGEMENT CLASS
>1 and <=2	Moderate	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	C

Wet-EcoServices - Unit 3

Wetland unit 3 received a moderate rating for indirect services and low rating for direct services (Table 4.24 and Table 4.25) (Figure 4.19). The higher indirect rating can be attributed to natural resource contribution provided by the wetland. This function can be attributed to the wetland vegetation, which assimilates nutrients, traps sediment and serves as a buffer during heavy flow events. A spike on the indirect services is observed on the trapping of phosphates, nitrate removal and toxicant removal.

Table 4.24: Class for the Overall Level of Indirect Services provided by Wetland Unit 3

CLASS BOUNDARIES	CLASS	CLASS DESCRIPTION
18 - 23.9	Moderate	Moderately modified, but with some loss of natural habitats.

Table 4.25: Class for the Overall Level of Direct Services provided by Wetland Unit 3

CLASS BOUNDARIES	CLASS	CLASS DESCRIPTION
8 - 11.9	Low	Local people have a low dependency on the wetland and seldom benefit from it.

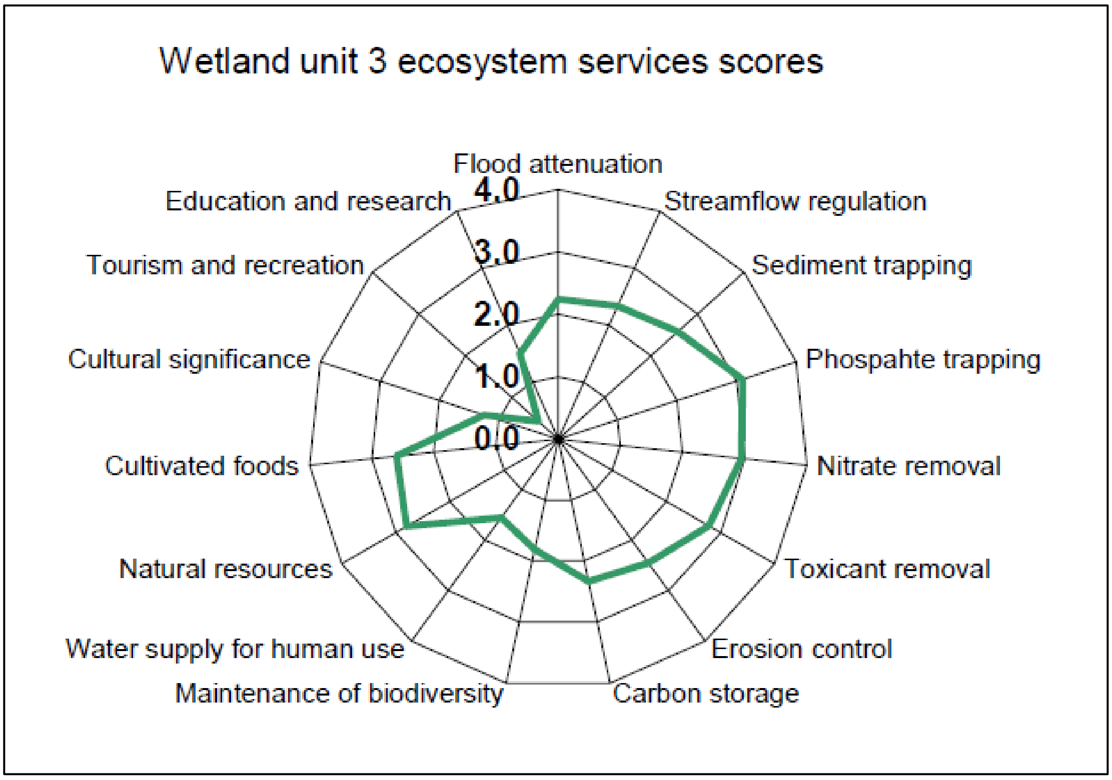


Figure 4.19: Summary diagram of Wetland Unit 3

Wetland Unit 3, covers the eastern and south western edges of the WRD, the gradient declines gradually to a larger wetland unit south of the mining rights of the site. The site was highly impacted on by anthropogenic impacts. These impacts include runoff filtering into the wetland unit from the Vertical Shaft and WRD, an unlined catchment channel along the eastern boundary of the WRD, and an unlined stormwater dam constructed within the upper reaches of the wetland.

The presence of the WRD, will result in an increase of flow through the wetland system, negatively effecting the functionality of the wetland. Accumulation of pollutants will most likely occur around the wetland unit surrounding the WRD, from deposition and erosion control generated by the vegetation within the wetland. This in turn might lead to point source pollution, resulting in increase of sulphates and potentially other salts and metals within the wetland system. The unlined stormwater dam may contribute to contamination of the downstream, wetland system through leeching. This will lead to further contaminates affecting the downstream wetland system. Water flowing from the Vertical Shaft into the upper reaches of the wetland unit may contribute to the integrity of the wetland systems with detrimental effect on the water quality within the wetland system.

The wetland unit 3, is a partially Stormwater fed wetland. The Stormwater is received from the adjacent Vertical Shaft by means of a 500mm Stormwater pipe. This wetland area has limited ecological functionality due to the fragmentation. It is recommended that the Stormwater pipe being extended or diverted, as per the GCS Stormwater Management Report (2018).

4.3 Groundwater

A geohydrological investigation was undertaken by GCS in 2018. Refer to Annexure 9 for the full Geohydrological report.

4.3.1 Aquifer Characterisation

4.3.1.1 Groundwater vulnerability and Classification

The aquifer vulnerability and classification maps of South Africa classify the underlying aquifer of the study area as a minor aquifer, which is further categorised as a moderately vulnerable aquifer system (DWS, 2012). According to Parsons and Conrad (1998), a minor aquifer system can be defined as fractured or potentially fractured rock assemblages, which do not have high permeability, or other formations of variable permeability. The aquifer extent may be limited and seldom produces large quantities of water.

4.3.1.2 Aquifer Protection Classification

Potential pathways for contamination of the underlying aquifer exist within the study area, and necessitate intensified preventative and remedial measures to enhance the protection of the underlying minor aquifers.

According to the 1:250 000 geological map series 2628 East Rand (Council for Geoscience, 1986), dolerite dykes and sills underlie the study area. The surface expression of a dolerite intrusion is located towards the northern extent of the surficial perimeter of Burnstone. This area is potentially at risk, as the contact of the intrusion with the adjacent host rock, may represent a preferential flow path for seepage from the mining activities, particularly the

TSF and associated dams, to the underlying shallow aquifers. Similarly, the contacts of dolerite intrusions at, and just outside of the western perimeter of Burnstone, could also represent preferential pathways for seepage flow.

An inferred dolerite dyke, located at depth, is indicated in the central area of the Burnstone site, extending for approximately 2.5 km from the southern to northern extent of the site. Potential seepage from mining activities, particularly the processing plant, WRD and TSF could follow the contact between the dyke and Ventersdorp Supergroup, Witwatersrand Supergroup and Karoo Supergroup. Geophysical studies conducted in 2005 and 2009 by Knight Piesold, indicate the existence of a potential north-south trending dyke within this area. An isolated anomaly perpendicular to the dyke observed from the geophysical results, was inferred as an intrusive sill, which supports the existence of a fault within this area. However, the magnetic anomaly shapes and lack of surface expression, indicated that the intrusions are located at an approximate depth of 80 mbgl, which lowers the risk of seepage interception from the TSF area.

Faults within the study area represent pathways for seepage from the mine activities. Several north-west to south-east, west to east, and south-west to north-east trending faults occur within the study area. The Sugarbush Fault located immediately south of the TSF, is considered a potential pathway for contaminated seepage to the intercepted aquifers. The likely existence of fracture zones at the TSF site, as well as areas of deep weathering were indicated by geophysical studies conducted by Knight Piesold in 2005 and 2009. However, as faults within the study area lack surficial expression, and do not intercept the overlying Karoo Supergroup of a thickness ranging between 85 to 121.5 m, the risk of faults intercepting seepage from the mine facilities is lowered.

According to the geological map, alluvial deposits are located along the length of the eastern-most and northern boundaries of the study area. The alluvial deposits are areas anticipated to be of potentially higher permeability, and thus areas of higher risk for aquifer contamination. The alluvial deposit forms part of a palaeochannel and existing watercourse, which is subject to discharge from the stormwater spills pond at the northern boundary of Burnstone. Non-perennial streams drain other areas of Burnstone, and the associated alluvial deposits are also considered areas of higher permeability.

It is suggested that areas where topsoil has been stripped could have increased rainfall and moisture infiltration rates. This is particularly plausible for the TSF and RWD area, where the substrate will be exposed to long periods of inundation by wet tailings. The underground workings and vertical and decline shafts also represent direct pathways of contamination into the underlying aquifers, and represent areas where the geology has been disrupted, through blasting, traffic, grouting activities etc. Wetland and riverine environments represent areas with shallower groundwater levels and higher permeability substrate, which could contribute contaminants from surface-derived sources to the underlying aquifers.

The following is concluded from the aquifer protection analysis (Figure 4.20):

- Faults and intrusions that occur at depth represent a risk to the aquifer, albeit perceived as low, for seepage interception and contamination of the minor aquifers of the study area;
- Increased risk of seepage and aquifer contamination is apparent at the following features:
    - Dolerite intrusions that outcrop at the surface;
    - Alluvial deposits and the palaeochannel;
    - Areas that have been stripped of topsoil;
    - Processing areas, containment structures, storage facilities;
    - Underground workings and vertical and decline shafts; and
    - Wetland and riverine environments.
- The processing plant, WRD and associated mine activities in the southern area of the site, represent a lower risk of shallow aquifer contamination than the northern TSF area. This is based on the type of materials stored in this area, contamination pathway analysis and their position on a topographic high;
- However, the underground workings and shafts located in the southern study area represent a high risk of contamination of the deeper aquifers; and
- It should also be noted that dewatering activities within the underground workings could disturb the groundwater levels in the shallow and deeper aquifers, and thereby alter the established hydraulic gradient for several decades.

It is accordingly suggested, that the general study area requires moderate aquifer protection, and protection measures of a higher ranking at the TSF, WRD, shafts and underground workings.

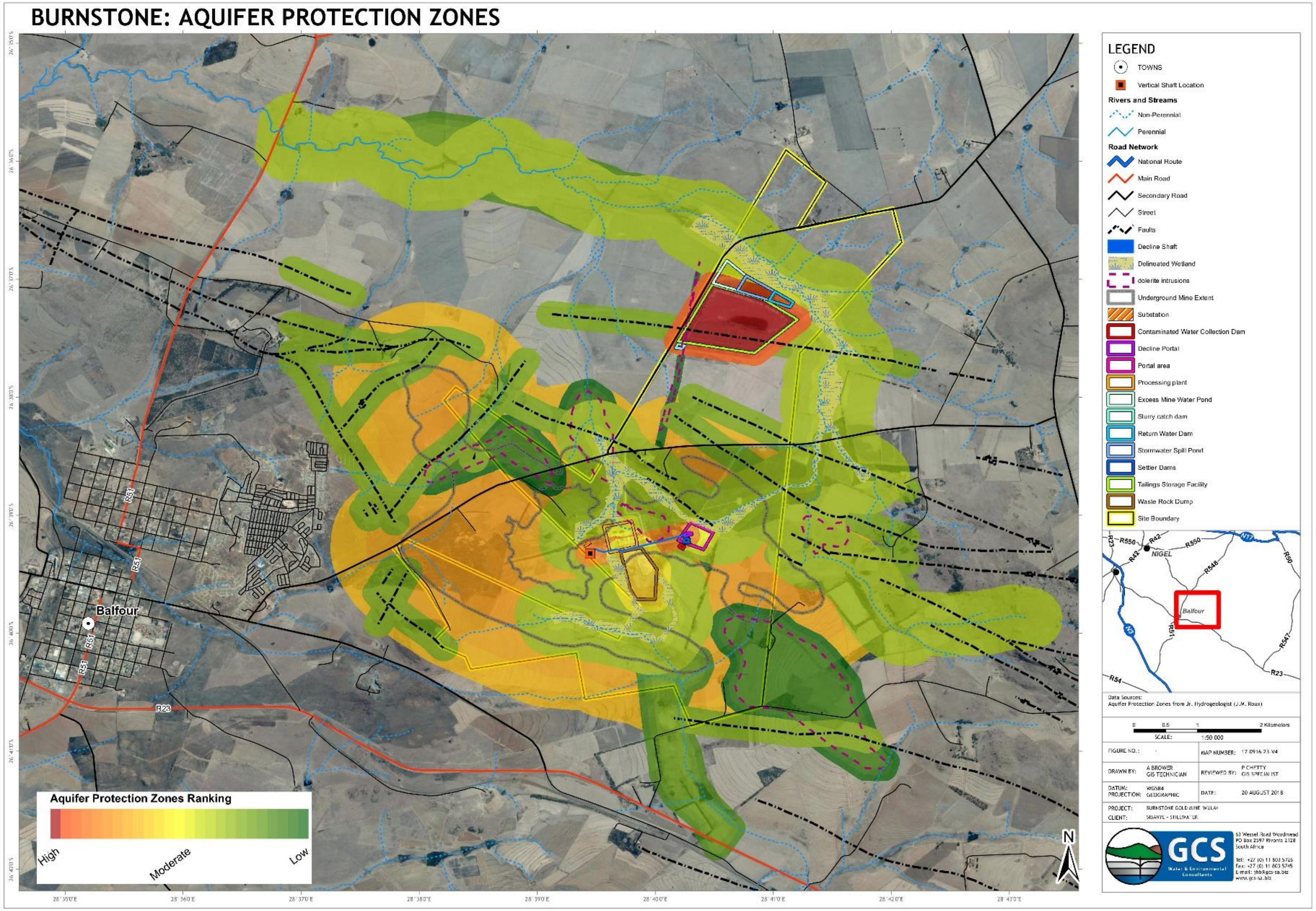


Figure 4.20: Aquifer Protection Zones - Low, Moderate or High Protection required. Overlying zones indicate progressively shallower aquifers.

4.3.2 Hydrocensus

4.3.2.1 Previous Hydrocensus Results

A hydrocensus investigation was conducted within a 6 km radius of the Burnstone mining area, during the Preliminary Risk Assessment study that was undertaken in 2005 (GCS, 2005). A total of 62 boreholes were investigated.

It was found that most of the existing boreholes within the area are used for domestic purposes and for livestock watering. Groundwater use was generally less than $10m^3$/day per property, and the abstraction from boreholes was approximately 1 to $9m^3$/day. Total groundwater abstraction in the 6 km radius hydrocensus area was approximately $100m^3$/day.

The depth of the groundwater levels varied between artesian (at surface) to 21.70mbgl, and represented a good correlation with topography, with a linear correlation R-squared value of 88 % (Future Flow, 2015). Deeper water levels measured at BG2a, BG3a and BG9B were attributed to abstraction for domestic and livestock use purposes. No springs were identified during the field hydrocensus, however, two seasonal springs were considered based on the infrastructure planning map.

4.3.2.2 Recent 2017 Hydrocensus

A recent hydrocensus investigation was conducted from 21st to 24th November 2017 by GCS. Forty-nine (49) boreholes were identified within a 5 km radius. The depth of the measured static water levels (SWL) vary between artesian (at surface) to 44.5 meters below ground level (mbgl) (refer to Table 4.26). Deeper groundwater levels, particularly for boreholes BG9a, BG5a, HBH16 are HBH17, are potentially attributed to the impacts of abstraction for domestic and livestock watering purposes. The locations of the hydrocensus boreholes investigated are presented in Figure 4.21.

Table 4.26: 2017 Hydrocensus Borehole Information

ID	Latitude	Longitude	SWL (mbgl)	Collar Height (m)	Depth (m)	Equipment	Use
HBH2	-26.60732	28.653	2.94	0.11	29	Open well	Not in use
HBH3	-26.60635	28.64034	3.29	0.17	23	Open well	Not in use
HBH4	-26.62966	28.62532	9	0.54	13.63	Open well	Not in use
HBH5	-26.62117	28.63924	6.58	0.38	Not known	Wind pump	Not in use
HBH6	-26.62342	28.63063	11.095	0.23	40	Submersible pump	Domestic and Cattle

ID	Latitude	Longitude	SWL (mbgl)	Collar Height (m)	Depth (m)	Equipment	Use
BG9a *	-26.62644	28.62948	31.8	0.15	90	Submersible pump	Domestic and Cattle
HBH7	-26.62306	28.62265	4.2	0.54	5	None	Not in use
HBH8 *	-26.62531	28.61417	<50	0.6	Not known	Submersible pump	Domestic
HBH9	-26.62397	28.60925	Unable to measure	0.2	56	Submersible pump	Use at Workshop, when needed
BG10g	-26.622	28.60013	4.94	0.24	100	None	Not in use
HBH10	-26.62889	28.61254	6.1	0.14	26.5	None	Not in use
BG4b	-26.62338	28.71247	6.85	0	Not known	Submersible pump	Domestic and Cattle
BG4a	-26.62424	28.71116	Unable to measure	0	Blocked at 8m	Submersible pump	Not in use
BG4c	-26.60738	28.69829	12.74	0.25	Not known	Windpump broken	Not in use
BG2h	-26.57656	28.67836	0.2	0.5	7	Windpump broken	Not in use
BG2i	-26.57618	28.67922	2.2	0.21	Not known	Mono pump	Use for cattle and mixing
BG2g	-26.57618	28.69175	Unable to measure	0	Not known	Mono pump	Use for cattle and mixing
HBH11	-26.58907	28.685	3.59	0.17	Not known	Mono pump	Not in use
HBH12	-26.58953	28.68443	2.81	0.05	Not known	Windpump broken	Not in use
BG2f*	-26.592	28.68538	1.17	0.08	Not known	Mono pump	Domestic and Cattle
BG2e	-26.59787	28.68693	18.55	0.14	20	None	Not in use
HBH13	-26.60106	28.68896	9.23	0.37	9.4	Windpump broken	Not in use
HBH14	-26.64506	28.69868	3.71	0.32	40	Submersible pump	Domestic watering and house water
BG5a *	-26.64027	28.68893	25.86	0	30	Submersible pump	Domestic watering and house water

ID	Latitude	Longitude	SWL (mbgl)	Collar Height (m)	Depth (m)	Equipment	Use
HBH15*	-26.65681	28.72294	20.2	0.2	Not known	Submersible pump	Domestic
HBH16*	-26.66315	28.72972	30.86	0.31	50	Submersible pump	Domestic and Livestock watering
HBH17	-26.66925	28.72877	44.5	0.2	60	Windpump	Domestic for workers
BG6a	-26.63536	28.64727	12.37	0	Not known	Submersible pump	Domestic watering and cattle
BG6b	-26.61972	28.66386	8.99	0.51	Not known	Submersible pump	Cattle
HBH18*	-26.68748	28.66392	Unable to measure	0	Not known	Submersible pump	Domestic and Livestock watering
HBH19	-26.68834	28.66198	26.42	0.17	30	Windpump broken	Not in use
HBH20	-26.67213	28.69371	8.41	0.12	11.2	Windpump broken	Not in use
HBH21	-26.68618	28.69798	Unable to measure	0.12	Not known	Mono pump	Not in use
HBH22	-26.68567	28.69919	4.36	0.55	Not known	Windpump	Cattle
HBH23	-26.68317	28.70752	25.12	0.25	32	None	Not in use
HBH24	-26.67886	28.71469	15.05	0.1	25	Windpump	Cattle
WBH 14*	-26.68028	28.70886	17.39	0.18	75	Submersible pump	Domestic and Livestock watering
HBH25	-26.67778	28.69045	Unable to measure	0.06	Not known	Windpump	Livestock watering
HBH26	-26.69244	28.67884	5.3	0.17	Not known	Windpump	Cattle
HBH27	-26.6956	28.689	Unable to measure	0	Not known	Windpump	Cattle
HBH28	-26.69927	28.69855	0.39	0.002	4	Windpump	Cattle
BG9b	-26.62742	28.62987	-	-	Blocked at 17m	Open well	Not in use

ID	Latitude	Longitude	SWL (mbgl)	Collar Height (m)	Depth (m)	Equipment	Use
A2	-26.66901	28.62873	-	-	-	-	No access
SSG079	-26.69298	28.69657	0	0.39	Not known	None	Cattle

(*Groundwater sample collected)

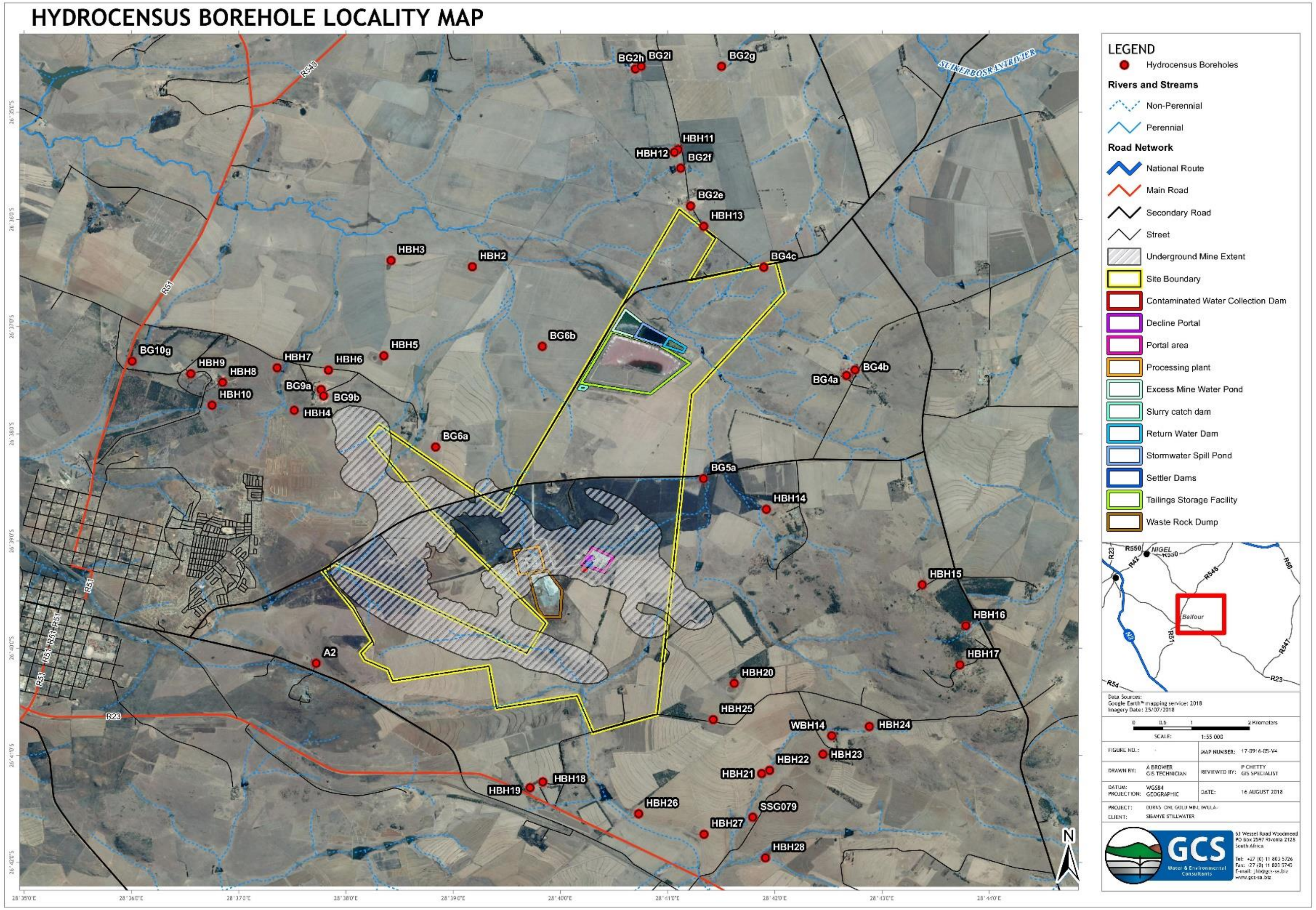


Figure 4.21: Hydrocensus Borehole Locality

4.3.2.3 Hydrocensus Bayesian Correlation

Figure 4.22 expresses the linear relationship between observed groundwater levels in 2017 and associated topographic elevations for the hydrocensus boreholes. This relationship suggests that the groundwater levels generally mimic the topography of the area; and it is suggested that at present the majority of the hydrocensus boreholes are not significantly influenced by a potential external influence, such as domestic abstraction or mining. A linear correlation, with an R-squared value of 92.3 % exists between groundwater levels and the topographic elevation.

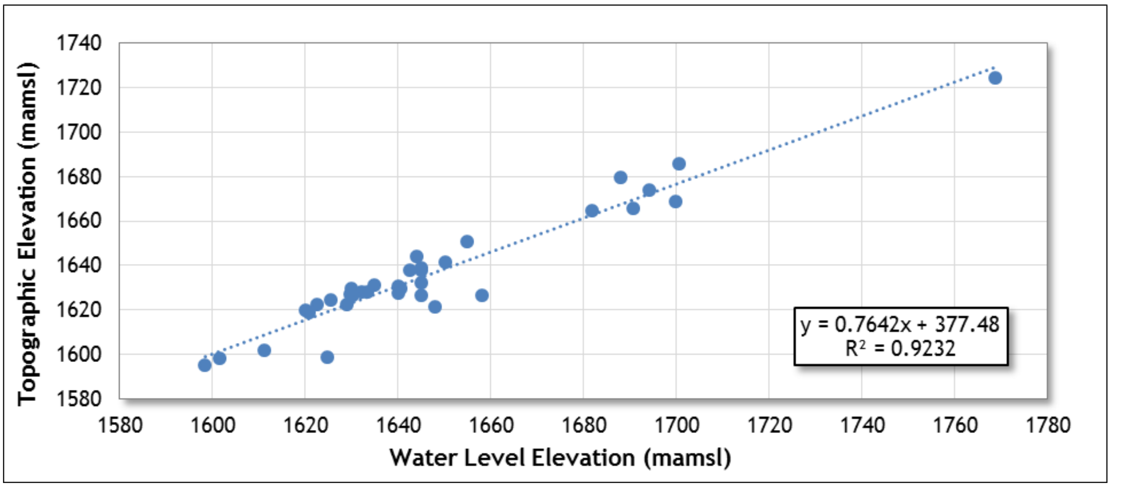


Figure 4.22: Correlation between hydrocensus borehole surface elevations and the measured groundwater levels

4.3.2.4 Groundwater Contour Map

Based on the relationship between groundwater levels obtained during the 2017 hydrocensus investigation and their associated topographic elevations, an interpolated groundwater contour map is shown in Figure 4.23. Groundwater flow directions are also illustrated. It should be noted that the map is representative of the groundwater levels measured for the hydrocensus boreholes surrounding Burnstone, and does not include the groundwater levels of the Burnstone monitoring boreholes.

The following is concluded from the groundwater contour map produced from the 2017 hydrocensus results:

<u>Tailings Storage Facility (TSF)</u>

The depth of the groundwater level at the TSF site varies between 12 and 18mbgl. Groundwater is flowing in a westerly to north westerly direction toward the drainage area situated down-gradient of the TSF.

Processing plant and shaft

The processing plant and shaft are located on a local water divide. Groundwater flow occurs towards the north and south, however, predominant flow is towards the north. The water level depth at the plant site is approximately 18.4mbgl.

Waste rock dump

The waste rock dump is also located on the water divide. The water level depth at the waste rock dump is approximately 18.5mbgl, and two distinct groundwater flow directions occur within this area: north and south.

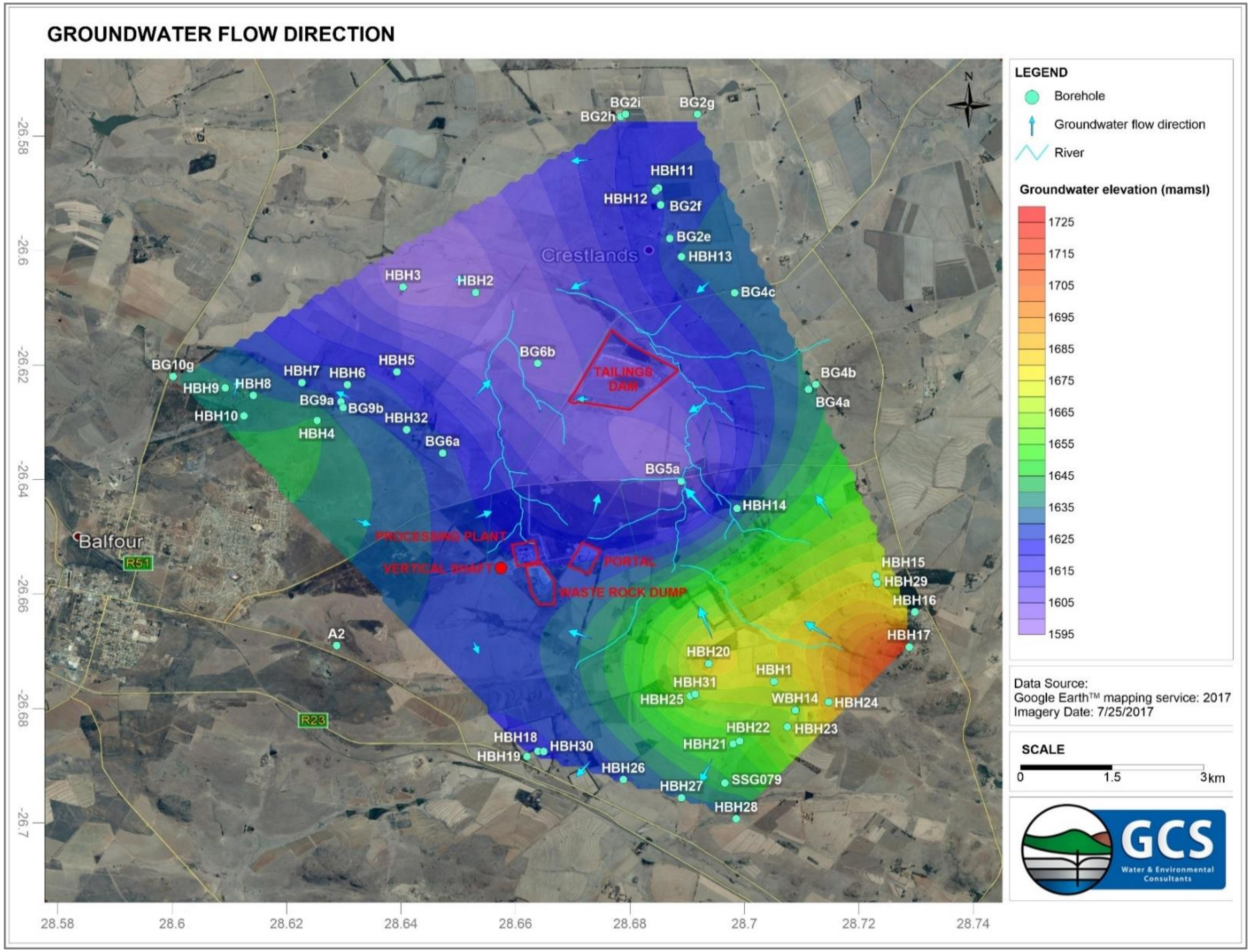


Figure 4.23: Groundwater Level Contour and Flow Direction Map based on the 2017 hydrocensus information only

4.3.3 Existing Monitoring Borehole Framework

Burnstone Mine has monitored the groundwater levels and quality of several boreholes located within the site perimeter, and a few boreholes outside of the surficial extent of the mine, as well as the water quality of selected surface water sites in the study area, as per the terms of the approved Water Use License (WUL) (DWS, 2010). The details of each WUL monitoring point and other monitoring points, not listed in the WUL (DWS, 2010), are presented in Table 4.27. The locations of all known monitoring boreholes are presented in Figure 4.24.

Table 4.27: Burnstone Monitoring Points (*Water Use license Point)

Locality	Latitude	Longitude	Start	End	Description
BG3b*	-26.644689	28.664569	Jul-2015	Oct-2017	Down-gradient of Plant, WRD and portal
BG7d*	-26.653223	28.654861	Jul-2015	Oct-2017	Down-gradient of Vertical Shaft
BGM058	-	-	Jul-2015	Jul-2016	-
BPB1*	-26.653593	28.670674	DRY	-	Portal Area
BPB3*	-26.652791	28.660987	DRY	-	Plant Area
BPB4	-26.654306	28.662778	Jul-2015	Oct-2017	Plant Area
BSB1*	-26.647708	28.669775	DRY	-	Adjacent to settler dams (portal area)
BSB2*	-26.651961	28.670134	Jun-2015	Oct-2017	Down-gradient of portal
BTB1*	-26.616713	28.679652	Jun-2015	Oct-2017	Adjacent to excess mine water pond and down-gradient of TSF
BTB2*	-26.618641	28.681354	Jun-2015	Oct-2017	At stormwater spills pond and down-gradient of TSF
BTB3*	-26.619984	28.685451	Jun-2015	Sep-2017	In RWD area and down-gradient of TSF
BTB4*	-26.627205	28.67611	Jun-2015	Oct-2017	TSF Area
BTB5*	-26.623627	28.669727	Jun-2017	Oct-2017	TSF Area
BTB6*	-26.62353	28.671581	Jun-2017	Oct-2017	TSF Area
BUR02	-26.626833	28.672725	Jun-2015	Oct-2017	TSF Area and adjacent to slurry catch dam
BUR03	-26.626297	28.669403	Jun-2015	Oct-2017	TSF Area and adjacent to slurry catch dam
BWB3*	-26.660346	28.662903	Jun-2015	Oct-2017	WRD Area
BWR2	-26.659628	28.663175	Jun-2015	Oct-2017	WRD Area
BWR03	-26.660800	28.665622	Jun-2015	Oct-2017	WRD Area
PCD 4 (JB windmill)	-26.619792	28.663869	Sep-2015	Oct-2017	Down-gradient of plant area and TSF

Locality	Latitude	Longitude	Start	End	Description
GW1	-	-	May-2015	Jun-2015	-
GW4	-	-	Jul-2015	-	-
Hardus Brits*	-26.649583	28.655228	Jul-2015	Oct-2017	Down-gradient of plant and vertical shaft
Jabu Binda Homestead	-	-	Sep-2015	May-2017	-
WB18*	-26.640983	28.665026	Jul-2015	Oct-2017	Down-gradient of Plant, WRD and portal
Surface Water					
SW5*	-26.639866	28.689243	Jul-2015	Oct-2017	Upstream of TSF
SW6*	-26.641484	28.65931	Feb-2016	Oct-2017	Downstream of plant area and shaft
SW7*	-26.628498	28.667382	Feb-2016	Oct-2017	Upstream of TSF
SW8*	-26.612662	28.676897	Jun-2015	Oct-2017	Downstream of TSF and stormwater spills pond
SW9*	-26.609832	28.659224	Mar-2016	Oct-2017	Downstream of plant area
SW10*	-26.595779	28.613627	Jun-2015	Oct-2017	Furthest downstream instream point
PCD 4	-26.651372	28.669481	Aug-2015	Oct-2017	Dam downstream of portal
RWD	-26.617833	28.682411	Jul-2015	Oct-2017	Spill from return water pond

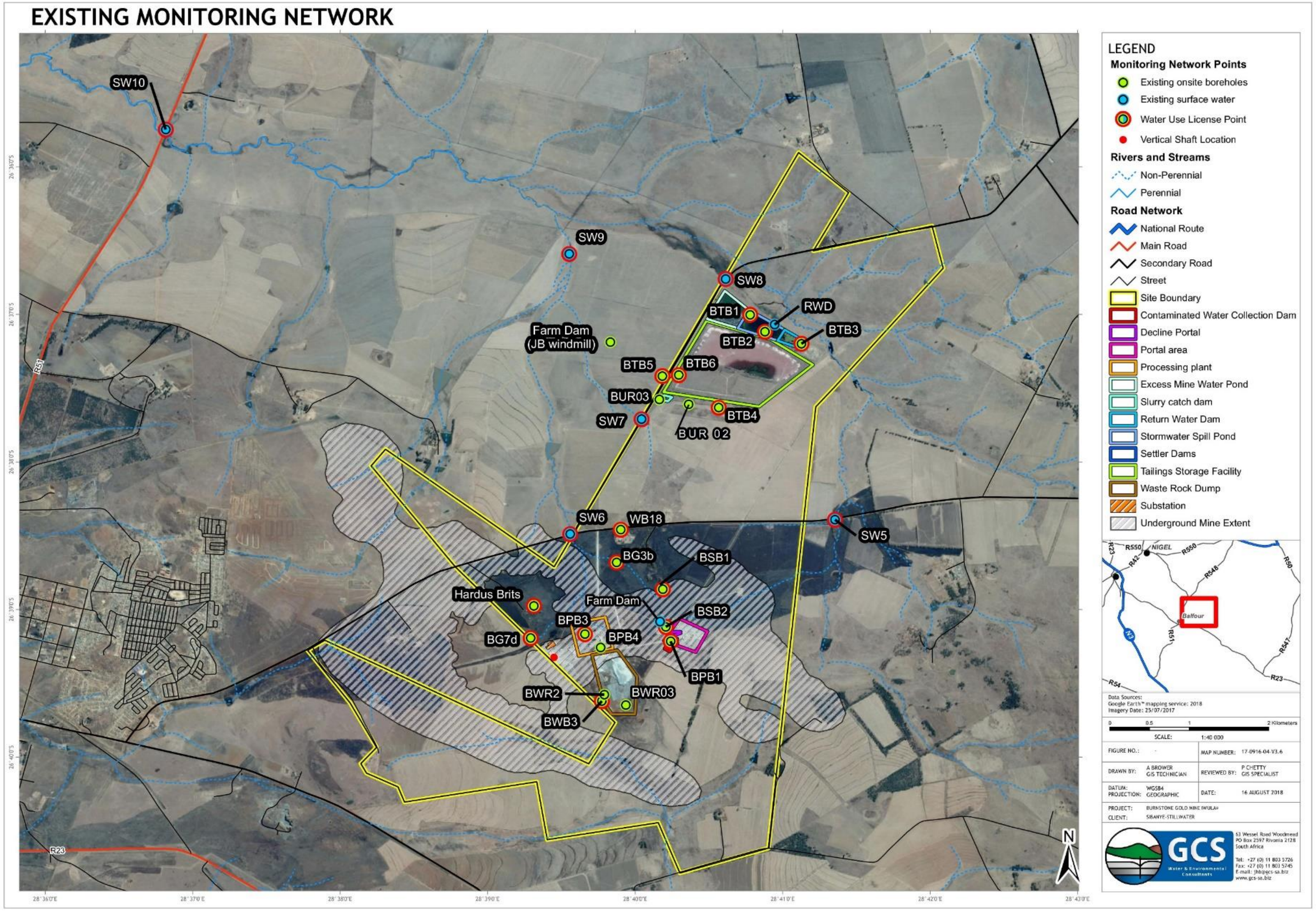


Figure 4.24: Existing Burnstone Monitoring Network

4.3.3.1 Burnstone Monitoring Groundwater Levels

Groundwater levels measured between 2015 and 2018 at the monitoring boreholes were provided by the client, and subsequently analysed (refer to Figure 4.25). No significant change was observed for the groundwater levels prior to April 2017 with the exception of boreholes BG7d and Hardus Brits which varied between 4 to 48 mbgl and 20 to 57 mbgl, with an average groundwater level of 33 and 45 mbgl, respectively. It should be noted, however, that boreholes Hardus Brits, BG7d, BG3b and WB18 are used for groundwater abstraction for domestic purposes. Variation in the water table at BG7d and Hardus Brits may be attributed to groundwater abstraction, however, other potential causes could include, seasonal rainfall variances, the reaching impact of groundwater abstraction from surrounding domestic and/or agricultural boreholes, and/or mine dewatering. GCS (2005) indicates that the water level at BG7d was 0.89 mbgl in 2005, which is significantly shallower than the current average groundwater level. This potentially indicates that the groundwater level at BG7d is affected by groundwater abstraction, particularly if the groundwater levels were measured subsequent to pumping, however, this should be confirmed by future monitoring.

Major variations in the measured groundwater levels of the monitoring boreholes are evident from April 2017 onwards. According to the monitoring data, the groundwater levels change significantly from this period onwards, which may be attributed to a range of potential causes. An average groundwater level decline of 33 mbgl is noted for the monitoring boreholes. An event or activity in 2017 that could cause these sudden alterations, has not been clearly discerned. The monitoring network and data should be evaluated to eliminate the possibility of inaccurate readings, and the potential activity/activities that have resulted in the erratic groundwater levels should be determined. It is accordingly suggested that future monitoring is conducted as per Table 5.10.

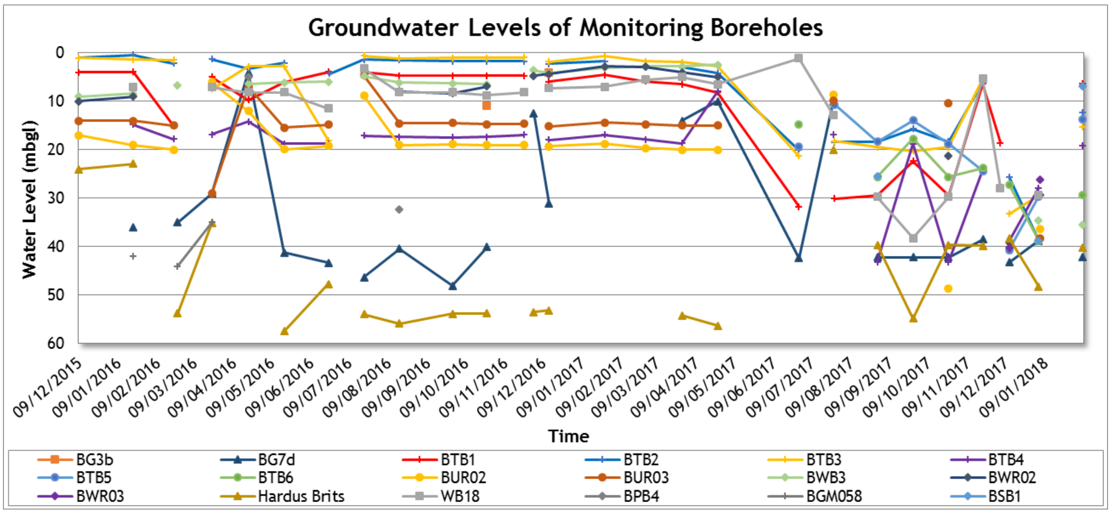


Figure 4.25: Burnstone monitoring borehole groundwater levels (2015 – 2018)

4.3.4 Groundwater Quality

The water quality results of the recent hydrocensus and monitoring events at Burnstone are compared to the following standards (refer to Table 4.28):

- South African National Standards (SANS) 1:2015 (SABS, 2015); and
- The Blesbokspruit in stream Water Quality Objectives (WQO) as set out in the WUL (DWS, 2010).

Table 4.28: SANS Standards and Blesbokspruit Water Quality Objectives (DWS, 2010)

Variables	Unit	SANS 241-1:2015	WQO Limit
Physical			
Conductivity	mS/m	170	65
Dissolved Oxygen	mg/l	NS	>6
pH	pH Units	>5 to <9.7	6.5 to 8.5
Total Dissolved Solids	mg/l	<1200	NS
Suspended Solids	mg/l	NS	30
Organic			
Chemical Oxygen Demand	mg/l	NS	35
Macro Elements			
Aluminium (Al)	mg/l	<0.3	<0.3
Arsenic (As)	mg/l	<0.01	NS
Ammonium (NH4 as N)	mg/l	<1.5	1.5
Antimony (Sb)	mg/l	<0.02	NS
Boron (B)	mg/l	<2.4	NS
Cobalt (Co)	mg/l	NS	NS
Calcium (Ca)	mg/l	NS	NS
Chloride (Cl)	mg/l	<300	140
Cadmium (Cd)	mg/l	<0.003	NS
Chromium (Cr)	mg/l	<0.05	NS
Copper (Cu)	mg/l	<2	NS
Cyanide (CN^-)	mg/l	<0.2	NS
Fluoride (F)	mg/l	<1.5	0.7
Iron (Fe)	mg/l	<2	0.5
Lead (Pb)	mg/l	<0.01	NS
Magnesium (Mg)	mg/l	NS	30
Manganese (Mn)	mg/l	<0.4	0.5
Mercury (Hg)	mg/l	<0.006	NS
Nitrate (NO3 as N)	mg/l	<11	3
Nickel (Ni)	mg/l	<0.07	NS
Phosphate (PO4 as P)	mg/l	NS	0.4
Sodium (Na)	mg/l	<200	100
Sulphate (SO4)	mg/l	<500	200
Selenium (Se)	mg/l	<0.04	NS
Uranium (U)	mg/l	<0.03	NS
Vanadium (V)	mg/l	NS	NS
Zinc (Zn)	mg/l	<5	NS

NS – No Standard

4.3.4.1 Recent 2017 Hydrocensus

During November 2017, GCS collected water samples from nine (9) boreholes surrounding the Burnstone study area to characterise the regional groundwater quality (Table 4.29). The groundwater samples were submitted to a SANAS accredited laboratory for chemical analysis.

Table 4.29: Groundwater chemistry of hydrocensus boreholes

Date sampled:		SANS 241-1:2015	Water Quality Objectives (WQO)	21-Nov-2017	21-Nov-2017	22-Nov-2017	22-Nov-2017	21-Nov-2017	22-Nov-2017	22-Nov-2017	23-Nov-2017	24-Nov-2017
Borehole Name				BG9a	HBH8	BG2f	HBH14	BG5a	HBH15	HBH16	HBH18	WBH14
Analyses	Unit											
General Parameters												
pH @ 25°C	pH	>5 to <9.7	6.5 - 8.5	7.35	7.8	7.81	8.16	8.21	7.31	7.2	7.31	7.38
Electrical conductivity (EC) @ 25°C	mS/m	<170	65	22.4	17.3	**65.8**	**117**	35.7	23.5	**144**	**71.3**	41.9
Total Dissolved solids @ 180°C	mg/l	<1200	NS	144	122	390	718	224	174	1102	568	290
Total alkalinity	mg CaCO3/l	NS	NS	110	83.5	421	268	188	112	204	147	182
Bicarbonate alkalinity	mg CaCO3/l	NS	NS	110	83	418	264	186	112	203	146	182
Anions												
Ammonium (NH_4) as N	mg/l	<1.5	1.5	0.045	0.03	0.041	0.08	0.043	0.035	0.041	0.042	0.045
Chloride (Cl)	mg/l	<300	140	10.8	4.62	8.12	**182**	19.2	6.48	**197**	58.1	17.1
Fluoride (F)	mg/l	<1.5	0.7	<0.263	<0.263	<0.263	<0.263	0.31	<0.263	<0.263	<0.263	<0.263
Nitrate (NO_3) as N	mg/l	<11	3	1.29	1.49	0.302	0.289	0.351	2.2	**76.2**	**32.7**	**5.5**
Nitrite (NO_2) as N	mg/l	<0.9	NS	0.067	0.063	0.065	0.071	0.07	0.064	0.073	0.065	0.065
Orthophosphate (PO_4) as P	mg/l	NS	0.4	0.009	0.007	<0.005	<0.005	0.007	0.017	<0.005	0.047	<0.005
Sulphate (SO_4)	mg/l	Acute health: <500 Aesthetic: <250	200	0.958	<0.141	7.25	44.4	<0.141	<0.141	54.2	26.6	19.7
Cations and Metals												
Aluminium (Al)	mg/l	<0.3	<0.3	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Antimony (Sb)	mg/l	<0.02	NS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic (As)	mg/l	<0.01	NS	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Barium (Ba)	mg/l	<0.7	NS	<0.002	<0.002	0.077	0.11	0.117	<0.002	0.023	0.078	0.003
Cadmium (Cd)	mg/l	<0.003	NS	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium (Ca)	mg/l	NS	NS	15.3	18.9	42.4	104	22.9	23.8	164	60.8	55.6

Date sampled:		SANS 241-1:2015	Water Quality Objectives (WQO)	21-Nov-2017	21-Nov-2017	22-Nov-2017	22-Nov-2017	21-Nov-2017	22-Nov-2017	22-Nov-2017	23-Nov-2017	24-Nov-2017
Borehole Name				BG9a	HBH8	BG2f	HBH14	BG5a	HBH15	HBH16	HBH18	WBH14
Analyses	Unit											
Chromium (Cr)	mg/l	<0.05	NS	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Copper (Cu)	mg/l	<2	NS	<0.002	<0.002	0.027	0.016	<0.002	0.006	0.019	0.005	0.054
Dissolved Uranium (U)	mg/l	<0.03	NS	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Iron (Fe)	mg/l	chronic health: <2 Aesthetic: <0.3	0.5	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Lead (Pb)	mg/l	<0.01	NS	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Magnesium (Mg)	mg/l	NS	30	13.2	8.04	**31.5**	**63.8**	8.22	11.6	**95.8**	**32**	15.5
Manganese (Mn)	mg/l	chronic health: <0.4 Aesthetic: <0.1	0.5	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury (Hg)	mg/l	<0.006	NS	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Nickel (Ni)	mg/l	<0.07	NS	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Potassium (K)	mg/l	NS	NS	1.17	0.752	3	1.54	2.1	0.49	0.507	4.37	0.382
Selenium (Se)	mg/l	<0.04	NS	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Sodium (Na)	mg/l	<200	100	14.1	7.2	75.3	45.7	48.8	9.54	24.3	26.6	13.5
Total Cyanide (CN)	mg/l	<0.2	NS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

NS - No Standard

*Exceeds SANS 241-1:2015 drinking water quality standard (SABS, 2015)

*Exceeds the WQO (DWS, 2010)

4.3.4.1.1 Hydrocensus Laboratory Analysis

The EC measured in BG2f, HBH14 and HBH16 exceeded the more stringent WQO limits of 65mS/m, however, the values were below the SANS standard of 170mS/m. These sampling points are located up gradient of the site. Non-compliant chloride (Cl) was also detected in HBH14 and HBH16, located within close proximity of the surface water bodies.

Nitrate (NO_3) detected in HBH16 and HBH18 exceeded both standards, while nitrate detected in WBH14 exceeded the WQO of 3mg/l. These sampling points are also located up gradient of the site. Elevated nitrate concentrations in the area may be attributed to natural conditions as the water quality measured for the site in 2005 by GCS indicated elevated nitrate concentrations, however, agricultural activities in the vicinity of HBH16 and HBH18 may be contributing nitrates to the groundwater in these areas.

Magnesium (Mg) concentrations detected in BG2f, HBH14, HBH16 and HBH18 marginally exceeded the WQO of 30 mg/l and are likely associated with natural soil-water interaction. Magnesium is anticipated to occur naturally within the study area within various silicates.
Based on the water quality results, a good water quality is inferred for the area surrounding Burnstone, with sporadically elevated nitrate, magnesium and chloride concentrations potentially pertaining to natural conditions and/or minor contamination by agricultural activities.

4.3.4.1.2 Groundwater Classification

Piper and Expanded Durov diagrams are useful to distinguish between different types of groundwater, by the graphic presentation of major anion and cation concentrations as percentages on trilinear/diamond shape fields. The Stiff diagram is a graph type diagram that plots constituent concentrations. Water with a similar chemical character has the same plot shape. Figure 4.26, Figure 4.27 and Figure 4.28 illustrates different diagrams that are used to characterise the chemical character of groundwater surrounding the study area.

<u>Piper Diagram</u>

Based on the piper diagram (Figure 4.26), the samples represent unpolluted water with some chloride enrichment in HBH16 and sodium (Na) enrichment in BG5a. The piper diagram also shows that all samples have relatively low sulphate concentrations. It can be observed in the HCO_3-SO_4-Cl triangle, that all the samples are plotted near the HCO_3-Cl line. This is also observed in the Stiff diagrams (Figure 4.28).

Calcium-magnesium bicarbonate dominant

As presented in Figure 4.26, the groundwater samples collected from WBH14, HBH8, HBH15, BG2f, BG9a and HBH18 can be classified as recently recharged water rich in calcium, magnesium and bicarbonate. The majority of the boreholes included in this group are drilled into the surface expression of the Ventersdorp Supergroup, namely: WBH14, HBH8, HBH15 and BG9a. BG2f and HBH14 intercept a dolerite sill and Karoo strata, respectively, however, these boreholes could extend into the Ventersdorp Supergroup at depth.

Calcium/magnesium sulphate/chloride dominant

HBH16 and HBH14 can be classified as mixed water (chloride-calcium and chloride-magnesium water types). These boreholes are located on or adjacent to the Ventersdorp lavas and could be influenced by the geological formation, however, higher chloride concentrations in comparison to the previous hydrochemical facies, could indicate contamination of the groundwater at these boreholes by neighbouring anthropogenic activities east of Burnstone.

Sodium bicarbonate dominant

BG5a can also be classified as mixed (calcium-sodium bicarbonate water type). This borehole is located within alluvial sediments overlying the Karoo Supergroup, and is situated down gradient of the portal area.

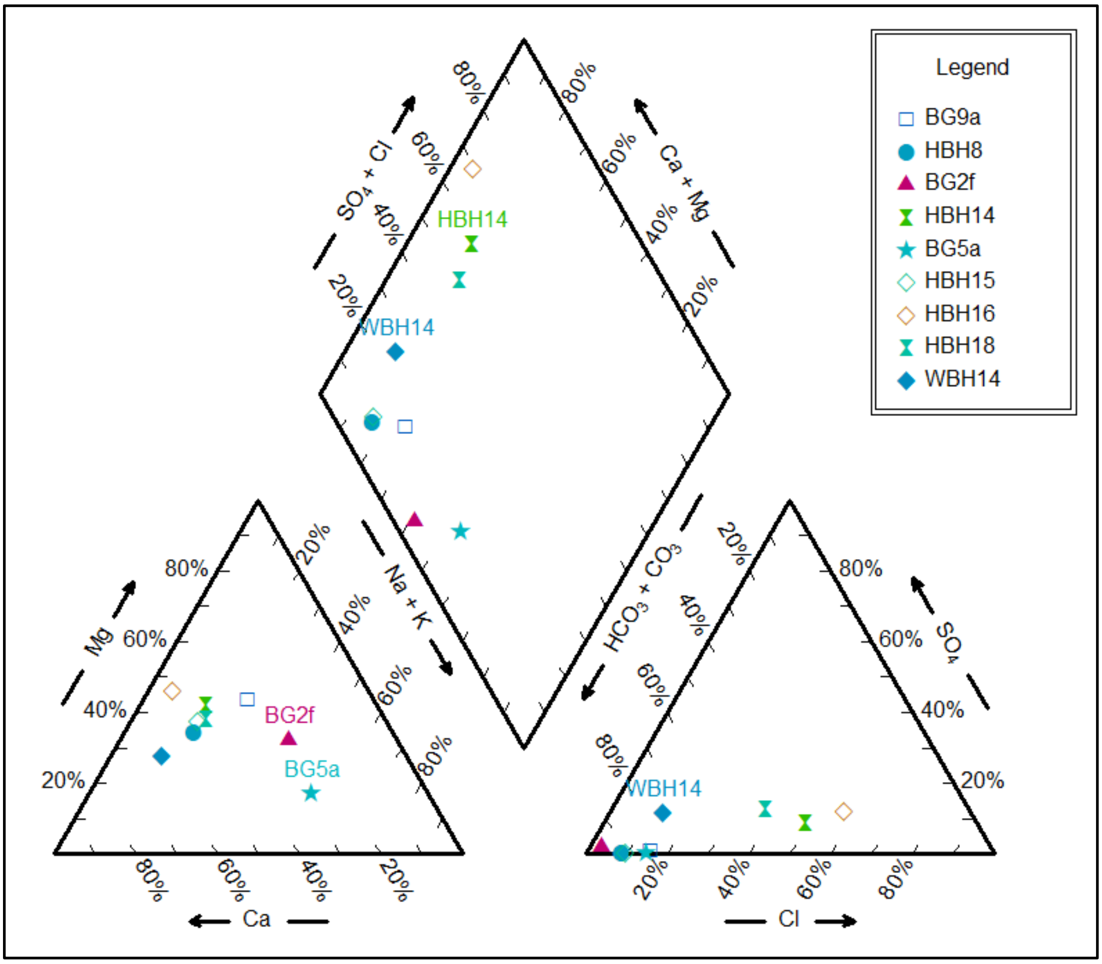


Figure 4.26: Hydrocensus Piper Diagram

<u>Durov Diagram</u>

As presented in Figure 4.27, the groundwater samples indicate that most of the samples are in the mixing or dissolution phases. The pH section of the plot reveals that groundwater at the hydrocensus boreholes is neutral to alkaline which is preferable for domestic use purposes. The TDS of most of the groundwater samples occurs within the range of drinking water standards.

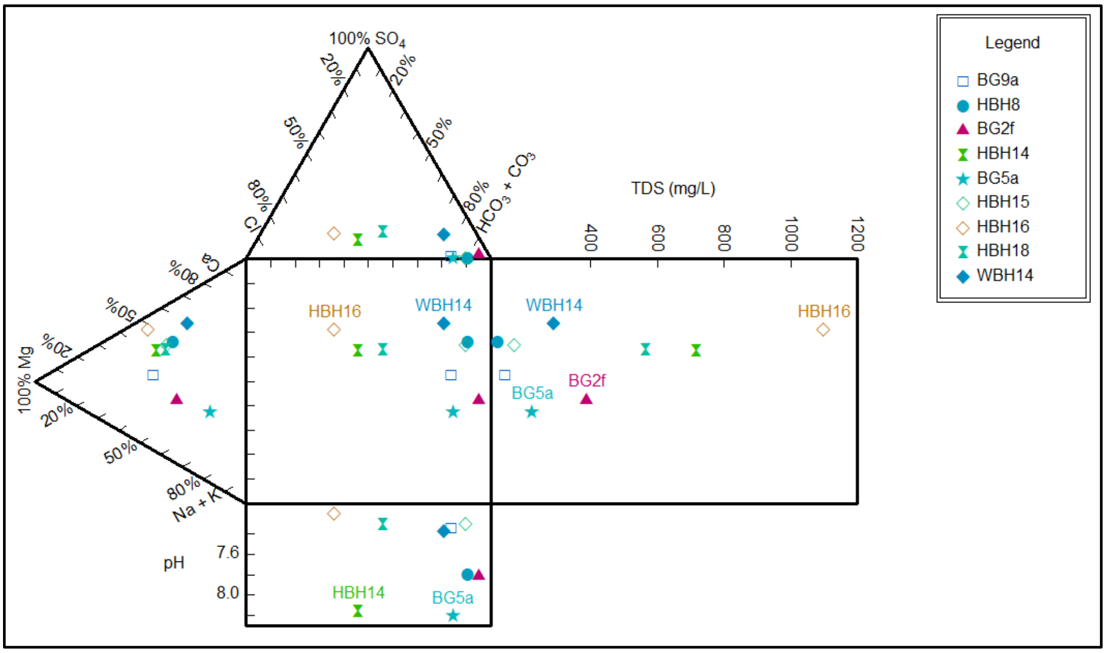


Figure 4.27: Hydrocensus Durov Diagram

Spatial Stiff Diagram Illustration

The Stiff diagrams, as presented in Figure 4.28, have varying shapes (potentially varying hydrochemical facies), which may indicate differences in the mineral content of the aquifer materials, and/or the existence of constituent-contributing anthropogenic activities in some areas. Borehole HBH16 has the highest dissolved solids followed by HBH14. Both of the boreholes have similar shapes, unlike the other boreholes, which may indicate that they intersect a similar geological formation, and/or are affected by similar anthropogenic activities. HBH16 intersects the surface expression of the Ventersdorp Lavas and HBH14 is located immediately adjacent to the outcrop, most likely intersecting the igneous rocks at depth.

HBH8, BG9a, HBH18, BG2f, BG5a and HBH15 have similar shapes, which may be indicative of similar geological formations intercepted at the surface or at depth. BG9a is slightly more enriched in magnesium than calcium, and the dominant cation for BG5a is sodium.

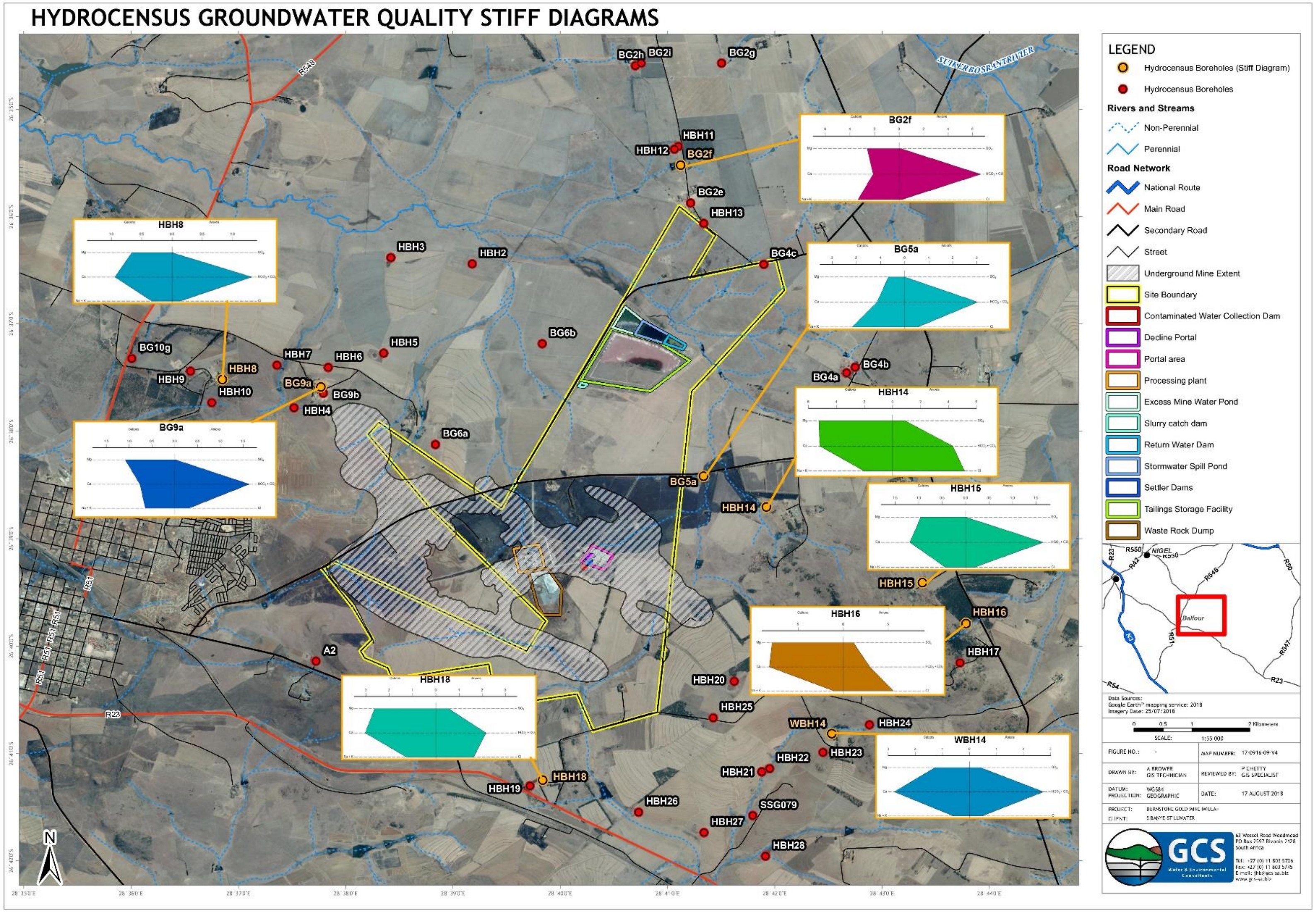


Figure 4.28: 2017 Hydrocensus – Stiff Diagrams

4.3.4.2 Burnstone Monitoring Boreholes

Monitoring groundwater quality data was obtained from the client for the years 2015 to 2017. The following points were included in the groundwater-monitoring programme and monitored by the client: BG3B, BG7D, BGM058, BPB4, BSB2, BTB1, BTB2, BTB3, BTB4, BTB5, BTB6, BUR02, BUR03, BWB3, BWR2, PCD 4 (JB windmill), GW1, GW4, Hardus Brits, Jabu Binda Homestead and WB18.

<u>Electrical Conductivity (EC)</u>

All boreholes had EC concentrations below the SANS standard of 170mS/m, with the exception of BUR03 and BTB5. EC was elevated above the WQO standard during the entire monitoring period for BUR02. BUR03 exceeded the SANS standard from June 2015 to October 2016. A slight decrease was noted during October 2016 to February 2017 for BUR03, however the EC increased to above the standard from April 2017 to May 2017. EC values are only available between June and September 2015 for BTB5, and between June and November 2015 for BTB6. EC exceeded the SANS and WQO standards, respectively, for all monitoring events for the two boreholes, however a slight overall decrease in EC was noted. EC at FD (JB Windmill) was intermittently elevated above the WQO standard. EC concentrations are elevated above the WQO standard across the monitoring period for WB18, however concentrations tend to decrease towards end-2017.

<u>pH</u>

Neutral to slightly alkaline pH values were recorded for the majority of the boreholes during the 2015 to 2017 monitoring period. Slightly alkaline pH levels, above the WQO standard of 8.5 but below the SANS standard of 9.7, were intermittently recorded for BTB1, particularly in 2016, and BTB2, BTB3 and BTB4. In field pH levels substantiate the laboratory-determined pH levels. The field pH levels recorded for BWB3 indicate slightly alkaline groundwater conditions during 2016. Slightly lower pH values, predominantly ranging between 5 and 7, were measured in BSB2, located east of the processing plant. However, the pH values remained above the SANS standard of 5.

<u>Total Dissolved Solids (TDS)</u>

The TDS detected in BTB5 and BUR03 exceeded the SANS standard of 1200mg/l. A decrease was noted in BTB5 from August 2017. The TDS in BUR03 remained elevated between June 2015 and October 2016. Thereafter a decrease was noted, however the TDS values increased from February 2017. This may be indicative of a seasonal rainfall influence on TDS concentrations.

Chemical Oxygen Demand (COD)

The COD was elevated above the WQO standards in 2015 for BGM058 and BTB1, but subsequently decreased for BTB1. The COD of BTB2 was intermittently elevated in 2015, and early 2016, however the concentrations decreased for the remainder of the monitoring period. The COD of BUR03 was elevated during early-2017. The COD at BWR2 and Hardus Brits intermittently exceeded the WQO standard, particularly in 2015 and 2016, respectively.

Suspended Solids (SS)

Suspended solids (SS) are elevated above the WQO standards for the majority of the boreholes. SS were significantly elevated for the majority of the monitoring period for BG7d and BGM058, and were elevated across the monitoring period for Hardus Brits and BTB2, with the highest concentrations measured in the middle of each monitoring year, potentially indicating a seasonal influence at BTB2. Concentrations decreased to below the standard in 2017 at BTB2, however, 700 mg/l was recorded in July 2017. SS concentrations at BTB3 were continually elevated for 2015 and 2016, but decreased to intermittently elevated concentrations in 2017. High suspended solid concentrations evident for BTB4 from 2015 until mid-2017, decreased significantly for the remainder of 2017. Elevated SS concentrations were recorded for BTB6 towards the end of 2017. SS at BUR02 and BUR03 intermittently exceeded the WQO standard, with a notable increase in October 2017 for BUR03. The SS of BWB3, BWR2 consistently exceeded the WQO standard, with a notable increase in October 2017 for BWR2. SS were intermittently elevated above the WQO standard at WB18.

Turbidity

Turbidity values were intermittently elevated for BTB1 during 2017. Turbidity was slightly high for BTB3 during late-2017.

Cations

Ammonium (NH_4) concentrations elevated above the WQO standard, were sporadically recorded for BTB1. Ammonium concentrations at BWR2 were consistently elevated above the WQO standard for the entire monitoring period, with a significant decrease noted in October 2017. Ammonium intermittently exceeded the WQO standard during end-2016 at Hardus Brits. Calcium (Ca) and Potassium (K) concentrations remained relatively consistent during the monitoring period with no significant changes observed.

Magnesium (Mg) was slightly elevated above the WQO standards at BPB4, BTB4 and BTB6 for the majority of the monitoring period. Magnesium exceeded the WQO standards during all monitoring events for BTB5, BUR02 and WB18. Magnesium concentrations exceeded the WQO standards for the majority of the monitoring period for BUR03, with reduced concentrations recorded for early 2017.

Sodium (Na) concentrations detected in BUR03, FD (JB Windmill) and BTB5 exceeded the SANS standard of 200 mg/l. A decrease was noted in BUR03 from October 2016, however the Na concentrations increased again from January 2017 to May 2017. BUR02, BTB4 and BTB6 exceeded the WQO standards for the majority of the monitoring period, however, the concentrations remained below the SANS standard.

Anions

All monitoring boreholes were compliant with the SANS standard for chloride (Cl), with the exception of BUR03, BUR02 and BTB5, which exceeded the SANS standard for chloride of 300 mg/l. However, a decrease was observed for BTB5 from June 2017 to August 2017.

Chloride exceeded the WQO standard during all monitoring events for BUR02, however, it significantly increased to above the SANS standard in October 2017. Chloride concentrations were intermittently elevated above the WQO standards for the majority of the monitoring period for BTB4, particularly in 2016, and BTB6 and FD (JB Windmill), however concentrations decrease towards the end of 2017 for FD (JB Windmill). Chloride concentrations exceeded the WQO standard in 2015 at WB18, however subsequently decreased.

Fluoride (F) concentrations for all of the boreholes were below the SANS standard, with the exception of BUR02 and BTB5. BUR02 marginally exceeded the standard in May 2016, July 2016 and January 2017. The fluoride concentrations of BUR02, decreased to below the SANS standard but above the WQO standard, until July 2017, subsequent to which it decreased to below both standards. Fluoride consistently exceeded the WQO standard during the monitoring period for BUR03. Fluoride concentrations elevated above the WQO standards were consecutively recorded from June 2015 until October 2015 for BTB1, but the concentrations subsequently decreased. Fluoride was slightly elevated above the WQO standards for BTB2 during 2015, and early- to mid-2016 and 2017, and intermittently elevated above the WQO standard, however only slightly, across the monitoring period for BTB4 and BTB6, with a slight increase noted towards end-2017 for BTB4. Fluoride concentrations were intermittently elevated above the WQO standard for BTB5, and once above the SANS standard in September 2017. Fluoride was slightly elevated above the WQO standard at FD (JB Windmill), but decreased towards end-2017.

Nitrate (NO3) concentrations at BG3b slightly exceeded the WQO standards for the majority of the monitoring period, however nitrate was intermittently elevated above the WQO standards for BG7d during early 2016 and early 2017, which could be indicative of a seasonal influence. Nitrate concentrations exceeded the WQO limit intermittently across the 2016 and 2017 monitoring events for Hardus Brits, and was elevated above the WQO standard during all monitoring periods for Jabu Binda. Nitrates exceeded the WQO standards for BGM058 from early- to mid-2016. Boreholes BPB4, WB18 and BSB2 showed elevated nitrate concentrations above the SANS standards for the majority of the monitoring period, however the concentrations decreased, particularly for WB18 and BSB2 in mid-2016 and early-2017, respectively, which subsequently only exceeded the WQO standards intermittently. Nitrate was intermittently elevated above the SANS standards during 2015 at BTB4, but subsequently decreased. A general decrease in nitrate concentrations were noted for most boreholes from early-2017.

All monitoring boreholes were compliant with the WQO and SANS standards for sulphate (SO4), however higher than typical sulphate concentrations for the area were recorded for BPB4, BTB5 and BUR03. Sulphate is elevated above the WQO standards once in February 2017 for BPB4.

Total cyanide (T CN) is elevated in BTB4 at the TSF in September 2015 only.

Metals and Metalloids

Aluminium (Al) concentrations remained below the SANS standard of 0.3 mg/l during the monitoring period, with few monitoring boreholes exceeding the standard during the wet season (January to March) as well as dry season (July). Aluminium was sporadically elevated above the WQO standard for BWB3.

Antimony (Sb) at BTB4 and WB18 was intermittently elevated above the SANS standard in 2015, however the concentrations subsequently decreased.

An Arsenic (As) concentration of 0.6mg/l detected in BTB4 in September 2015 exceeded the SANS standard of 0.01mg/l. Concentrations decreased to below the standard from January 2016 onwards. Arsenic was elevated above the SANS standards from late-2015 until early-2016 for BGM058, and again in late-2016. It was also elevated for BG7d in late-2015 and mid-2016.

Cadmium (Cd) detected in WB18 exceeded the SANS standard in July 2015, while BUR03 exceeded the standard in August 2015. The concentrations decreased thereafter, however a slight increase was noted in WB18 during June 2017. No boreholes exceeded the SANS standard of 0.003 mg/l since August 2015.

Chromium (Cr) detected in BPB4 in August 2015 and November 2016 exceeded the SANS standard of 0.05 mg/l, however it was below the standard during the remainder of the monitoring period. BWR2 and BG7D exceeded the standard during June 2016, however decreased thereafter to below the SANS standard.

All Iron (Fe) concentrations were below the SANS standard, with the exception of BTB3 which exceeded the chronic health SANS standard of 2 mg/l during June 2017. However, Fe decreased to below SANS thereafter, and exceeded the WQO standard for the remainder of the monitoring period. Iron concentrations were intermittently elevated above the WQO standards from beginning-2016 until end-2017 for BG7d, in 2016 for Hardus Brits, and in 2015 for BGM058. Iron exceeded the WQO standard from early-2017 for BTB1.

Mercury (Hg) detected in Hardus Brits and BWB3 exceeded the SANS standard during December 2015 and April 2016, respectively. These concentrations decreased to below the SANS standard of 0.006mg/l for the remainder of the monitoring period. BPB4 marginally exceeded the standard during February 2017, however decreased to below the standard thereafter.

Manganese (Mn) concentrations detected in the majority of the monitoring boreholes were below the SANS standard of 0.4 mg/l, however, Mn detected in Hardus Brits (July 2016), BGM058 (July 2015) and BUR02 (June 2015) exceeded the SANS and WQO standards. Concentrations decreased from February 2017 and were below the standards from May 2017.

Nickel (Ni) detected in BSB2 exceeded the SANS standard of 0.07 mg/l between June 2015 to October 2015 as well as December 2015, however, Ni decreased to below the standard thereafter. An increase in the majority of Ni concentrations was noted during January 2017, however a decrease was observed thereafter.

Lead (Pb) was slightly elevated above the SANS standard from mid- to late 2017 at BG3b, from beginning-2016 until end-2017 for BG7d, intermittently in 2017 for Hardus Brits, sporadically across the monitoring period for WB18 and intermittently elevated for BSB2, with the highest frequency recorded for 2017, however, the concentrations exceeded the SANS standards only slightly. Lead was intermittently elevated across the monitoring period for BTB2, with a higher prevalence recorded in 2017, during several 2017 monitoring events for BTB3, intermittently across the monitoring period, specifically in 2015 and 2017 for BTB4, and consistently elevated during 2017 for BTB5. Lead was rarely elevated during the monitoring period for BUR02.

Uranium (U) was slightly elevated above the SANS standard at BTB5 from September 2017 until the end of the monitoring period. Uranium slightly exceeded the SANS standard during the 2015 and 2016 monitoring events for BUR03, however the concentrations predominantly reduced in 2017 to below the standard, with the exception of October 2017.

4.3.4.2.1 Groundwater Classification

<u>Piper Diagram</u>

The water quality results of the groundwater samples collected were plotted on a piper diagram, as presented in Figure 4.29. The majority of samples represent unpolluted water. Chloride enrichment was noted in the sample collected from BUR03, while sodium enrichment was noted in BSB2. BSB2 is located down gradient of the portal while BUR03 is located adjacent to the slurry catch dam and TSF.

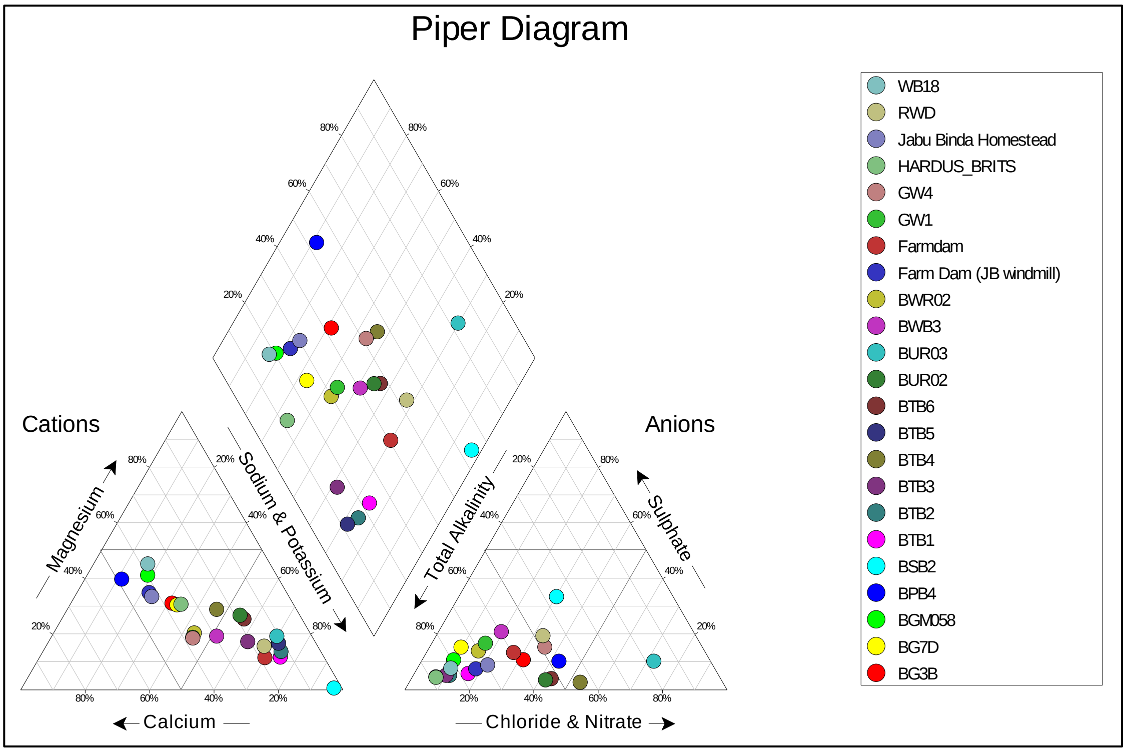


Figure 4.29: Piper Diagram - Groundwater

<u>Durov Diagram</u>

The groundwater quality results were also plotted on a Durov Diagram, as presented in Figure 4.30. Fields 2 and 3 illustrated in Figure 4.30, indicate fresh, clean and relatively young water that has undergone Mg (field 2) and Na (field 3) ion exchange.

BPB4 and GW4 fall within field 5 which is usually a mix of different types of water – either clean water from fields 1 and 2 that has undergone SO_4 and sodium chloride (NaCl) mixing /

contamination, or old stagnant NaCl-dominated water that has mixed with clean water. An investigation of potential contaminants from the processing plant should be conducted, to determine if the water quality in this area could be related to the plant.

BSB2 (field 6) could be representative of water that has been in contact with a natural/anthropogenic source rich in Na. BSB2 is located close PCD 4 and the portal; area, and high nitrate concentrations for BSB2 should be confirmed and investigated by future monitoring.

BTB4 (field 8) can be classified as groundwater that is usually a mix of different types, including clean water from fields 1 and 2 that has undergone SO_4, but especially Cl mixing / contamination. This could be related to natural/anthropogenic conditions at the TSF, and should be confirmed by future monitoring.

BUR03 (field 9) has undergone significant ion exchange reactions, which could be associated with natural and/or anthropogenic contamination, particularly due to its proximity to the TSF.

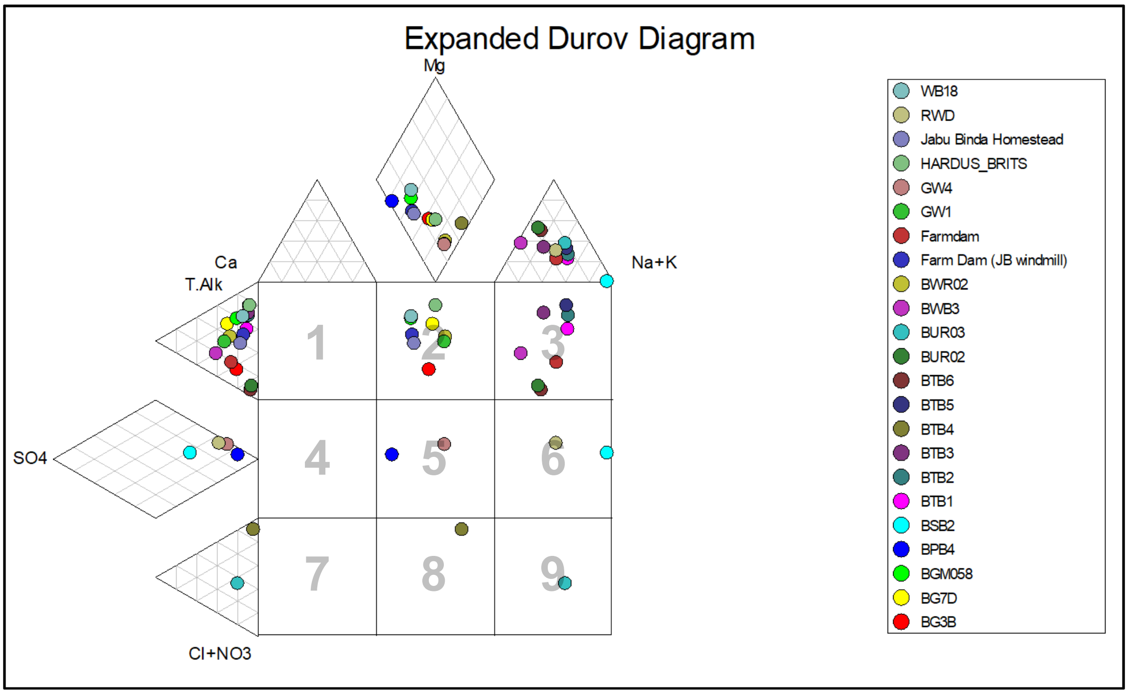


Figure 4.30: Durov Diagram

4.3.4.2.2 Discussion based on Trend Analysis and Classification

According to GCS (2005), the natural groundwater quality of the study area measured in 2004 indicated elevated concentrations of sulphate, magnesium, chloride and bicarbonate, particularly at the TSF area. Calcium-magnesium bicarbonate dominant water was associated with boreholes drilled into the Karoo Supergroup, and boreholes with high sodium concentrations were associated with doleritic geology. Elevated parameter concentrations were attributed to the local geology, as well as the presence of a coal seam at the TSF. EC and TDS were elevated for the TSF area, whereas nitrate concentrations were elevated at the plant area. The pH values ranged between 6 and 8.3. Metal concentrations, including iron, manganese, aluminium, total chromium, nickel and lead were low, but intermittently elevated. Groundwater quality results for 2005, prior to mining, indicated significantly elevated sulphate at SGG174, intermittently elevated iron, manganese, aluminium and high TDS, EC, calcium, magnesium and chloride concentrations.

The recent groundwater quality results show that the majority of the boreholes have relatively fresh, clean and young water. However, sodium and chloride are elevated at several boreholes, nitrates are elevated at the southern processing area, and metals and metalloids intermittently exceed the WQO and/or SANS standards.

Metal and metalloid concentrations, including arsenic, lead and iron, at boreholes BG7d and Hardus Brits, located west of the southern processing area, were intermittently elevated during the monitoring period, particularly the latter two metals. More metals were elevated for BG7d compared to Hardus Brits. Suspended solid concentrations exceeded the WQO standard for the monitoring period of both boreholes, and nitrate concentrations exceeded the WQO standard in 2016 and 2017. Ammonium was elevated for Hardus Brits at the end of 2016.

Magnesium and other metals, including arsenic and lead were elevated for BPB4, located at the processing plant, with one isolated anomaly of elevated sulphate. Metal concentrations decrease significantly in 2016 and 2017 at this borehole. Nitrate was also elevated for BPB4. Slightly alkaline conditions were noted for BWB3 at the WRD, as well as sporadically elevated aluminium and similar to BWR2, also located at the WRD, consistently high suspended solid concentrations and several elevated metals in July 2015. Ammonium concentrations were elevated at BWR2 and could be related to the artificial and natural wetland environment in this area. COD was also high at BWR2. Borehole BGM058 indicated intermittently elevated nitrates, metal and metalloids (arsenic, antimony and iron), COD and suspended solids, which correlate to the elevated parameters of the above boreholes. In contrast to the other boreholes located in the southern processing area, slightly acidic pH levels were recorded at BSB2, located at the decline portal area, however, similarly, nitrate and metal (lead and nickel) concentrations are intermittently elevated at this borehole.

The trend analysis for boreholes BG3b and WB18, located down gradient of the southern processing area, indicate that nitrates were elevated in this area for the majority of the monitoring period. However, nitrates occur within the concentrations range previously measured for the site and indicated by GCS (2005). WB18, north of BG3b, also showed elevated EC, magnesium, chloride, antimony, lead and suspended solid concentrations. The borehole is located just north of what appears to be a residential/commercial area. PCD 4 (JB Windmill) further north and down-gradient of the southern processing area, indicated elevated EC, sodium, chloride and fluoride concentrations for the majority of the monitoring period, and the borehole at Jabu Binda Homestead shows elevated nitrate concentrations for all monitoring events.

At the TSF area, boreholes BTB1, BTB2 and BTB3, located down gradient of the TSF, showed slightly alkaline pH levels for the monitoring period. Ammonium, fluoride, iron, lead, COD, suspended solids and turbidity were intermittently elevated for BTB1. Similarly, these parameters, with the exception of ammonium and iron, were elevated at BTB2 and predominantly decreased in concentration towards end-2017. More parameters were elevated in 2015 and 2017 for these boreholes compared to 2016, and the groundwater at this site is potentially seasonally influenced based on the trend analysis, particularly for suspended solids. Iron and lead are intermittently elevated for BTB3, and a high turbidity towards end-2016 supports the measurement of high suspended solid concentrations for this area. These boreholes are located at the dams adjacent to the TSF, and close to a water course and natural wetland area.

Borehole BTB4 located on the southern edge of the TSF indicated EC concentrations exceeding the WQO standard, likely related to elevated magnesium, sodium and chloride concentrations at this borehole for the majority of the monitoring period. Nitrate was mostly elevated in 2015, however fluoride concentrations were intermittently and slightly elevated across the monitoring period. Arsenic and antimony were intermittently elevated in 2015, and cyanide exceeded the SANS standard once in 2015. Lead is elevated in 2015 and 2017. Suspended solid concentrations predominantly decreased across the monitoring period. Several parameters are elevated for BTB4, with a higher prevalence recorded in 2015 and 2017 compared to 2016. Similar to BTB4, BTB5 and BTB6 indicate consistently elevated EC concentrations that exceed the WQO standard, however the concentrations of BTB5 also exceed the SANS standard. Magnesium, sodium and chloride concentrations are also elevated for these boreholes, located adjacent to the western edge of the TSF. Fluoride concentrations are intermittently elevated for BTB6 and BTB5. Lead was elevated for both boreholes; however, uranium is slightly elevated at BTB5 towards the end of 2017. Elevated suspended solid concentrations predominantly decreased across the monitoring period for BTB4 and BTB6.

Boreholes BUR02 and BUR03 located adjacent to the southern boundary of the TSF and close to the slurry catch dam, indicate several consistently elevated parameters, including EC, TDS (BUR03 only), magnesium, sodium, chloride and fluoride. Lead and suspended solids were less frequently elevated. Uranium was intermittently elevated in 2015 and 2016 at BUR03, but subsequently decreased to below the standard. It should be noted that an overall decrease in parameter concentrations was noted from 2015 to 2017. Contamination of the groundwater at BTB4, BTB5, BTB6, BUR02, and BUR03 may be related to the proximity of the Sugarbush Fault, as well as an inferred underlying dolerite dyke. However, the slurry catch dam and TSF located near to the boreholes could be impacting the water quality in this area.

4.3.5 Potential Pollution Source Identification

Burnstone mines ore by conventional stoping with mechanised footwall development, and uses the CIL process to extract gold from ore. The following potential contamination sources are present at the site:

- Tailings Storage Facility (TSF) and associated infrastructure such as a slurry pipeline from the plant to the TSF;
- Return water dam (RWD) and associated infrastructure such as a return water pipeline from the TSF to the plant;
- Stormwater Spills Pond;
- Excess Mine Water Pond;
- Waste Rock Dump (WRD) and Pollution Control Dam (PCD);
- Sanitation infrastructure such as septic tanks;
- Waste water treatment works (WWTW's);
- Workshops and service bay;
- Fuel storage facility and bay;
- Dirty water dams and water storage tanks; and
- Underground mine voids.

Potential parameters of concern are:

- pH;
- Electrical Conductivity (EC) and Total Dissolved Solids (TDS);
- Nitrate ($NO_{3});$
- Ammonium (NH_3);
- Fluoride (F);

- Magnesium (Mg);
- Sodium (Na);
- Chloride (Cl);
- Cyanide (CN);
- Sulphate (SO_4);
- Arsenic (As);
- Cadmium (Cd);
- Chromium (Cr);
- Mercury (Hg);
- Lead (Pb);
- Iron; and
- Uranium (U).

Pyritic minerals co-exist with the targeted gold reef in the Witwatersrand Supergroup, and based on this association, pyrite oxidation within the wall rock of the underground workings, waste rock and processed ore material may lead to contamination of the surrounding environment with sulphate. Acid mine drainage could potentially occur at the site under the correct conditions, depending on the sulphide content and buffering capacity of the material. Previous geochemical assessments have indicated that tailings at the site have the capacity of generating acid mine drainage. Current water quality monitoring results indicate sulphate concentrations below the relevant standards mentioned in Section 4.3.4.2, however the potential of acid mine drainage generation at the mine site exists and has been modelled within the contaminant transport simulations.

4.3.6 Groundwater Model

A detailed groundwater model was undertaken by GCS and is attached as Annexure 9 to this report.

4.3.6.1 Objective of the Model

The objective of the model was to provide an assessment of the groundwater ingress into the existing mine and future mine development, during mine dewatering and post-closure. The numerical hydrogeological model is based on groundwater flow and transport models constructed by GCS (2005) and GCS (2007) for the study area. Based on communication with the client, the extent of the existing mine and proposed future sections of the mine were incorporated into the model. Other modifications include the extension of the model boundary, addition of aquifer layers, and the incorporation of additional lithological zones and calibration targets.

Groundwater levels used as calibration targets in the previous model were checked against the groundwater level data measured in 2017, and the 2017 water levels were subsequently used. However, aquifer parameters were based on the results of aquifer tests incorporated into the 2005 numerical model by GCS and expected contaminant input concentrations were based on the geochemical assessment conducted by Knight Piesold (2004) and studies previously conducted for similar sites. Scenarios are used to simulate changes within the natural and anthropogenic environment; the following scenarios are therefore considered for the Burnstone model:

- Operational phase: simulate groundwater ingress into the existing and proposed shafts and underground mine workings, and simulate contaminant plume movement from the existing and proposed shafts, underground mine workings, tailings storage facility (TSF) and waste rock dump (WRD); and
- Post-closure phase: simulation of rebounding groundwater levels upon cessation of mine dewatering; and contaminant plume movement from the above-mentioned structures/facilities.

4.3.6.2 Governing equation

The conceptual hydrogeological model, a representation of the hydrogeological system based on data derived from the desktop and baseline investigations, provides the basis for the numerical hydrogeological model used in this modelling study. The numerical hydrogeological model simulates groundwater flow based on a three-dimensional, block-centred finite-difference grid. Additional aspects of the hydrogeological system are also simulated, including recharge, drains and rivers, including flow associated with these external stresses. The following partial-difference equation describes the movement of groundwater of a constant density through porous material in three dimensions (Harbaugh et al., 2005):

(1)
$$\frac{\partial}{\partial x}(K_x\frac{\partial h}{\partial x})+\frac{\partial}{\partial y}(K_y\frac{\partial h}{\partial y})+\frac{\partial}{\partial z}(K_z\frac{\partial h}{\partial z})\pm W=0$$

where:

- Kxx, Kyy, and Kzz are values of hydraulic conductivity along the x, y, and z coordinate axes, which are assumed to be parallel to the major axes of hydraulic conductivity (L/T);
- h is the potentiometric head (L);
- W is a volumetric flux per unit volume representing sources and/or sinks of water, with W < 0.0 for flow out of the ground-water system, and W > 0.0 for flow in to the system (T-1);
- Ss is the specific storage of the porous material (L-1); and
- t is time (T).

Transient three-dimensional groundwater flow within a heterogeneous and anisotropic medium can be simulated based on Equation 1, when combined with boundary and initial conditions and provided that the principal axes of hydraulic conductivity are aligned with the coordinate directions (Harbaugh et al. 2005).

A numerical model is essentially a combination of the above governing equations, boundary and initial head conditions, and hydrogeological parameters that define the groundwater flow system.

4.3.6.3 Mine Schedule

Three separate mine schedules were simulated during the modelling exercise, in consideration of historical underground mining which seized in 2012, proposed future mining due to start in 2019 and intermittent dewatering from the underground mine during the interval period, based on communication with the client. The mine schedules are listed as follows:

- Historical underground mining: 2009 to 2012 with active dewatering;
- Future underground mining: 2019 to 2036 with active dewatering; and
- Interval period of residual mining activities: 2012 to 2019 with intermittent dewatering.

4.3.6.4 Input Parameters

The model input parameters for the numerical flow model include the aquifer parameters, recharge value, initial conditions, perennial river and stream conductance, general head boundary and underground void conductance. A detailed summary of the input parameters can be found in Section 9.10 in Annexure 9 (Geohydrological Report).

4.3.6.5 Model Calibration

Model calibration involves the iterative procedure of estimating parameters that describe the hydrogeological properties and boundary conditions of a groundwater system, so that the model results closely resemble observed field measurements. Manual trial-and-error or automated parameter-fitting procedures can be applied to calibrate the model to historical observations including hydraulic heads and flows, while preparing the model for predictions of future behaviour. During calibrations of a regional groundwater flow model, a difference of several meters between the calculated and observed heads can be tolerated, and is usually expressed as a function of the total range of observations. It should be ensured, however, that parameter estimates do not vary excessively from the reasonable initial estimates (Barnett et al., 2012).

The root mean squared error (RMSE) of a groundwater flow model describes the fit between calculated and observed measurements, and a value below 10% is generally regarded as acceptable for a regional model (Barnett et al., 2012). Calibration of the Burnstone numerical model was conducted under steady state conditions. Subsequent to model calibration, the influence of various scenarios that stress the groundwater resources of the project site can be predicted.

Based on the hydrocensus results groundwater abstraction is low for the area, and mainly used for domestic and livestock purposes. For this reason, groundwater abstraction was not included in the simulation, and the groundwater system was assumed to be in a quasi-steady state.

Calibration Targets

The calibration targets assigned for model calibration included on-site monitoring boreholes and hydrocensus boreholes with measured groundwater levels for November 2017. Groundwater levels measured in November 2017 for these calibration targets, represent the most comprehensive and recent data set for steady state numerical flow model calibration.

Steady State Calibration

For steady state conditions the groundwater flow equation (1) reduces to the following equation:

$$\frac{\partial}{\partial x}(K_x \frac{\partial h}{\partial x}) + \frac{\partial}{\partial y}(K_y \frac{\partial h}{\partial y}) + \frac{\partial}{\partial z}(K_z \frac{\partial h}{\partial z}) \pm W = 0 \quad (2)$$

The hydrogeological properties of the model domain including recharge, hydraulic conductivity and assigned boundary conditions influence the state variables/head distribution (hx,y,z) computed by the model. The head distribution across the aquifer can, therefore, be obtained for a given set of boundary conditions, hydraulic conductivity values and specified recharge values. The simulated head distribution is subsequently compared to historical head values measured at a number of locations within the model domain. An acceptable correspondence can be obtained by adjusting recharge and hydraulic conductivity values within a reasonable range. This improves the estimates of the model parameters.

The steady state simulation of the Burnstone Mine model was calibrated by altering the horizontal hydraulic conductivity and vertical anisotropy ratio within an acceptable range, relative to the adjustment of specified recharge values assigned to the model area. The hydrogeological parameters were altered by a combination of manual trial-and-error calibration, and automated calibration. The automated tool used to assist model calibration is the non-linear inverse modelling code, PEST, which analyses the sensitivity of the model and works to minimise the residual head in the model by estimating new sets of parameters using aquifer property zones for all model layers (Doherty and Hunt, 2010)

The following statistical quantities assess the goodness of fit between the modelled and observed heads during trial and error calibration:

- Mean Error $$ME = \frac{1}{n}\sum_{i=1}^{n}(h_m - h_s)_i$$;
- Mean Absolute Error $$MAE = \frac{1}{n}\sum_{i=1}^{n}|h_m - h_s|_i$$;
- Root Mean Square $$RMS = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(h_m - h_s)_i^2}$$;
- Normalized RMS $$RN = \frac{RMS}{H_{\max} - H_{\min}}$$;

where h_m represents measured head, h_s represents simulated head, n is the number of calibration targets, H_{max} represents maximum measured head and H_{min} represents minimum measured head.

Burnstone steady state model calibration

The Burnstone numerical model successfully converged based on an iteration convergence criterion, two orders of magnitude smaller than the level of accuracy required in the head prediction. Statistical analysis of the manual trial-and-error calibration of the numerical model indicate an acceptable fit between simulated and observed heads (Table 4.30).

Table 4.30: Performance Measures of Final Burnstone Steady State Calibration.

Scenario	Mean Residual (ME)	Mean Absolute Residual (MAE)	Root Mean Squared Residual (RMS)
Steady State	-0.11 m	4.04 m	5.02 m

A graphical illustration of the relation between final simulated and observed head is depicted in Figure 4.31 for the end of the calibration process. The results indicate a tolerable level of conformity along a straight line in the graph, particularly in relation to the spatial heterogeneity of the hydrogeological properties within the system. The modelled steady state groundwater contours are illustrated in Figure 4.31.

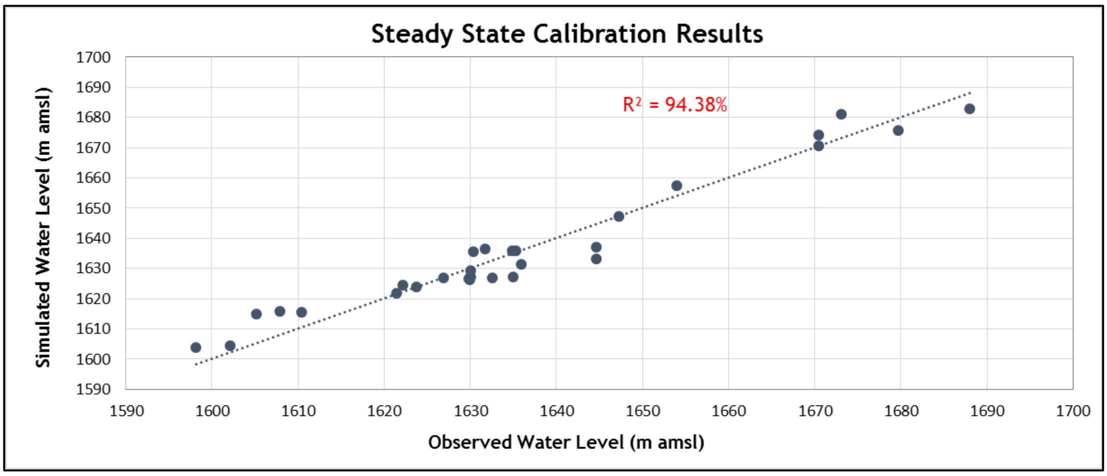


Figure 4.31: Steady state calibration results

The model water balance is an indication of the total simulated inflows and outflows out of the system; and the associated water balance error refers to the difference between the total simulated inflow and total simulated outflow, divided by either total inflow or outflow and expressed as a percentage. A water balance error of less than 0.01% was achieved for the Burnstone Numerical Model, and is regarded as acceptable. The steady state mass balance for the entire model domain is presented in Table 4.31.

Table 4.31: Mass balance of steady state model (pre-mining)

	Flow In (m3/day)	**Flow Out (m3/day)**
General Head Boundary	5364.61	-4825.31
River leakage	1498.93	-6838.46
Recharge	11398.12	0.00
Drains	0.00	-6599.05
Total flow	18261.66	-18262.82
Summary	In - Out	% difference
Total	-1.16	-0.006

<u>**Calibrated model parameters**</u>

Hydraulic conductivity and aquifer storage parameters

The hydraulic conductivity values assigned to the various lithological units within the model domain were derived from the results of aquifer tests conducted as part of fieldwork during the GCS (2005) study, and associated values calibrated during the Burnstone numerical model calibration attempts by GCS (2007). Representative values of the aquifer storage parameters, including specific storage, specific yield and porosity, were obtained from values specified in the GCS (2005) study, the Groundwater Resource Assessment: Task 1D Groundwater Quantification (DWAF, 2006) for the two quaternary catchments (C21B and C12G), and published values for rock types similar to the lithologies present within the study area. Faults within the study area were input, and assigned hydraulic conductivity and storage parameters based on the GCS (2005) and GCS (2007) studies.

These initial estimates were adjusted during manual and automated calibration (PEST) attempts, and the resulting calibrated hydraulic conductivity and storage parameters for each materials zone are summarised in Table 4.32. The transmissivity of each aquifer domain (layer assemblage) is summarised in Table 4.33.

Recharge

The initial recharge value assigned to the Burnstone numerical model was adjusted during model calibration. Model calibration resulted in a recharge value of 1.1 % of the MAP, within the range of 0.4 to 2 % of MAP used in previous models (GCS, 2005 and GCS, 2007).

4.3.6.6 Mine Dewatering

The elevation of the gold mine floor is below the general groundwater level. Active mine dewatering during the Life of Mine (LOM) is, therefore, necessary to ensure safe working conditions. Abstraction of groundwater from the vertical shaft, decline shaft and mine voids to the surface will induce a pressure deficit within the aquifer, which will result in groundwater influx into these structures and lowering of the groundwater levels within the associated zone of influence.

Several factors influence the extent of the zone of influence, including the depth and size of mining below the regional groundwater level, aquifer parameters, particularly the hydraulic conductivity and storativity of the aquifers that the mine is located within, structural features, including fracture zones, faults and intrusions, and recharge from rainfall. Groundwater inflows into the shafts and underground mine and the development of the cone of drawdown over time, was simulated with the use of the calibrated numerical model and the associated aquifer parameters, and yearly mining depletion plan.

It should be noted that hydraulic barriers, such as dolerite dykes that intercept the underground mine workings, were not simulated, so as to ascertain that the groundwater inflows represent the most conservative scenario. Furthermore, it was assumed that any exploration boreholes into the mine are sealed.

Table 4.32: Calibrated aquifer parameter values for geological material zones

Aquifer Domain	Layer	Lithology	Material Zone	Hydraulic conductivity (m/day)		Vertical Anisotropy (Kh/Kv)	Specific Storage	Specific Yield	Porosity
				Horizontal Kh (m/day)	Vertical Kh (m/day)				
1	1	Dolerite Intrusions	1	5.00E-02	2.50E-03	20	1.00E-04	8.50E-03	0.01
		Alluvium	2	1.00E-01	5.00E-03	20	3.00E-04	1.00E-01	0.4
		Ventersdorp Supergroup	3	1.60E-02	8.00E-04	20	1.00E-04	8.50E-03	0.01
		Karoo Supergroup	4	7.20E-02	3.60E-03	20	1.50E-04	1.50E-02	0.04
		Witwatersrand Supergroup	5	5.00E-02	2.50E-03	20	1.00E-04	1.50E-02	0.04
		Diabase	6	5.00E-03	2.50E-04	20	1.00E-04	8.50E-03	0.01
		Transvaal Supergroup	7	7.50E-02	3.75E-03	20	1.00E-04	1.50E-02	0.04
		Swazian Mafic and Ultramafic Rocks	8	3.30E-02	1.65E-03	20	1.00E-04	8.50E-03	0.01
		Barberton Sequence	9	7.50E-02	3.75E-03	20	1.50E-04	9.50E-03	0.045
2	2 - 3	Dolerite Intrusions	11	2.00E-02	1.00E-03	20	3.00E-05	5.00E-03	0.007
		Ventersdorp Supergroup	12	8.00E-03	4.00E-04	20	3.00E-05	5.00E-03	0.007
		Karoo Supergroup	13	3.70E-02	1.85E-03	20	3.20E-05	9.00E-03	0.01
		Witwatersrand Supergroup	14	1.80E-02	9.00E-04	20	3.00E-05	9.00E-03	0.01
		Diabase	15	5.00E-04	2.50E-05	20	3.00E-05	5.00E-03	0.007
		Transvaal Supergroup	16	1.50E-02	7.50E-04	20	3.00E-05	9.00E-03	0.01
		Swazian Mafic and Ultramafic Rocks	17	7.00E-03	3.50E-04	20	3.00E-05	5.00E-03	0.007
		Barberton Sequence	18	1.50E-02	7.50E-04	20	3.20E-05	7.50E-03	0.015
3	4 - 7	Ventersdorp Supergroup	20	1.00E-03	5.00E-05	20	1.00E-06	5.00E-03	0.008
		Witwatersrand Supergroup	22	1.00E-03	5.00E-05	20	1.00E-06	5.00E-03	0.008
4	8 - 13	Witwatersrand Supergroup	22	1.00E-03	5.00E-05	20	1.00E-06	5.00E-03	0.008
2, 3, 4	2 - 13	Faults	28	1	1.00E-01	10	1.00E-04	1.00E-02	0.05
2, 3, 4	2 - 13	Faults	29	5.00E-02	5.00E-03	10	1.00E-05	8.00E-03	0.01

Table 4.33: Calibrated values of transmissivity for the model aquifers

Aquifer Domain	Layer	Thickness (m)	Lithology	Transmissivity values (m^2/day)
1	1	40	Weathered aquifer	2
2	2 - 3	100	Highly to moderately fractured aquifer	1.8
3	4 - 7	200	Moderately to slightly fractured aquifer	0.2
4	8 - 13	860	Moderately to slightly fractured aquifer	0.86
Total				4.86

4.3.6.7 Contaminant Transport

Contaminant transport modelling was conducted for the underground mine based on the calibrated steady state model. The following was assumed and input for the transient simulations:

- The underground mine will not be backfilled with any waste material;
- The mine voids will be inundated by water during groundwater rebound;
- Sulphate is the major potential future parameter of concern for the project site based on the existence of pyritic minerals associated with gold in the underground workings, the potential impacts of acid mine drainage on the environment that are considered significant, and sulphate is considered a conservative tracer;
- The underground mine, shafts, WRD and TSF are potential sources of sulphate contamination;
- Input sulphate concentrations were based on studies conducted for similar sites and geochemical tests previously conducted which involved the testing of WRD and TSF samples;
- The WRD materials were anticipated to have acid-generating potentials lower than the tailings materials; and
- Acid generation was anticipated for the tailings of the TSF, under oxidising conditions, and based on studies at similar sites, acid generation could take place longer than anticipated in the previous geochemical studies.

Sulphate concentrations were generated for the WRD and TSF from the start of LOM, until 100 years after mine cessation. Potential contaminant plume movement from the shafts and underground mine was calculated for several interval periods, until 100 years after mine cessation. The input sulphate concentrations are shown in Table 4.34.

Based on the TSF Design report compiled by Knight Piesold (2009), the TSF is underlain by natural low permeability (<8.64×10^{-4} m/day) clay material at least 1.5 m thick, which will act as a natural liner to limit the seepage of contaminated water into the underlying aquifer.

Seepage analysis was conducted for the TSF, and vertical and horizontal hydraulic conductivity 10^{-8} and $5x10^{-8}$ m/s, respectively, were assumed for the tailings. Underdrains were also proposed by Knight Piesold (2009), at the outer part of the tailings deposit, which will facilitate drainage of the containment wall section and depression of the phreatic surface to enhance the structural integrity of the facility. A recharge value, for transient simulation purposes, of $1.73x10^{-4}$ m/day (9 % of MAP) was allocated to the TSF for the operational phase, to account for the moisture content of the deposited tailings. During the post closure phase, tailings deposition within the TSF will seize, and it is thus assumed that the recharge rate is $8.64x10^{-5}$ m/day (5 % or MAP) during this time.

The WRD is not currently lined, however, it is located on hard overburden and hard clay, which is assumed to have low permeability. Based on the Waste Classification Report for the WRD compiled by GCS (2018), extensions to the WRD should be lined with a Class D containment barrier. A recharge of 4 % of MAP was assumed for the WRD ($7.61x10^{-5}$ m/day) for the operational phase, to account for seepage from the WRD into the underlying aquifer. A recharge rate of 2 % ($3.80x10^{-5}$ m/day) was assumed for the WRD for the post closure phase, as the deposition of additional waste material will seize during the decommissioning phase and the porosity of the dump may decrease as the materials settle under the pressure of overlying material and gravity. The recovery of groundwater levels in the shafts and underground mine was considered for the sulphate contaminant plume modelling.

Table 4.34: Conservative input sulphate concentrations for the mine section based on the previous geochemical assessment and studies conducted for similar sites

Mine Section	Change in SO_4 (mg/l)	
WRD	**Operational Phase**	**Post-Closure Phase**
	SO_4 0 – 500	SO_4 500 – 1100
TSF	**Operational Phase**	**Post-Closure Phase**
	SO_4 0 – 1 000	SO_4 1 000 – 2500
Vertical and Decline Shafts	**Operational Phase**	**Post-Closure Phase**
	SO_4 0 – 0	SO_4 0 – 3000
Underground Mine	**Operational Phase**	**Post-Closure Phase**
	SO_4 0 – 0	SO_4 0 – 4000

The main parameter of concern was anticipated to be sulphate, in consideration of historic gold mining activities. Sulphate was also considered a conservative tracer i.e. advection and dispersion was taken into account, not sorption or decay, for the transport modelling.

4.4 Socio-economic Environment

4.4.1 Regional Context

Burnstone lies in the south-western parts of Mpumalanga Province and falls within the Dipaleseng Local Municipality which is under the jurisdiction of the Gert Sibande District Municipality (Stats SA, 2018). Balfour is located 6km east of Burnstone and is in the heart of world-renowned coalfields and the Goldfields belt. This modern and predominantly industrial town is located in close proximity (80km) to the nationally well-known industrial areas of Johannesburg (Stats SA, 2018). The Balfour/Siyathemba urban area is 340km from Nelspruit. The internationally known abattoir, the "biggest abattoir in Africa", is found in Dipaleseng (Balfour town), with a vast number of by-products including inorganic chemicals, fertilizers, etc. being manufactured in the area (Stats SA, 2018).

4.4.2 Local Context

1.1.1.1 Demographics

According to the 2011 census, Mpumalanga recorded a population size of 4 039 939, ranking it sixth out of the nine provinces (Stats SA, 2014). The total population of Dipaleseng Local Municipality is approximately 42 390. Almost 90% of the population is black African, with the white population making up 8.6%. The other population groups make up the remaining 1.4% (Figure 4.32). The majority of the population is the youth (15-35 years), and the high unemployment rate leads to socio-economic problems such as substance abuse, crime and early pregnancy, to name a few (Stats SA, 2018).

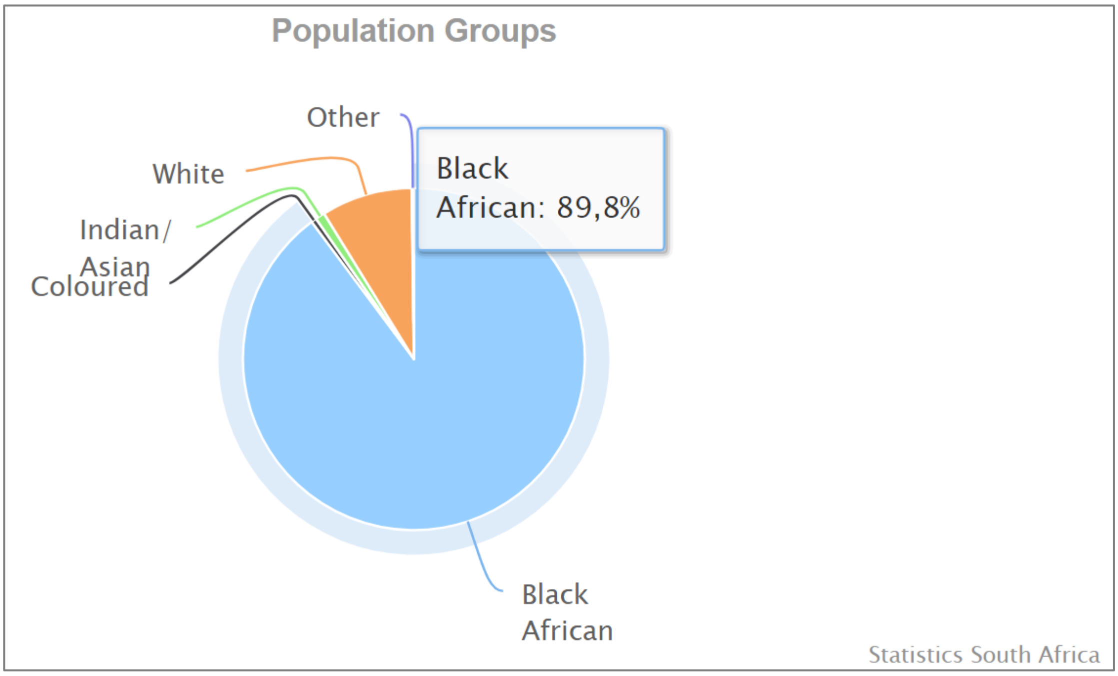


Figure 4.32: Population groups (Stats SA, 2018)

The majority of the population is men with 51.4% (as seen in Figure 4.33). The most spoken language (Figure 4.34) in the Dipaleseng Local Municipality is isiZulu (55.6%), followed by Sesotho (24%) and Afrikaans (8.9%).

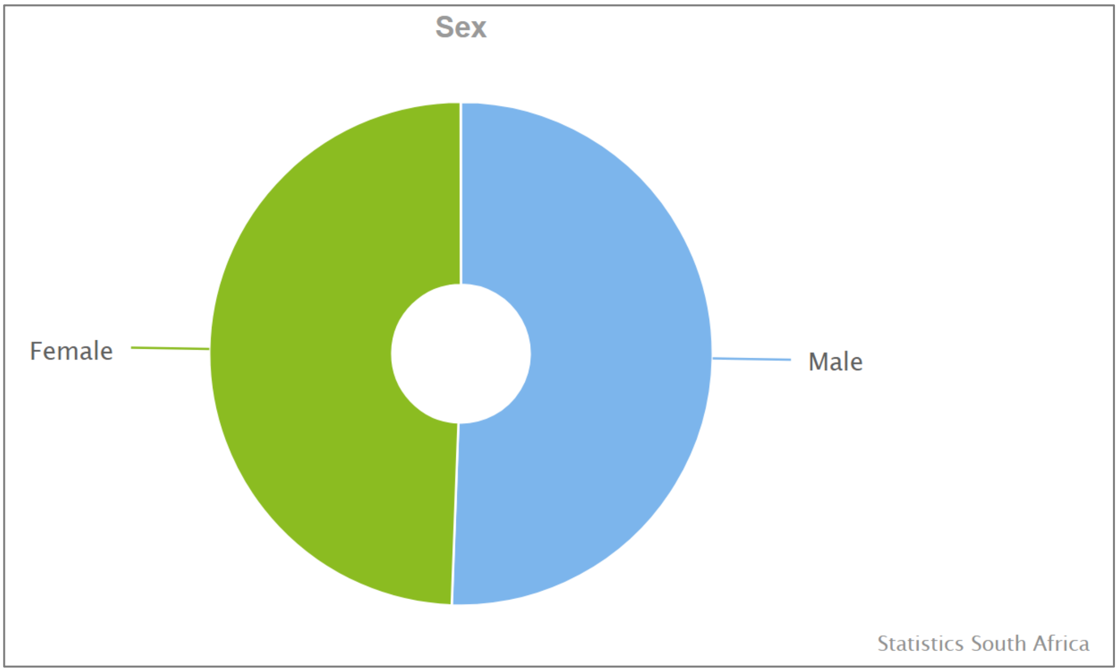


Figure 4.33: Sex (Stats SA, 2018)

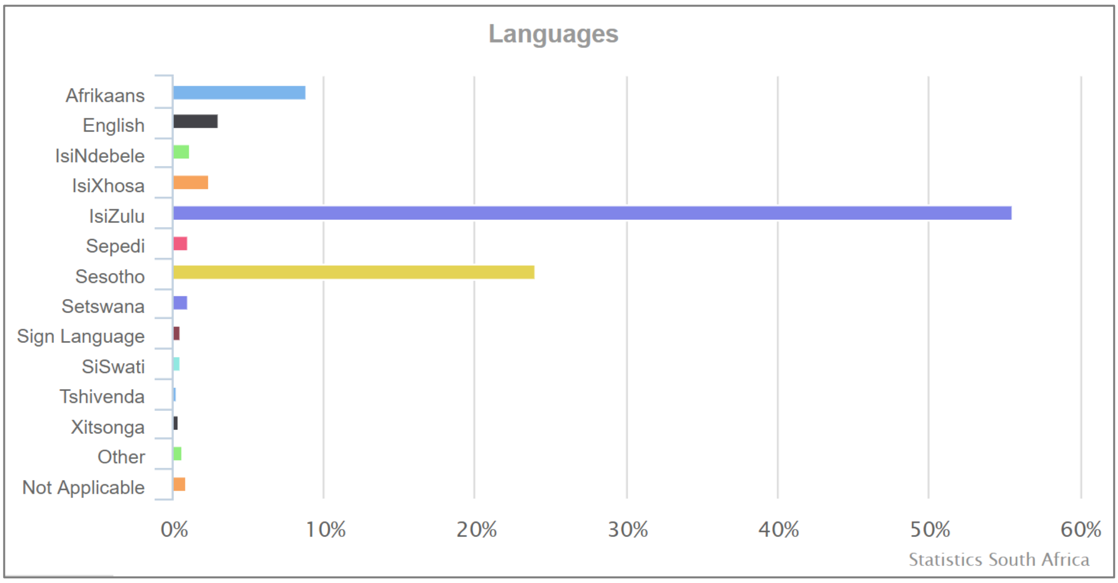


Figure 4.34: Languages spoken (Stats SA, 2018)

In addition, the highest level of education (Figure 4.35) includes 'some primary' (43.4%), 'some secondary' (33.5%) and 'completed secondary' (12.2%). A total of 2.8% have no schooling, while 1% have a higher education level (Stats SA, 2018).

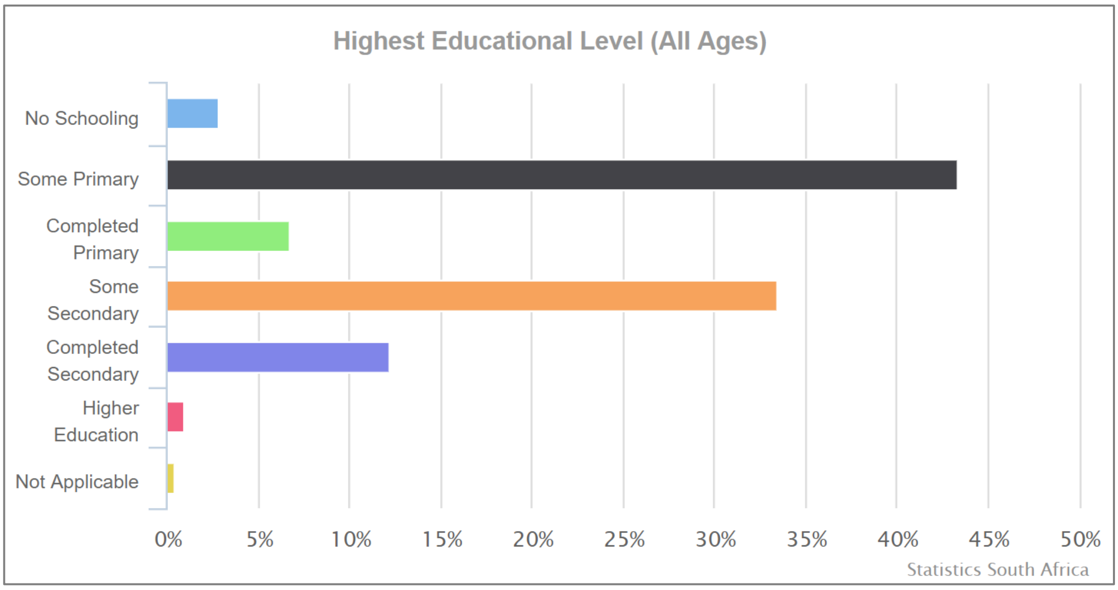


Figure 4.35: Highest educational level (Stats SA, 2018)

1.1.1.2 Living Conditions

Dipaleseng Local Municipality has the smallest population in Mpumalanga, with a third of its total population still living in informal settlements (Stats SA, 2018). The quality of water is within acceptable standards though poor at times. Much needs to be done to improve the quality of drinking water (Stats SA, 2018).

Although Dipaleseng Local Municipality has the lowest population, it also has the highest HIV prevalence in the province (Stats SA, 2018). The municipality does not have a hospital, but does have clinics in all three nodal towns. As much as these clinics seek to address the needs of the communities, the demand far exceeds them (Stats SA, 2018).

According to Stats SA (2018), the majority (78.3%) of the population live in an urban area and the majority use electricity (Figure 4.36) for cooking (73.4%), heating (57.6%) and lighting (83.1%). Coal is the second most used energy source for cooking (10%) and heating (20.3%) (Stats SA, 2018). In terms of the source of water (Figure 4.37), 83.6% use regional/local water schemes, while 6.5% use boreholes and 3.5% use water tankers.

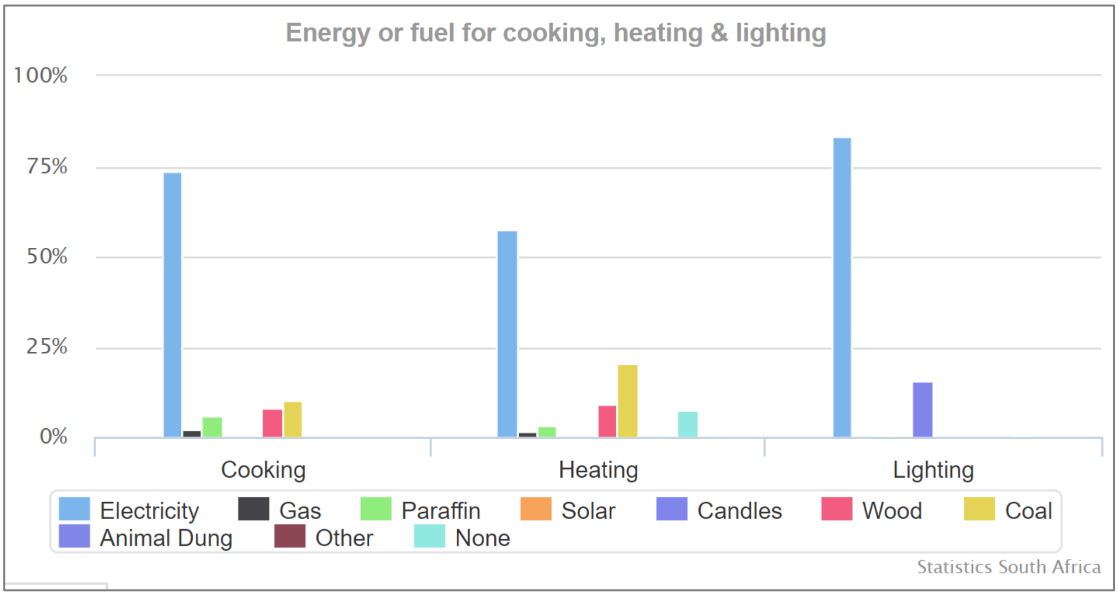


Figure 4.36: Energy or fuel for cooking, heating and lighting (Stats SA, 2018)

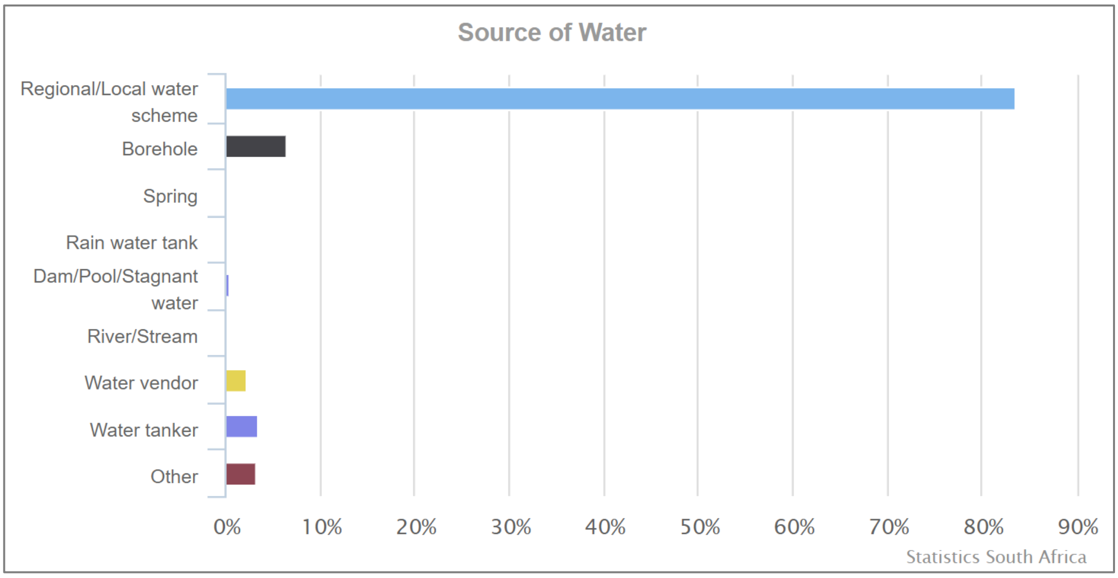


Figure 4.37: Source of water (Stats SA, 2018)

1.1.1.3 Economy

Seeing that the jurisdiction of Dipaleseng is rural, the majority of the economic sector in the municipality is agricultural, followed by mining, electricity, wholesale and retail trade, transport, construction and manufacturing fields (Stats SA, 2018). Although the economy reflects growth, the pace is slow and discouraging. With the boost of the introduction of new mining prospects and new developments within the area, it is hoped this will have a positive impact on the economic activities of Dipaleseng. In terms of employment between the ages of 15-64 (Figure 4.38), 10 546 people are employed, while 6244 (37.2%) are unemployed.

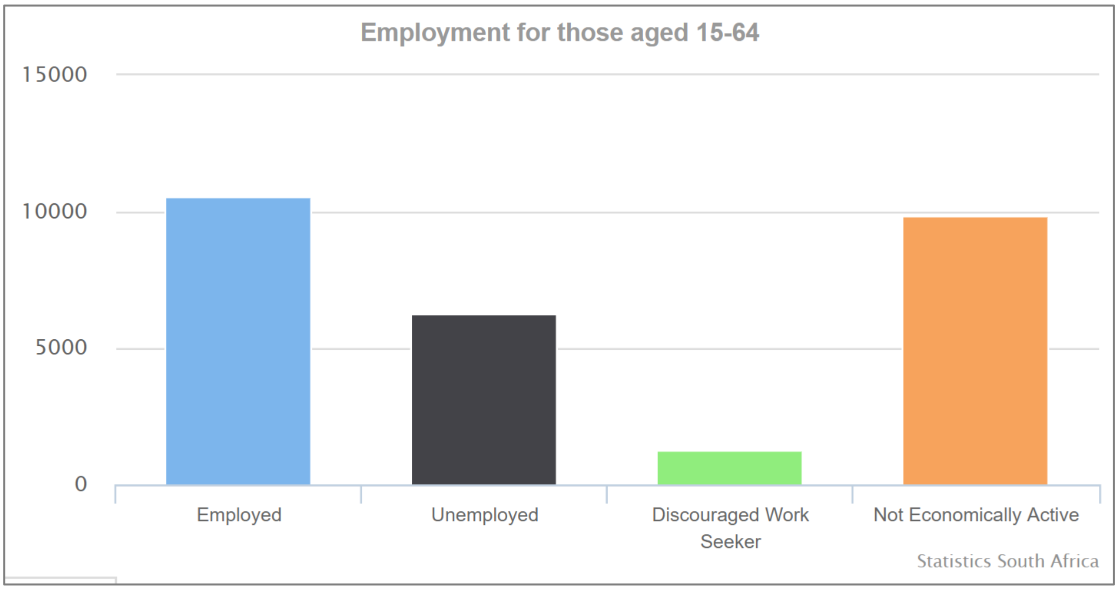


Figure 4.38: Employment for those aged 15-64 (Stats SA, 2018)

5 ANALYSIS AND CHARACTERIZATION OF THE WATER USE ACTIVITY

5.1 Site Delineation for Characterization

Refer to Section 1.3 for the extent of the project area.

5.2 Water and Waste Management

5.2.1 Process Water

Process water will be kept in a closed loop and all contaminated runoff from site as well as water from the TSF return water dam will be routed into the process water circuit. Any sewage effluent from the treatment plant on site will be fed into the process water circuit for reuse in order to reduce their use of raw water intake.

However, the process water is pumped to the TSF RWD with an overflow to the TSF SWD. Excess water from the TSF RWD is discharged into the stream. Locality SW8 is located in the stream downstream of TSF RWD discharge locality.

5.2.2 Stormwater

The purpose of a SWMP is to minimise the potential contamination of water resources in and around the mine processing plant and areas where mining-related activity occurs. It also prevents flooding and provides a safe working environment during extreme events. This conceptual SWMP is based on the infrastructure layout provided by Sibanye (drawings reference number M0761-G0000: Sibanye Gold Overall Block Plan).

5.2.2.1 Delineation of Clean and Dirty water Catchments

GCS was provided with a proposed future block plan infrastructure layout for the Burnstone Mine. This block plan included the following: processing plant area, vertical shaft area, decline area, WRD area, TSF area and other smaller mine infrastructure (drawings reference number M0761-G0000: Sibanye Gold Overall Block Plan). In addition a 2 m contour topographical survey was provided (Southern Mapping GEO Spatial, 2015) to determine natural run-off flow directions.

Dirty water catchment areas were delineated based on topography, the mine infrastructure block plan and the existing stormwater channels. Proposed SWMP measures were defined that aim to mitigate potential (clean) surface water contamination.

Each of the dirty water catchment areas have different drainage characteristics. Dirty water areas were mapped out and can be seen in Table 5.1 and Figure 5.2. A summarised overview of all delineated water catchments, listing maximum footprint sizes and slopes, are given in Table 5.1. The runoff coefficients and peak runoff values for each delineated catchment are also presented.

Table 5.1: Overview of Delineated Dirty Water Areas

			Return Interval (1:50 year)	
Catchment ID	**Area (ha)**	**Slope (%)**	**Runoff coefficient**	**Runoff peak (m^3/s)**
Processing Plant Area	**5.951**			
• *Plant_1*	*1.174*	*0.5*	*0.64*	*0.88*
• *Plant_2*	*0.759*	*0.5*	*0.64*	*0.62*
• *Plant_3*	*2.275*	*0.5*	*0.64*	*1.47*
• *Plant_4*	*1.118*	*0.5*	*0.64*	*0.89*
• *Plant_5*	*0.162*	*0.5*	*0.64*	*0.13*
• *Plant_6*	*0.200*	*0.5*	*0.64*	*0.16*
Vertical Shaft Area	**9.937**			
• *Ver_1*	*0.833*	*0.5*	*0.77*	*0.68*
• *Ver_2*	*0.656*	*0.5*	*0.77*	*0.55*
• *Ver_3*	*0.505*	*0.5*	*0.77*	*0.42*
• *Ver_4*	*1.146*	*0.5*	*0.77*	*0.89*
• *Ver_5*	*0.388*	*0.5*	*0.77*	*0.32*
• *Ver_6*	*0.426*	*0.5*	*0.77*	*0.35*
• *Ver_7*	*0.778*	*0.5*	*0.77*	*0.62*
• *Ver_8*	*0.269*	*0.5*	*0.77*	*0.24*
• *Ver_9*	*0.085*	*0.5*	*0.77*	*0.08*
• *Ver_10*	*0.103*	*0.5*	*0.77*	*0.09*
• *Ver_11*	*0.080*	*0.5*	*0.77*	*0.07*
• *Ver_12*	*0.492*	*0.5*	*0.77*	*0.45*
• *Ver_13*	*0.821*	*0.5*	*0.77*	*0.62*
• *Ver_14*	*0.035*	*0.5*	*0.77*	*0.03*
• *Ver_15*	*1.021*	*0.5*	*0.77*	*0.88*
• *Ver_16*	*0.504*	*0.5*	*0.77*	*0.44*

			Return Interval (1:50 year)	
Catchment ID	**Area (ha)**	**Slope (%)**	**Runoff coefficient**	**Runoff peak (m³/s)**
• *Ver_17*	*0.529*	*0.5*	*0.70*	*0.44*
• *Ver_18*	*0.538*	*0.5*	*0.69*	*0.42*
• *PCD_1*	*0.417*	*0.50*	*1.00*	*0.39*
• *PCD_2*	*0.275*	*0.50*	*1.00*	*0.25*
• *Overflow PCD*	*0.038*	*0.50*	*1.00*	*0.04*
Waste Rock Dump Area	**29.779**			
• *WRD_1*	*7.703*	*0.40*	*0.8*	*0.40*
• *WRD_2*	*6.083*	*0.40*	*0.6*	*0.40*
• *WRD_3*	*7.771*	*0.40*	*0.84*	*0.40*
• *WRD_4*	*7.658*	*0.40*	*0.71*	*0.40*
• *PCD@WRD*	*0.563*	*0.5*	*1.00*	*0.52*
Decline Area	**11.084**			
• *Decline_1*	*0.440*	*0.5*	*0.76*	*0.37*
• *Decline_2*	*0.111*	*0.5*	*0.76*	*0.10*
• *Decline_3*	*0.258*	*0.5*	*0.76*	*0.23*
• *Decline_4*	*0.326*	*0.5*	*0.76*	*0.29*
• *Decline_5*	*0.088*	*0.5*	*0.76*	*0.08*
• *Decline_6*	*0.159*	*0.5*	*0.76*	*0.13*
• *Decline_7*	*0.712*	*0.5*	*0.76*	*0.60*
• *Decline_8*	*0.171*	*0.5*	*0.76*	*0.14*
• *Decline_9*	*0.121*	*0.5*	*0.76*	*0.11*
• *Decline_10*	*0.780*	*0.5*	*0.61*	*0.54*
• *Decline_11*	*1.341*	*0.5*	*0.76*	*1.07*
• *Decline_12*	*0.940*	*0.5*	*0.76*	*0.80*
• *Decline_13*	*1.270*	*0.5*	*0.68*	*1.01*
• *Decline_14*	*1.739*	*0.5*	*0.68*	*1.31*
• *Decline_15*	*0.180*	*0.5*	*0.76*	*0.16*
• *Decline_16*	*0.165*	*0.5*	*0.76*	*0.15*
• *Decline_17*	*0.061*	*0.5*	*0.62*	*0.05*
• *Decline_18*	*0.225*	*0.5*	*0.76*	*0.19*
• *Decline_19*	*0.499*	*0.5*	*0.76*	*0.42*
• *Decline_20*	*0.318*	*0.5*	*0.76*	*0.26*
• *PCD_3*	*0.603*	*0.5*	*1.00*	*0.55*
• *PCD_4*	*0.579*	*0.5*	*1.00*	*0.52*

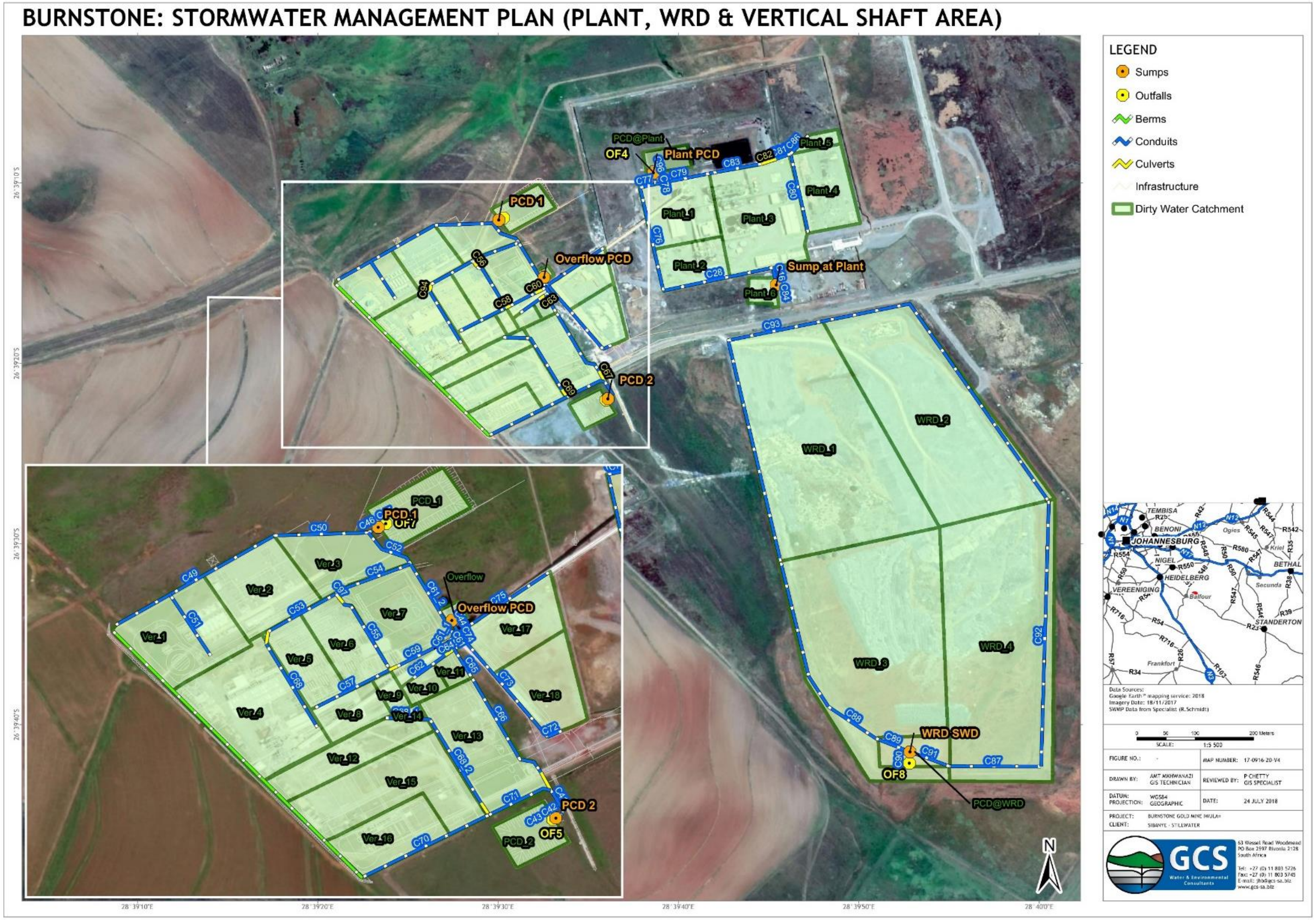


Figure 5.1: Overview of the conceptual SWMP of processing plant, vertical shaft and WRD area

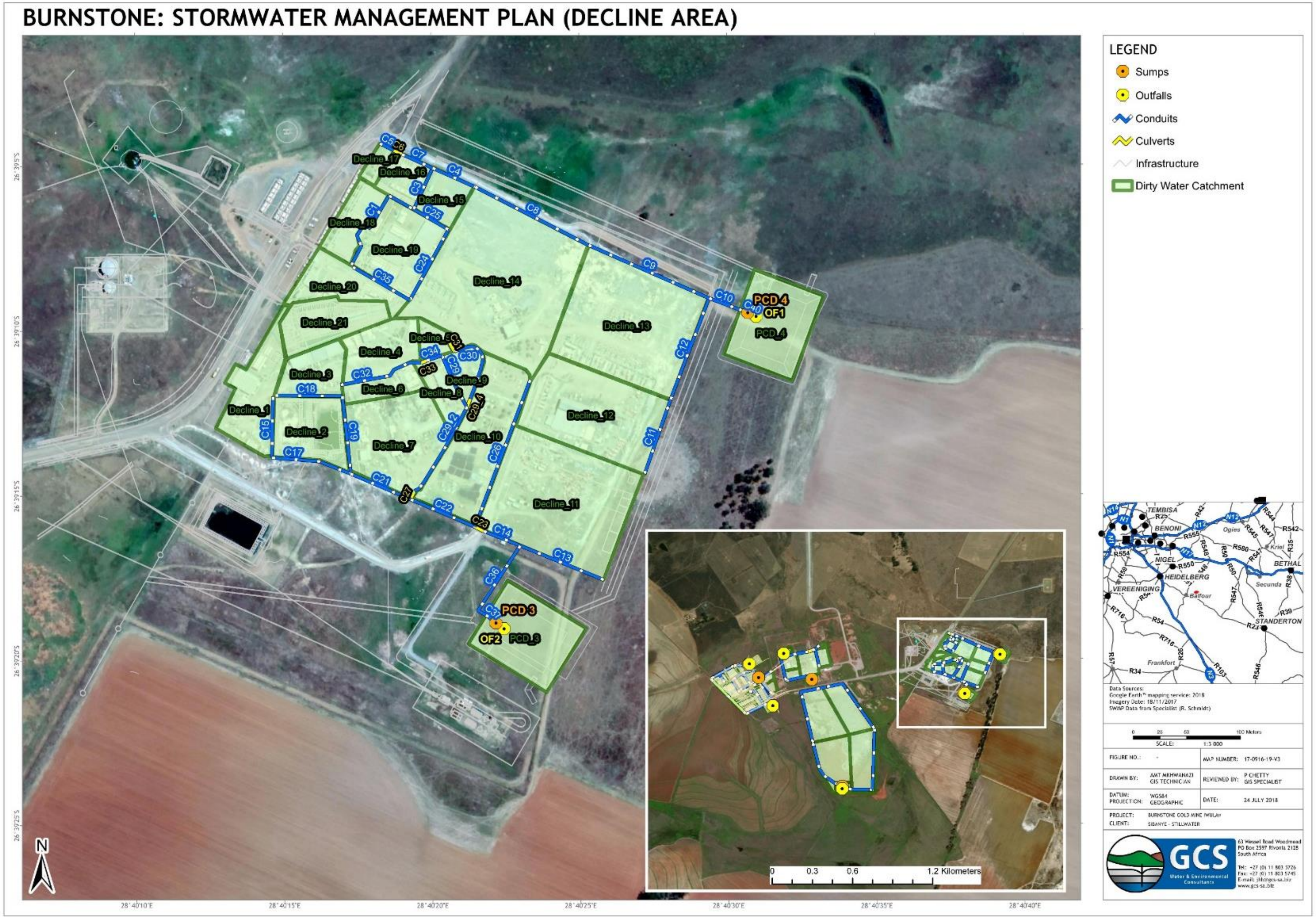


Figure 5.2: Overview of the conceptual SWMP of decline area

5.2.2.2 *Proposed SWMP Measures*

Locations of proposed conceptual SWMP measures associated with the processing plant, vertical shaft, WRD and decline areas are shown in Figure 5.1 and Figure 5.2. Proposed SWMP measures include the following stormwater infrastructure: drains, culverts, berms and PCDs. It is advisable that sediment / silt traps be placed before water enters to PCDs and sumps to reduce the amount of silt that deposits in these dams, which is likely to affect the storage areas of these dams. If not regular planned maintenance would be required to maintain the dam capacity. It is recommended, that oil separators be placed at downstream points of areas that contain/use fuel (fuel storage areas and parking areas).

The processing plant dirty water area was divided into smaller sub-catchments and has a series of stormwater drains leading into the Plant PCD. Water from this PCD would either be used in the processing plant to make up the demand instead of pumping from the TSF RWD or if this water cannot be used in the process will be pumped to the TSF RWD. This water will be reused within the dirty water reticulation system.

Additional infrastructure proposed at the vertical shaft area. This includes two new PCDs (PCD 1 and PCD 2), change houses, office, stores and parking area along with new roads. This area was divided into smaller sub-catchments and the runoff from these sub-catchments are drained into the different PCDs using a series of stormwater drains and culverts. Water from these PCDs should be pumped to the TSF RWD where the water will be able to evaporate. It is proposed that water from PCD 1 and Overflow PCD be pumped into the PCD 2 and from PCD 2 the water is pumped to Dam 3 where the water will eventually end up in the TSF RWD.

The WRD dirty water area was divided into four (4) sub catchments. A drain is proposed around the entire facility that collects runoff and leads this runoff into the existing unlined WRD SWD.

Runoff from dirty water areas at the decline area were drained into two PCDs (PCD 3 and PCD 4) using a series of drains and culverts. It is proposed that water from PCD 4 is pumped into PCD 3 and from PCD 3 pumped to Dam 3 where it will eventually be pumped to the TSF RWD. Proposed location of PCD 4 is currently within the 100 m buffer of wetland unit 1 (GCS, 2018). Adherence to the SWMP and adequate mitigation measures, according to the wetland study, must be taken to reduce contamination into the wetland area.

5.2.2.3 *Sizing of Stormwater Infrastructure*

A PCSWMM (Chiwater, 2015) model was used to size stormwater channels and requires soil classification input to incorporate infiltration into the analysis. The Green-Ampt infiltration method (Rawls, Brakensiek, & Miller, 1983) was used and input data for this method is presented in Table 5.2.

The processing plant is a terraced area that is largely impervious and was classified as a silt loam. The vertical shaft and decline area were modelled as silt loam soils. The WRD was classified as sandy clay loam.

Table 5.2: Green-Ampt Infiltration Parameters for Soil Classes

Catchment Area	Silt Loam	Sandy Clay Loam
Wetting front soil suction head (mm)	166.8	218.5
Hydraulic conductivity (mm/h)	6.5	3
Initial deficit (fraction)	0.25	0.25

A conceptual layout of the clean and dirty water diversions can be seen in Figure 5.1 and Figure 5.2. Diversion channel characteristics can be seen in Table 5.4 and the culvert characteristics can be seen in Table 5.5. Diversion channels and culverts should all be concrete lined. All stormwater diversions have been sized to prevent flooding more than once in 50 years. Maximum flows and velocities in these divisions have also been provided in the Table 5.4 and Table 5.5 for the 1:50 year recurrence interval flood event.

PCDs were sized to prevent spilling during a once-off storm event with a return period of 50 years per GN704 and additional 15% operational storage margin. Practically the PCDs will never be complete empty thus an additional 15% is recommended. Storage capacities of the proposed PCDs are presented in Table 5.3. Additional capacity is required for PCD at WRD as the 17 250 m^3 is not sufficient to capture a 1:50 year event. During storm events silt from the WRD and unlined channels enter into the PCD. It is recommended that a silt trap be place at the WRD SWD to prevent siltation.

Table 5.3: PCD and Sump Capacities

Dam	Current Capacity	Calculated Capacity (m^3)
Plant PCD	7 000	7 000
Sump at Plant	-	60
WRD SWD	17 250	22 785
PCD 1	-	8 360
PCD 2	-	4 575
Overflow PCD	-	1 440
PCD 3	-	7 725
PCD 4	-	8 245

Table 5.4: Characteristics and results for Stormwater Drains

										Return Interval (1:50 year)	
Name	Roughness	Inlet offset (m)	Outlet offset (m)	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (w:h)	Right Slope (w:h)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. Velocity (m/s)
Processing Plant Area											
C16	0.013	1.25	0	TRAPEZOIDAL	0.25	0.25	1.5	1.5	0.0067	0.155	2.17
C28	0.013	0	0.25	TRAPEZOIDAL	0.25	0.25	1.5	1.5	0.0093	0.134	1.58
C76	0.013	0	0	TRAPEZOIDAL	0.5	1	1.5	1.5	0.0079	0.673	2
C77	0.013	0	0	TRAPEZOIDAL	0.5	1	1.5	1.5	0.0279	1.503	2.52
C78	0.013	0	2.4	TRAPEZOIDAL	0.6	1	1.5	1.5	0.0151	3.9	4.38
C79	0.013	0	0	TRAPEZOIDAL	0.6	2	1.5	1.5	0.0107	2.386	2.24
C80	0.013	0	0	TRAPEZOIDAL	0.6	1	1.5	1.5	0.0102	0.872	2.14
C81	0.013	0	0	TRAPEZOIDAL	0.6	1	1.5	1.5	0.0085	0.978	1.67
C83	0.013	0	0	TRAPEZOIDAL	0.6	2	1.5	1.5	0.0110	2.401	3.16
C84	0.02	0	1.25	RECT_OPEN	0.25	0.5	0	0	0.0141	0.158	1.45
C86	0.013	0	0	RECT_OPEN	0.5	0.5	0	0	0.0072	0.13	1.05
WRD Area											
C87	0.02	0	0	TRAPEZOIDAL	1	1.5	1.5	1.5	0.0050	3.38	2.48
C88	0.02	0	0	TRAPEZOIDAL	1	1.5	1.5	1.5	0.0099	4.14	2.90
C89	0.02	0	2	TRAPEZOIDAL	1	1.5	1.5	1.5	0.0087	4.14	3.09
C90	0.02	2.75	0	RECT_OPEN	0.25	1	0	0	0.0132	0.00	0.00
C91	0.02	0	2	TRAPEZOIDAL	1	1.5	1.5	1.5	0.0055	3.38	3.10
C92	0.02	0	0	TRAPEZOIDAL	1	1.5	1.5	1.5	0.0091	1.60	1.35
C93	0.02	0	0	TRAPEZOIDAL	1	1.5	1.5	1.5	0.0081	2.02	1.63

										Return Interval (1:50 year)	
Name	Roughness	Inlet offset (m)	Outlet offset (m)	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (w:h)	Right Slope (w:h)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. Velocity (m/s)
Vertical Shaft Area											
C43	0.013	2.1	0	RECT_OPEN	0.1	1	0	0	0.03056	0	0
C45	0.013	1.75	0	RECT_OPEN	0.25	1	0	0	0.02093	0	0
C47	0.013	2.4	0	RECT_OPEN	0.1	1	0	0	0.01238	0	0
C16	0.013	1.25	0	TRAPEZOIDAL	0.25	0.25	1.5	1.5	0.00669	0.155	2.17
C2	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.0038	0.184	0.57
C29_3	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00608	0.187	1.58
C39	0.013	0	1	TRAPEZOIDAL	1	1	1.5	1.5	0.02303	4.066	5.17
C41	0.013	0	0	TRAPEZOIDAL	0.5	1	1.5	1.5	0.01041	2.297	2.96
C42	0.013	0	1.7	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.01476	2.299	3.86
C44	0.013	0	1.25	TRAPEZOIDAL	0.75	1	1.5	1.5	0.03071	0.831	3.62
C46	0.013	0	1.75	TRAPEZOIDAL	0.75	1	1.5	1.5	0.00906	4.201	3.71
C49	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.01133	0.667	2.37
C50	0.013	0	0.25	TRAPEZOIDAL	0.5	1	1.5	1.5	0.00903	1.201	2.5
C51	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00935	0.679	2.48
C52	0.013	0	0	TRAPEZOIDAL	0.5	1	1.5	1.5	0.01563	3.025	3.7
C53	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00937	1.232	2.6
C54	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.01035	1.547	2.96
C55	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00979	0.344	1.22
C57	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.01	0.237	1.31
C59	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00886	0.229	0.68
C61	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.0082	0.269	1.24
C61_1	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.01099	0.857	2.92

										Return Interval (1:50 year)	
Name	Roughness	Inlet offset (m)	Outlet offset (m)	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (w:h)	Right Slope (w:h)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. Velocity (m/s)
C61_2	0.013	0	0	TRAPEZOIDAL	0.5	1	1.5	1.5	0.00967	1.098	1.91
C62	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.01079	0.201	1.23
C64	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00851	0.198	1.24
C65	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.01034	0.072	0.68
C66	0.013	0	0	TRAPEZOIDAL	0.5	1	1.5	1.5	0.00983	0.613	1.69
C68	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00999	0.88	1.87
C68_1	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00733	0.443	1.21
C68_2	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00688	1.296	2.23
C70	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00806	0.432	1.13
C71	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00764	1.695	3.06
C72	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00672	0.003	0.05
C73	0.013	0	0	TRAPEZOIDAL	0.5	0.75	1.5	1.5	0.00652	0.411	1.65
C74	0.013	0	0	TRAPEZOIDAL	0.75	1	1.5	1.5	0.0107	0.831	2.98
C75	0.013	0	0	TRAPEZOIDAL	0.5	0.75	1.5	1.5	0.00846	0.436	1.8
Decline Area											
C1	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00481	0.186	0.98
C3	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00518	0.821	2.46
C4	0.013	0	0.5	TRAPEZOIDAL	0.5	1	1.5	1.5	0.00876	1.009	2.47
C5	0.013	0	0	TRAPEZOIDAL	0.25	0.5	1.5	1.5	0.00469	0.052	0.44
C7	0.013	0	0.25	TRAPEZOIDAL	0.25	0.5	1.5	1.5	0.0054	0.052	0.95
C8	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.00838	1.148	1.93
C9	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.00895	2.359	2.77
C10	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.01333	4.065	4.66

										Return Interval (1:50 year)	
Name	Roughness	Inlet offset (m)	Outlet offset (m)	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (w:h)	Right Slope (w:h)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. Velocity (m/s)
C11	0.013	0	0	TRAPEZOIDAL	0.5	1	1.5	1.5	0.00816	0.795	2.22
C12	0.013	0	0.5	TRAPEZOIDAL	0.5	1	1.5	1.5	0.0069	0.77	2.1
C13	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.00948	1.059	1.66
C14	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.01084	2.448	2.92
C15	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00524	0.37	1.67
C17	0.013	0	0.5	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00529	0.359	1.63
C18	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00638	0.23	1.49
C19	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00503	0.225	1.37
C21	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.00978	0.672	1.42
C22	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.00919	1.944	1.96
C24	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00493	0.246	0.95
C25	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.0048	0.655	1.7
C26	0.013	0	0.5	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00614	0.522	1.9
C29	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00562	0.529	1.99
C29_2	0.013	0	0.1	TRAPEZOIDAL	0.5	1	1.5	1.5	0.00532	0.713	1.59
C30	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00654	0.079	0.8
C32	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00994	0.414	1.31
C34	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.0099	0.393	1.6
C35	0.013	0	0	TRAPEZOIDAL	0.5	0.5	1.5	1.5	0.00405	0.255	1.42
C36	0.013	0	0	TRAPEZOIDAL	1	1	1.5	1.5	0.00991	3.4	3.51
C37	0.013	0	1	TRAPEZOIDAL	1	1	1.5	1.5	0.00837	3.399	3.4
C38	0.013	1.75	0	RECT_OPEN	0.25	1	0	0	0.01608	0	0
C40	0.013	1.75	0	RECT_OPEN	0.25	0.5	0	0	0.02417	0	0

Table 5.5: Characteristics and results for the stormwater culverts

										Return Interval (1:50 year)	
Name	Roughness	Inlet offset (m)	Outlet offset (m)	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (w:h)	Right Slope (w:h)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. Velocity (m/s)
Processing Plant Area											
C82	0.013	0	0	RECT_CLOSED	0.6	0.9	0	0	0.00812	0.975	2.94
Vertical Shaft Area											
C60	0.013	0	0	CIRCULAR	0.6	0	0	0	0.01188	0.93	4.08
C63	0.013	0	0	CIRCULAR	0.5	0	0	0	0.01032	0.198	2.33
C67	0.013	0	0	RECT_CLOSED	0.6	0.9	0	0	0.0097	0.594	1.75
C69	0.013	0	0	RECT_CLOSED	0.6	0.9	0	0	0.00677	1.272	2.68
C94	0.013	0	0	CIRCULAR	0.6	0	0	0	0.00764	0.899	3.68
C56	0.013	0	0	CIRCULAR	0.5	0	0	0	0.00835	0.34	2.03
C58	0.013	0	0	CIRCULAR	0.5	0	0	0	0.01149	0.23	2.74
Decline Area											
C6	0.013	0	0	CIRCULAR	0.25	0	0	0	0.00367	0.06	2.06
C31	0.013	0	0	CIRCULAR	0.25	0	0	0	0.00554	0.079	2.25
C27	0.013	0	0.4	RECT_CLOSED	0.6	0.9	0	0	0.01147	1.254	3.06
C29_4	0.013	0	0	RECT_CLOSED	0.6	0.9	0	0	0.01891	0.187	1.11
C33	0.013	0	0	CIRCULAR	0.5	0	0	0	0.00897	0.405	2.85
C23	0.013	0	0	RECT_CLOSED	0.6	0.9	0	0	0.01103	2.444	5.19

5.2.3 Groundwater

The following recommendations are made in terms of the Groundwater Management Plan:

- The actions presented in the Groundwater Management Plan should be adhered to during the operational and post-closure phases;
- Actions within the proposed groundwater monitoring plan should be adhered to during the operational and post closure phases;
- A qualified hydrogeologist should analyse and report groundwater quality results on a quarterly basis, for a two (2) year period. If it is observed that significant changes to the groundwater quality have not occurred over the course of the two (2) year monitoring period, annual reporting of the groundwater quality results can commence. The monitoring network should be audited annually. Groundwater monitoring should be continued into the post-closure phase, however, the frequency of groundwater sampling and analysis, reporting and auditing could be re-evaluated by a qualified hydrogeologist, based on the operational and post-closure groundwater quality trends.
- A stormwater management system should be implemented and maintained during the operational and post-closure phases, and all facilities/structures that are potential contamination sources should have suitable measures in place to avoid spills. These facilities should also be lined, and/or seepage/runoff should be intercepted by cut-off trenches or underdrains. The structural integrity of the facilities should be maintained;
- Water should be re-used on site, or treated, if necessary, and discharged to natural surface water bodies;
- If the mine activities are proven to affect the groundwater resources of the area; affected parties should be suitably compensated;
- The underground mine workings should be allowed to flood as soon as possible;
- Remedial measures for shallow contaminant plumes potentially arising at the WRD, TSF and other mine infrastructure should be investigated;
- Rehabilitation measures for the WRD, TSF and associated containment facilities should be investigated;
- The hydrogeological numerical model should be updated triennially, or after significant changes to the mine schedule or plans; and

The geochemical assessment should be updated within the next 3 years, and it is recommended that geochemical modelling be conducted for the mine based on this assessment.

5.2.4 Waste

Sibanye required a waste classification of one solid waste sample in order to determine the waste classification to meet the requirements in terms of the NEM:WA. GCS Environmental Engineering (GCS EE) was appointed by Sibanye to conduct the waste classification. Inorganic elements were tested for the classification as it is unlikely that any organic elements would be present in the waste.

Regulation 7 of the Norms and Standards, lists the conditions to which the results must be compared to, in order to determine the type of waste or in this case waste. This will ultimately determine the containment barrier requirements for the storage facility for the specific waste class type. Waste types are determined through comparison of the Total Concentration (TC) and Leachable Concentration (LC) with threshold limits. Five waste type categories were developed, as detailed in Table 5.6.

Table 5.6: Waste Categories

Criteria Waste Type	Criteria Waste Type
LC > LC3; or TC > TC2	Type 0
LCT2 < LC ≤ LCT3; or TCT1 < TC ≤ TCT2	Type 1
LCT1 < LC ≤ LCT2; and TC ≤ TCT1	Type 2
LCT0 < LC ≤ LCT1; and TC ≤ TCT1	Type 3
LC ≤ LCT0; and TC ≤ TCT0	Type 4

In addition to the above, a waste will be classified as Type 1 if a particular substance in the waste is not listed in the TC list and the waste has been classified as hazardous in terms of Section 4(2) of NEM:WA, based on health or environmental hazard characteristics of the specific element or chemical substance.

If the TC of an element is above TCT2 (Total Concentration Threshold) and the concentration cannot be reduced to below the TCT2 limit, but the LC is below the LCT3 (Leachate Concentration Threshold) limit, the waste will also be considered a Type 1 waste.

Wastes with metal ions and inorganic anions below or equal to LCT0 limits are considered Type 3 waste, irrespective of the TC of the waste, provided that the inherent physical and chemical character of the waste is stable and will not change over time, the waste is disposed of to a landfill without any other waste and the concentrations for organics and pesticides.

Based on the above assessment, the waste sample is classified as a **Waste Type 3**, based on the results of the TC and LC and the determination of waste types for regulation7(2)(d) of the Norms and Standards stipulates that;

- Wastes with any element or chemical substance concentration below or equal to the TCT1 and LCT1 limits are Type 3 Wastes.

It must be noted that all the LC concentrations of this waste type are all below the LC0 limits indicating that this waste is relatively inert and pose little or no threat to the environment. Additionally due to the material being relatively inert, poses little or no risk to the environments and the nature of the material being a good construction material, GCS is of the view that the mine will be able to use this material for construction purposes in road building, landfilling and concrete mixtures. This also aligns with the National Waste Management Strategy to reduce and reuse waste.

Waste bins will be provided throughout the mine site for general or domestic waste and will allow for separation of waste. These bins will be emptied on a regular basis into designated waste skips. This waste will then be removed and disposed of at the nearest permitted landfill site.

Clearly marked hazardous waste bins will be provided in key locations on the mine site where hazardous waste could be generated, such as at the processing plant. These bins will be emptied on a regular basis into suitable containers in a specially demarcated area with overhead covering and an impermeable floor with appropriate drainage containment facilities. Hazardous waste will be disposed of at a permitted hazardous waste disposal facility and the relevant disposal certificates will be kept on file for the life of the mine.

5.3 Operational Management

5.3.1 Organisational Structure

Please refer to Section 2.7 for a diagram illustrating the organisational structure of the Burnstone operation.

5.3.2 Resources and Competence

Sibanye has appointed the following Environmental Team to support and drive environmental management at Burnstone: Environmental Superintendent for Burnstone and Beatrix: Alfonzo le Roux and Environmental Assistant Supervisor for Burnstone and Beatrix: Phenyo Rakhudu. They are supported by the Head of Environmental Compliance for the SA Region: Hennie Pretorius and the Environmental Coordinator for the Gold Operations: Simone Liefferink. All of whom ultimately report to the Senior Vice President (SVP) of Environment: Grant Stuart.

All employees and directors are expected to have a detailed understanding of Company policies and standards that directly relate to their job. It is every employee's responsibility to comply with the policies and standards relating to their work and to seek assistance from a manager or supervisor.

5.3.3 Education and Training

All new employees and contractors who will be carrying out work on the mine will have to undergo induction training. Basic environmental training does form part of this training. All existing and new employees that will be working on the mine, will undergo annual induction training when they need to renew their Red Ticket and undergo an annual medical check-up.

The Induction training will be a broad introduction to what the environment is and the reasons why it is important to conserve the animals, plants, water and other natural resources. The training will include topics but shall not be limited to the following:

- What activities can impact on the environment;
- Type of impacts associated with mining activities;
- Employees' responsibility and role in conserving the environment;
- Actions that will be needed to prevent or minimise the impacts;
- Waste management;
- Water conservation; and
- Emergency response and preparedness procedures.

Once the employees are trained in the basic environmental aspects, more detailed training will be provided on other aspects as required. This could include but shall not be limited to:

- Waste Management (recycling, reusing);
- Spill kit training; and
- Conservation of natural resources (water, electricity, oil).

This training will be applicable to employees working in areas where these topics are of importance.

Awareness training of employees will feature different environmental topics on a monthly basis. These topics will be discussed at their toolbox talks, shift meetings and posted on the notice boards for everyone to see.

These topics will summarise an issue and/or an incident that occurred during the previous month e.g. the pollution control dam overflowed due to poor housekeeping and maintenance. This method will also be used to disseminate information at the grass root level in an effective manner.

It is proposed that all employees will be scheduled for annual induction training. Other training will be conducted on an ad hoc basis, which will be determined by the need for specific training, e.g. spill kit training will be conducted when a new spill response team is appointed. A high level of awareness regarding the environment will be sustained through the use of monthly environmental topics. These topics could summarise themes from the induction training, or it could be based on the normal seasonal trends such as dry periods and the conservation of water and prevention of fires.

5.3.4 Internal and External Communication

A detailed communication strategy must be developed and implemented together with the development of a complaints register to be kept on site for the life of mine.

A system of information sharing with regulatory authorities and Interested and Affected Parties (I&APs) was developed with the following objectives-

- Keep them updated on environmental management progress;
- Inform them about new developments at the Mine and provide them with an opportunity to express their concerns about these;
- Provide them with a means to discuss environmental matters with the Mine whenever necessary;
- Simplify involvement in the processes of updating existing and obtaining new permissions; and
- Provide a forum for detailed discussion of issues when necessary.

Basic public involvement principles that need to be applied are as follows-

- Involvement of all I&APs;
- Respect for the opinions of all I&APs;
- True two-way exchange of information, with listening on both sides;
- Follow up on commitments made;
- Feedback on how concerns expressed by I&APs have been or are being addressed;
- Clear channels of communication;
- Accurate records of every interaction with I&APs, including names and contact details of people involved;
- Accurate records of information exchanged with I&APs – including letters, reports and other documents that were exchanged; and
- Records of meetings circulated to I&APs so that they can check that the record of information shared is correct.

For public meetings, the following principles should be applied-

- Advance notice of any meetings (at least 21 days) to allow people sufficient time to attend the meetings; and
- Scheduling of meetings with consideration of people's time constraints.

5.3.5 Awareness Raising

Section 39 of the MPRDA requires Burnstone to have an environmental awareness plan to inform employees of any environmental risks which may result from their work. In addition to this, environmental awareness training has been identified during the EIA process as a mitigation measure to prevent and minimise impacts on the receiving environment. Sibanye recognises the role of the environmental awareness plan in preventing and minimising its impacts from mining operations on the environment.

Therefore, the objectives of the environmental awareness plan will be:

- To educate employees regarding their role in conserving the environment and the importance of conserving natural resources;
- To identify environmental training needs for employees and contractors at all levels;
- To ensure that employees whose work could cause significant environmental impact identified by the mine are competent to perform those tasks to which they are assigned;
- To enable employees to identify environmental impacts or non-conformances in their work activities on the environment;
- To familiarise employees with emergency preparedness and response requirements;
- To be aware of the potential consequences of deviation from specified operating procedures; and
- To conduct their work and manage mining activities in an environmentally responsible manner.

5.4 Monitoring and Control

Water resources monitoring is undertaken in terms of the DWS Best Practice Guidelines (BPG) for Water Monitoring Systems (2007). The objective of monitoring system is to:

- Develop environmental and water management plans based on impact monitoring;
- Generate monitoring data for the operational phase of the mine to be compared with baseline date before project implementation;
- Assess the impacts on receiving water environment; and
- Assess compliance with legal requirements.

Internal reporting includes monthly reports to the mine management on the performance against management commitments and expectation against authorisations and permits. External reporting requirements is guided by the permit and licenses received to that effect and the mine commit to comply with these statutory requirements at all times, unless applications have been submitted for alternative monitoring programmes. This encompass incident reporting which, in terms of the Environmental Management System (EMS), requires classification of incidents into five categories (Levels 1 to 5) depending on their severity or potential consequence to the environment.

5.4.1 Surface Water Monitoring

A surface water monitoring programme is recommended for Burnstone Mine in terms of GN 704 (GN704, 1999). Monthly surface water monitoring of all water containment facilities is currently being undertaken (Table 5.7).

Table 5.7: Current surface water monitoring programme

Water Type	**Details**	**Monitoring Frequency**	**Monitoring Frequency**
		Operational Phase	**Closure Phase**
Surface Water Streams	Sample point upstream and downstream of the TSF, decline area, vertical shaft area, processing plant area and WRD.	Monthly water samples	Quarterly water samples
Drinking Water (RO plant)	Any supplied water used for domestic purposes should be monitored for parameters such as total and faecal coliform; water released from RO plant	Monthly water samples	
Process Water	PCDs and outlets of PCDs, process water dams (Dam 3, Dam 4, Plant RWD, WRD PCD and TSF RWD) and outlets of process water dams and WWTW facility.	Ad hoc spillage	

Burnstone Mine surface water monitoring programme to include current surface water monitoring points, additional surface water monitoring points and monitoring points to be investigated (Table 5.8. It should be noted that these locations should be verified in the field for better representation. An overall overview of the surface water quality monitoring programme is presented in Figure 4.6. All PCDs should be sampled on ad hoc spillage and it is recommended that a once off sampling round be undertaken to establish a baseline salt balance.

Table 5.8: Proposed additional surface water monitoring locations

Name	Latitude	Longitude	***Description / Monitoring Purpose***	***Monitoring Frequency***
Current Monitoring Localities				
SW5	26°38’23.52”S	28°41’21.27”E	Stream up-stream.	Monthly
SW6	26°38’29.34”S	28°39’33.52”E	Located north of processing plant. Joint influence control point on water	Monthly

Name	Latitude	Longitude	***Description / Monitoring Purpose***	***Monitoring Frequency***
Current Monitoring Localities				
			quality downstream from processing plant, vertical shaft and Dam 4.	
SW7	26°37'42.59"S	28°40'02.58"E	Located southwest of the TSF.	Monthly
SW8	26°26'45.58"S	28°40'36.83"E	Located north of Mine Excess Dam in the stream.	Monthly
SW9	26°36'35.39"S	28°39'33.21"E	Located northwest of the TSF, outside the site boundary.	Monthly
SW10	26°35'44.81"S	28°36'49.06"E	Located northwest of the TSF, outside the site boundary in the stream.	Monthly
Dam 4	26°39'4.94"S	28°40'10.13"E	Located east of the Decline area	Monthly
RWD	26°39'20.96"S	28°40'20.10"E	Located north of the RWD at TSF. The RWD receives water from the underground, dirty water areas, brine from reverse osmosis (RO) plant and TSF	Monthly
Proposed additional surface water monitoring points				
SW11	26°40.023'S	28°39.919'E	Control point downstream of WRD. Located south of WRD.	Monthly
SW12	26°40.016'S	28°40.789'E	Control point downstream of decline area. Located south of decline area.	Quarterly
SW13	26°40.469'S	28°40.231'E	Joint influence control point on water quality downstream of WRD and decline area.	Monthly
SW14	26°39.041'S	28°40.570'E	Control point downstream of decline area, located northeast of decline area.	Monthly
SW15	26°38.838'S	28°40.967'E	Joint influence control point on water quality downstream for decline and explosive magazine	Quarterly
SW16	26°39.218'S	28°41.282'E	Control point upstream of the decline area, located east of decline	Quarterly
SW17	26°38.645'S	28°39.754'E	Control point downstream of Dam 4.	Quarterly
SW18	26°38.698'S	28°39.646'E	Control point downstream of processing plant and vertical shaft area.	Quarterly
SW19	26°39.193'S	28°39.526'E	PCD 1 (proposed) outflow	Ad hoc spillage
SW20	26°39.248'S	28°39.543'E	Overflow PCD	Ad hoc spillage
SW21	26°39.368'S	28°39.584'E	PCD 2 (proposed)	Ad hoc spillage
SW22	26°39.693'S	28°39.876'E	SWD at WRD	Ad hoc spillage
SW23	26°39.148'S	28°39.664'E	Plant PCD	Ad hoc spillage
SW24	26°39.141'S	28°39.716'E	RWD at processing plant	Ad hoc spillage
SW25	26°39.267'S	28°40.229'E	Dam 3	Ad hoc spillage

Name	Latitude	Longitude	***Description / Monitoring Purpose***	***Monitoring Frequency***
Current Monitoring Localities				
SW26	26°39.349’S	28°40.341’E	WWTW, control point after treatment	Monthly
SW27	26°39.316’S	28°40.386’E	PCD 3 (proposed)	Ad hoc spillage
SW28	26°39.162’S	28°40.526’E	PCD 4 (proposed)	Ad hoc spillage
SW29	26°37.150’S	28°40.905’E	RWD at TSF	Ad hoc spillage
Proposed additional surface water monitoring point to be investigated				
SW10A	26°36.269’S	28°39.406’E	We recommend an additional sampling point to be investigated (SW10A) that will be located it more upstream from the current SW10 locality.	Monthly

It is recommended that physical, chemical and other additional parameters be tested on a monthly basis (Table 5.9).

Table 5.9: Recommended surface water monitoring parameters

	Parameters
Physical	• Temperature (in-field) and turbidity
Chemical	• Ca, Mg, Na, K, NO_3, NH_4 as N, Cl, SO_4, PO_4 as P, F, Fe, Mn, Al, Total Cr, Cu, Ni, Zn, Co, Cd, Pb, CN, As, Se, Hg and B as well as total U • pH, EC, TDS, TSS, COD, Alkalinity and total hardness
Other	• Petroleum hydrocarbon contaminants; • E.coli at the WWTW

5.4.2 Groundwater Monitoring

Based on the analysis of current conditions and the results of the transient numerical simulations, a monitoring program has been compiled for Burnstone (refer to Figure 5.3). The individual and cumulative impact sites have been delineated, and existing monitoring and hydrocensus boreholes for each site are listed in Table 5.10. It should be noted that monitoring should be coupled with reporting during all monitoring events, and auditing of the program should be conducted on an annual basis. The monitoring program should continue into the post-closure phase, however, the frequency of monitoring and auditing could be re-evaluated, based on the monitoring results. If additional monitoring positions are deemed necessary in future, based on the results and findings of the groundwater monitoring program, additional positions can be sought from a selection of proposed additional monitoring borehole positions, summarised in the hydrogeological report (Appendix XX). These positions were determined based on the results of the numerical dewatering and contaminant plume modelling conducted for the site.

Table 5.10: Proposed monitoring program for existing boreholes at Burnstone

Impact/Facility	BH ID	Parameter	Frequency
TSF Area	BTB1, BTB2, BTB3, BTB4, BTB5, BTB6, BUR02 and BUR03	Groundwater Quality	Quarterly
		Groundwater Levels	Quarterly
Decline Portal Area	BPB1, BSB1 and BSB2	Groundwater Quality	Quarterly
		Groundwater Levels	Quarterly
WRD	BWR2, BWR03 and BWB3	Groundwater Quality	Quarterly
		Groundwater Levels	Quarterly
Vertical Shaft	BG7d and Hardus Brits	Groundwater Quality	Quarterly
		Groundwater Levels	Quarterly
Plant Area	BPB3, BPB4 , Hardus Brits and BG6a	Groundwater Quality	Quarterly
		Groundwater Levels	Quarterly
Cumulative of Southern Processing Area	Hardus Brits, BG3b,WB18, PCD 4 (JB Windmill) and BG6a.	Groundwater Quality	Quarterly
		Groundwater Levels	Quarterly
Underground Mine - Contamination	Hardus Brits, BG7d, BPB3, BPB4, BWR2, BWR3, BWB3, BPB1, BSB2, BG3b WB18, BSB1, BSB2, BG6a and BG5a.	Groundwater Quality	Quarterly
Underground Mine - Contamination	BG9a, HBH4, HBH5, and HBH6.	Groundwater Quality	Annually*
Underground Mine - Groundwater Level Drawdown and Recovery	BWB3, BWR2, BG7d, Hardus Brits, BG3b, BPB1, BPB3, BPB4, WB18, BSB1, BSB2, PCD 4 (JB Windmill), BTB4, BUR02, BUR03, BTB5, BTB6, BG5a, HBH14 and BG6a.	Groundwater Levels	Quarterly
Underground Mine - Groundwater Level Drawdown and Recovery	HBH5, HBH9, HBH20, HBH21, HBH22, HBH25, HBH6, HBH7, HBH10, HBH8, A2, BG9a, HBH4, BG9b* and BG10g.	Groundwater Levels	Annually*

* It is suggested that the boreholes are monitored on an annual basis, however, if significant hydrogeological impacts are identified during the monitoring of these boreholes, the monitoring frequency should be increased accordingly.

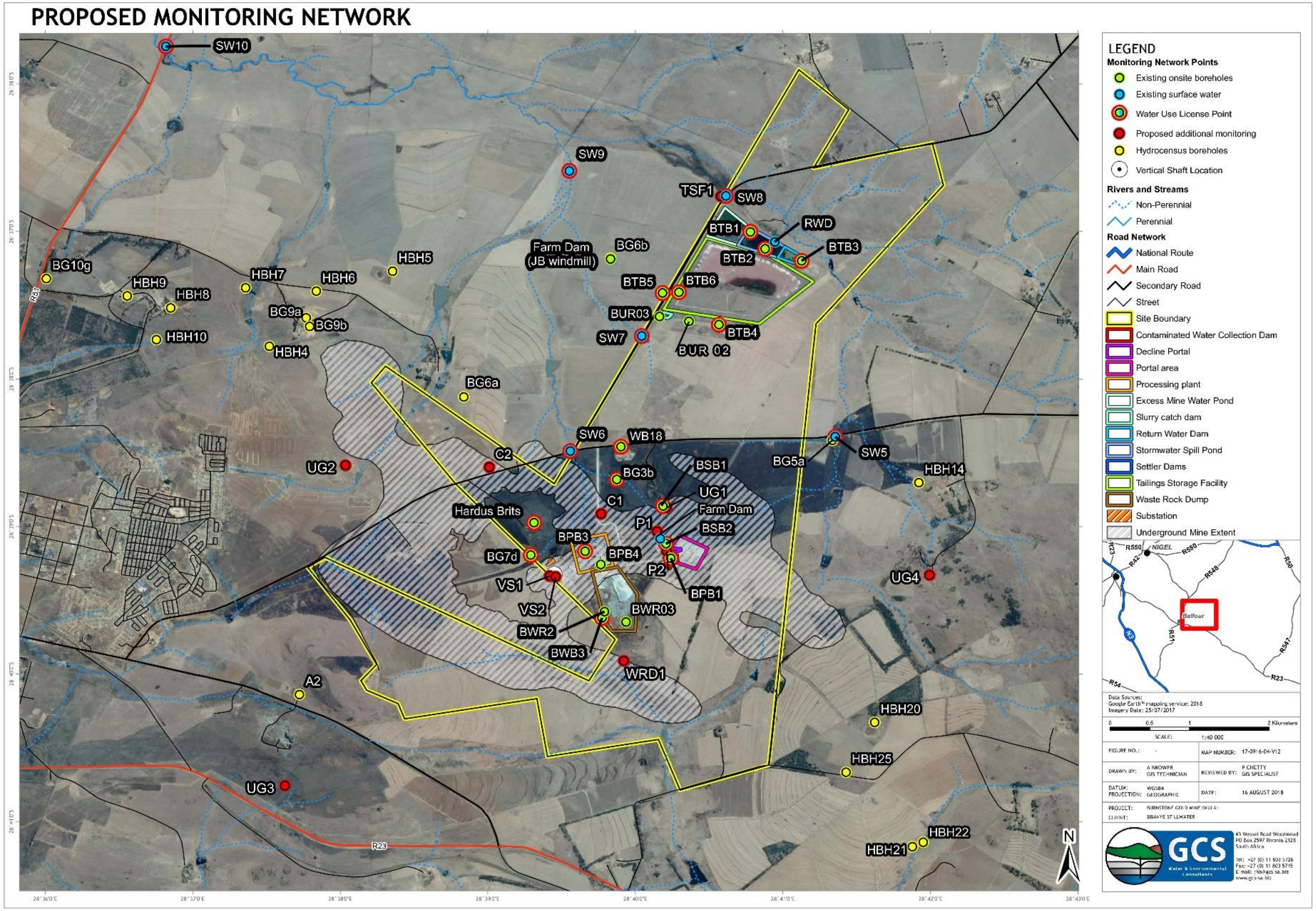


Figure 5.3: Existing and proposed Burnstone monitoring network

5.4.3 Bio Monitoring

Scientific Aquatic Services CC (SAS) was commissioned to maintain a biomonitoring programme for the Sibanye. The latest biomonitoring report (May 2018) for the Sibanye as well as the November 2017 report is attached as Annexure 11 to this report.

5.4.3.1 Sampling Sites

Site selection was based on previous studies regarding the proposed Burnstone TSF, which is now functioning but not operational, as the mine is not yet actively disposing of tailings onto the TSF. Site BuB1 is situated on a tributary of the Suikerbosrand upstream of the TSF in the southerly catchment. BuB2 is also situated north of the TSF in the southerly catchment and north west of site BuB1. Sites BuB3 and BuB4 have been removed from the biomonitoring program, as they are sites located in areas of small watercourses, which are tributaries of the Suikerbosrand Tributary, best described as wetlands, as mentioned before. BuB5 is situated downstream of the TSF in the northerly catchment and is located west of BuB2.

The sampling sites and geographic coordinates are listed in Table 5.11 and shown in Figure 5.4. The sampling locations fall within the Upper Vaal Catchment and the Highveld Lower ecoregion.

Table 5.11: Biomonitoring assessment sites

Biomonitoring site name	Surface water sampling point name	Coordinates	River	Sub-quaternary reach	Relevance of site	Assessment Status
BuB1	SW5	26°38’23.47”S; 28°41’20.99”E	Suikerbosrand Tributary	C21B-01650	Reference site when water is present	Water present and sampled
BuB2	SW8	26°36’45.63”S; 28°40’36.40”E	Suikerbosrand Tributary	C21B-01650	Receives water from and is downstream of TSF	Water present and sampled
BuB3	SW6	26°38’29.17”S; 28°39’33.35”E	Removed - not assessable during previous assessments as these sites are wetlands and rarely have surface flow.		Wetland no longer sampled	NA
BuB4	SW7	26°37’42.90”S; 28°40’02.29”E			Wetland no longer sampled	NA

BuB5	SW10	26°35'44.59"S; 28°36'48.09"E	Suikerbos rand Tributary	C21B-not assigned	Downstream site as indicator of impact	Water present and sampled

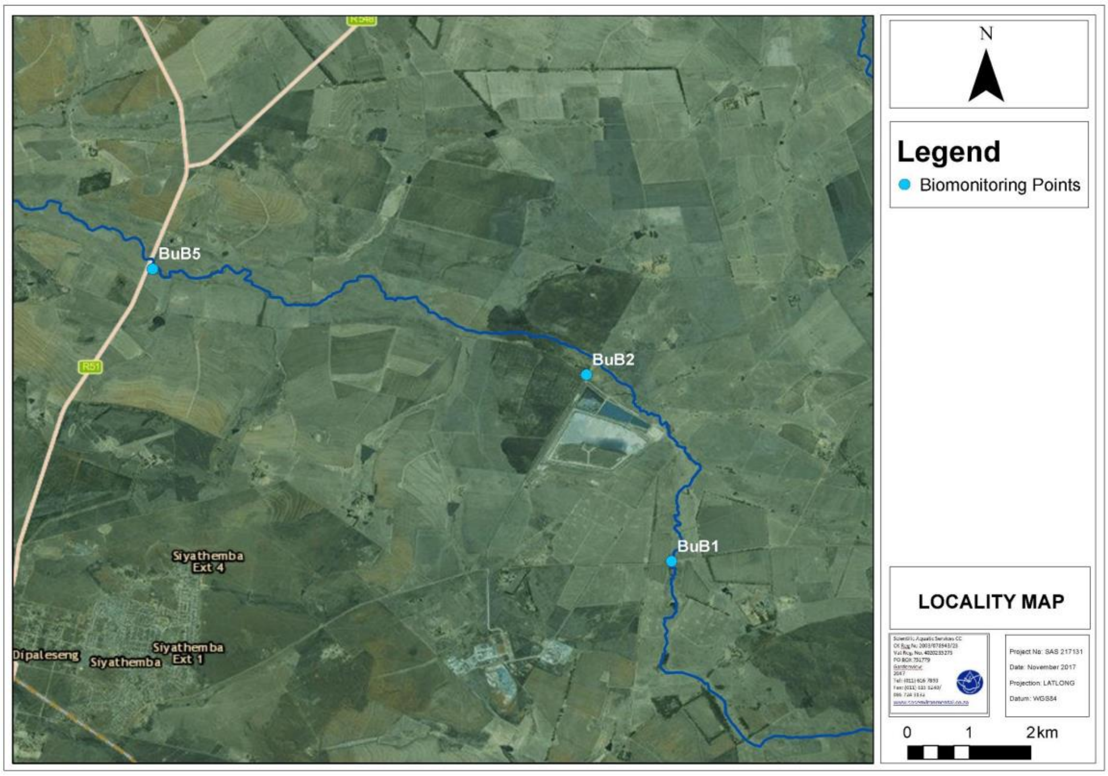


Figure 5.4: Biomonitoring Sampling Sites

5.4.3.2 Biomonitoring Results

The pH values recorded from all three sites are within the tolerable ranges stipulated by DWS (2011), and an insignificant (< 5%) increase in a downstream direction is evident. Electrical conductivity (EC) at all three sites is within the ideal range (< 50 mS/m) when compared to the Resource Water Quality Objectives (RWQO) adapted from DWA (2011). Dissolved oxygen (DO) concentrations are low at both sites BuB1 and BuB2, yet this could be due to the lack of flow and stagnated water conditions. DO saturation at site BuB5 falls within the 80% to 120% saturation recommendation provided by DWAF (1996). At the present time, a limited impact is deemed possible at the downstream BuB2 site in terms of water quality (low EC and very low DO), in relation to the upstream BuB1 site. However, EC at both sites still comply with the RWQO recommendations. The slight spatial increase suggests possible impacts resulting from the observed discharge from the TSF, as well as catchment-wide anthropogenic activities (suggested by temporal variability in EC), may be occurring. Said potential impacts are compounded by adjacent agricultural activities, anthropogenic activities, and limited to no flow conditions. The deteriorating downstream conditions at site BuB2 can thus not be totally attributed to the noted discharge from Burnstone's TSF (also considering that it is functioning but not yet operational), as catchment-wide impact on water quality along the entire system (also between BuB1 and BuB2), before any potential impact from Burnstone's activities, is likely. Due to the characteristics of the system which is more wetland like in nature, lack of flow is considered a major ecological driver, resulting in fluctuating levels of salts and stagnant conditions (decrease in DO). At the downstream site BuB5, any noteworthy impact from Burnstone's activities on EC and DO is deemed unlikely.

The SASS5 data indicates that the aquatic macro-invertebrate community in this section of the Suikerbosrand Tributary has suffered a loss in integrity when compared to the reference score for the Lower Highveld Ecoregion, however it is important to note that the wetland nature of the watercourses do not conform to the ideal habitat on which the reference scores are based, thus the loss in integrity should be interpreted with caution. This suggests that catchment-wide impact on macro-invertebrate community integrity along the entire system is likely, before any further potential impact from Burnstone's activities, and agrees with the water quality data conclusion drawn above. At the time of the assessment, the BuB1 site may be considered moderately to largely modified (Category C/D), site BuB2 severely modified (Category E/F), and site BuB5 largely modified (Category D) according to the Dallas (2007) SASS5 classification method. On application of the MIRAI (2007) Ecostatus tool to each assessment site, the upstream site (BuB1) may be categorised as a Category C, while declining to an Ecological Category D at the downstream sites BuB2 and BuB5.

Spatially between sites BuB1 and BuB2, the SASS5 score decreased by 21.9% and the ASPT score decreased by 17.4%. The decrease in macro-invertebrate community diversity and sensitivity is potentially, at least partially, due to the observed discharge from the TSF at the time of the assessment. However, cumulative impact from lack of flow as well as water quality changes (extremely low DO concentration at BuB2) also likely contributed to the decrease, with lack of flow considered a major ecological driver in the system. Spatially between sites BuB1 and BuB5, the variance was less substantial, with a 9.4% decrease in the SASS5 score and a 10.9% decrease in the ASPT score.

Spatially, the biotope suitability score increases by 38.4% in a downstream direction, which is likely due to the lack of the stone biotope at site BuB2, and the increased biotope availability and flow at site BuB5. Lack of flow with associated negative impact on biotope suitability is most likely the major driver for the decrease in SASS5 score observed at the BuB2 site (flow sensitive taxa absent leading to reduced diversity), but deterioration of water quality parameters at this site (very low DO concentrations) and potential impact from the discharge likely also contributed to the decrease. Overall, catchment-wide anthropogenic changes to the watercourse such as culverts, bridges and dams likely negatively impact on the macro-invertebrate community integrity along the entire system.

The water quality (with reference to trace metals such as aluminium in particular), remains largely variable between assessments. However, based on baseline assessments and the consideration of long term data, it is likely that the quality exceedances are due to either natural or anthropogenic activities not related to the current Burnstone mining activities. Site BuB2, directly downstream of the Burnstone TSF, receives mine water discharge from the Return Water Dam. Unlike the results from previous surveys, the current results do potentially indicate some deterioration (severely decreased SASS5 and ASPT scores, slightly elevated EC concentration as well as extremely low DO concentration) in the system nearest to the TSF. Close monitoring of community integrity in the system will thus need to continue to monitor any further changes in community integrity with particular focus on site BuB2. It is expected that the current status of the system, especially at site BuB5, can be maintained as long as the operations do not impact on the river system once active mining commences.

5.4.4 Waste Monitoring

In terms of the waste monitoring that is performed on site, a risk management approach is adopted. Continuous assessment are also performed i.e. audits, in order to assess the performance of the waste management on site. Sibanye keeps record of all industrial, domestic and scrap material waste as well as records are kept for used oil that is collected. Hazardous waste is not disposed of regularly but records will be kept if any is disposed of.

5.5 Risk Assessment/ Best Practice Assessment

5.5.1 Impact Assessment Methodology

The following methodology was used to rank these impacts. Clearly defined rating and rankings scales (Table 5.12 to Table 5.18) were used to assess the impacts associated with the proposed activities. The impacts identified by each specialist study and through public participation were combined into a single impact rating table for ease of assessment.

Each impact identified was rated according the expected magnitude, duration, scale and probability of the impact (Table 5.19).
To ensure uniformity, the assessment of potential impacts will be addressed in a standard manner so that a wide range of impacts is comparable. For this reason, a clearly defined rating scale will be provided to the specialist to assess the impacts associated with their investigation.

Each impact identified will be assessed in terms of scale (spatial scale), magnitude (severity) and duration (temporal scale). Consequence is then determined as follows:

Consequence = Severity + Spatial Scale + Duration

The Risk of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

The risk is then based on the consequence and likelihood.

Risk = Consequence x likelihood

In order to assess each of these factors for each impact, the ranking scales in Table 5.12–Table 5.18 were used.

Table 5.12: Severity

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5

Table 5.13: Spatial Scale - How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional / neighboring areas (5km to 50km)	4
National	5

Table 5.14: Duration

One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity (permanent)	5

Table 5.15: Frequency of the activity - How often do you do the specific activity?

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Table 5.16: Frequency of the incident/impact - How often does the activity impact on the environment?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2

Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table 5.17: Legal Issues - How is the activity governed by legislation?

No legislation	1
Fully covered by legislation	5

Table 5.18: Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property?

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Environmental effects will be rated as either of high, moderate or low significance on the basis provided in Table 5.19.

Table 5.19: Impact Ratings

RATING	CLASS
1 - 55	(L) Low Risk
56 - 169	M) Moderate Risk
170 - 600	(H) High Risk

5.5.2 Impacts Identified

The impacts identified for Burnstone and shown in Table 5.20.

Table 5.20: Impact descriptions for Burnstone gold mine

Impact description					Impact before mitigation	Impact after mitigation	Mitigation measures	Action plan
No	**Phases**	**Activity**	**Aspect (cause of the impact)**	**Impact**	**Risk Rating**	**Risk Rating**		
Groundwater (refer to Annexure 9)								
1	Operation	Underground mining	Underground Mine Dewatering	Contaminated seepage from underground workings into surrounding aquifer	H	M	No direct mitigation measures exist for groundwater level drawdown. However, the impacts of drawdown can be mitigated by discharging abstracted water from the mine workings into the wetlands and non-perennial river systems, to maintain their pre-mining environmental conditions. The water quality of the abstracted water should be analysed and treated, if necessary, prior to discharge. Surface water bodies and springs should be monitored for potential impacts. Compensation of affected parties, if proven that private groundwater resources are affected by mining activities, should be provided. Monitoring of the boreholes proposed in the monitoring network should be conducted on a quarterly basis to detect changes in the groundwater levels.	Refer to management plan
2	Operation	Underground mining	Underground Mine Dewatering	Infiltration of contaminated seepage from facilities into underlying aquifer an/or surface water bodies	M	M	Signs of subsidence within the shafts and underground workings, and affected study area should be monitored at all times, and stabilisation measures should be implemented, if required. A study into feasible stabilisation measures should be conducted.	Refer to management plan

3	Operation	Underground mining	Underground Mine Dewatering	Infiltration of contaminated seepage from facilities into underlying aquifer, and/or surface water bodies	M	M	Grouting of the mine workings should be investigated and where applicable implemented to minimise inflows into the mine, and the pump abstraction rates should be sufficient to provide for contingency in the abstraction of groundwater inflow to the land surface. Monitoring of the mine void walls, roof and floor for signs of seepage should be conducted on a daily basis.	Refer to management plan
4	Operation	Underground mining	Underground Mine Dewatering	Spills and contaminated seepage from facilities into underlying aquifer and/or surface water bodies	L	L	Seepage from Burnstone activities should be monitored and assessed. Source facilities should be appropriately lined, if not already, and drains or cut-off trenches should be installed to intercept seepage and direct it to a containment facility.	Refer to management plan
5	Operation	Underground mining	Underground Mine Dewatering	Contaminated seepage from underground workings into surrounding aquifer	M	M	Residual/loosened ore left on the floor of the mine workings should be removed as soon as possible to limit exposure to oxidising conditions, the workings should be kept dry at all times, and a groundwater flow gradient towards the mine workings should be maintained during the operational phase.	Refer to management plan
6	Operation	Underground mining	Tailings deposition in TSF, and water storage in associated dams	Infiltration of contaminated seepage from facilities into underlying aquifer an/or surface water bodies	M	M	The structural integrity of the TSF and associated facilities should be investigated on a regular basis and maintained; sloping of the TSF should conform to design specification to limit ponding; tailings deposition and the TSF pond size should be limited to the northern extent of the TSF; drains or cut-off trenches should be installed to capture seepage prior to contamination of surface water bodies; reticulation systems between the facilities should be investigated for leaks; water from the containment facilities adjacent to the TSF should be treated, if necessary, prior to discharge; and water quality monitoring of surrounding boreholes should be conducted on a quarterly basis. Existing boreholes could be upgraded to scavenging boreholes to limit and mitigate predicted contaminant plumes.	Refer to management plan

7	Operation	Plant operation	Waste rock deposition in WRD, and leachate storage in PCD	Infiltration of contaminated seepage from facilities into underlying aquifer, and/or surface water bodies	M	M	Extensions to the WRD should be lined with appropriate geotextiles or an analysis should be conducted into the suitability of the existing underlying layers for use as lining; runoff from the WRD should be intercepted and contained within a suitably lined PCD; the design specifications of the WRD should be upheld and maintained, including correct sloping, to minimise the ponding of rainwater and water quality monitoring of the boreholes adjacent to the WRD and PCD should be conducted on a quarterly basis. Existing boreholes could be upgraded to scavenging boreholes to limit and mitigate predicted contaminant plumes.	Refer to management plan
8	Operation	Plant operation	Processing plant, RO plant, WWTW's, housing, dirty water containment dams, PCD 4, reticulation systems and other similar facilities	Spills and contaminated seepage from facilities into underlying aquifer and/or surface water bodies	M	L	The stormwater management system should be investigated and updated if required. Spills from the facilities mentioned in the aspect column should be prevented. If spills occur, immediate mitigation measures should be implemented to limit contamination. Water from the mining activities should be re-used as far as possible, and discharged to natural surface bodies if treated; the structural integrity of all structures should be investigated regularly; containment facilities should be suitably lined, if not already; and water quality monitoring of the surrounding boreholes should be conducted on a quarterly basis.	Refer to management plan
9	Decommissioning and Closure	After closure rehabilitation	Termination of dewatering - underground	Recovery of groundwater levels and mine decant from vertical and decline shafts	M	L	The mine workings should be allowed to flood as soon as possible after mine closure; the vertical and decline shafts should be sealed; and water level monitoring of boreholes in close proximity of the shafts should be conducted on a quarterly basis. If the potential for decant becomes highly plausible, abstraction of groundwater at the shafts should be conducted and stored within a containment facility and/or discharged, to prevent decant from realising.	Refer to management plan

10	Decommissioning and Closure	After closure rehabilitation	Termination of dewatering - underground	Sulphate oxidation within the mine voids prior to groundwater level rebound	M	M	The shafts and underground workings should be allowed to flood as soon as possible; and the vertical and decline shafts, as well as the exploration boreholes should be sealed so as to limit oxygen ingress into the mine voids.	Refer to management plan
11	Decommissioning and Closure	After closure rehabilitation	Termination of dewatering - underground	Recovery of groundwater levels and migration of groundwater pollution plume	M	L	Flooding of the shafts and underground workings should be allowed to occur as soon as possible; parties potentially affected by the groundwater contaminant plume should be compensated if impact from the mining activities is proven; and groundwater quality monitoring of boreholes within the horizontal extent of the predicted sulphate plume should be conducted.	Refer to management plan
12	Decommissioning and Closure	After closure rehabilitation	Tailings storage in TSF, and water storage in associated dams	Infiltration of contaminated seepage from facilities into underlying aquifer an/or surface water bodies	M	L	The TSF should be sloped so as to limit the ponding of rainwater; and rehabilitated by covering the facility with low permeability material, and subsequently revegetating the slopes. Water within neighbouring dams should be allowed to evaporate or be discharged to natural surface water bodies, subsequent to treatment, if required; and water quality monitoring of boreholes surrounding the facilities should be conducted on a quarterly basis. If a significant contaminant plume arises, scavenging boreholes could be used to limit and mitigate the plume.	Refer to management plan
13	Decommissioning and Closure	After closure rehabilitation	Waste rock storage in WRD, and leachate storage in PCD	Infiltration of contaminated seepage from facilities into underlying aquifer, and/or surface water bodies	M	L	The WRD should be sloped so as to limit the ponding of rainwater; and rehabilitated by covering the facility with low permeability material, and subsequently revegetating the slopes. Leachate contained within the PCD should be allowed to evaporate. Water quality monitoring of boreholes surrounding the facilities should be conducted on a quarterly basis. If a significant contaminant plume arises, scavenging boreholes could be used to limit and mitigate the plume.	Refer to management plan

14	Decommissioning and Closure	After closure rehabilitation	Dirty water containment dams, PCD 4, reticulation systems and other similar facilities	Spills and contaminated seepage from facilities into underlying aquifer and/or surface water bodies	M	L	The stormwater management system of the mine should be investigated and updated, if required; dirty water should be allowed to evaporate within containment facilities or discharged upon treatment, if feasible; reticulation systems should be investigated for leakages; spills should be prevented and immediately remediated if they occur; and water quality monitoring of surrounding boreholes should be conducted on a quarterly basis.	Refer to management plan
Wetland (refer to Annexure 10)								
15	Operation	Storage of stormwater run-off	Seepage/ discharge from facilities and improper waste management	Contamination of wetland units 1, 2 and 3 which can adversely affect water quality in the area	M	L	1. Implement an effective waste management programme to ensure the effective removal of all waste from on-site activities to a licensed facility according to SABS standards and the relevant waste legislation. 2. All waste must be prohibited from entering any drainage line, wetland and riparian habitat 3. Implement a water quality monitoring programme so as to monitor potential waste contamination from on-site activities, as is currently in place 4. Manage clean and dirty water areas by separation of clean and dirty water areas in order to prevent impacts on water quality 5. Prevent any potential discharges and spills from on-site facilities 6. All dirty water storage facilities should be lined with HDPE liner to prevent seepage 7. Ensure that the quality of treated wastewater falls within the Water Use Licence discharge limits, and if it enters the catchment of the Suikerbosrand conforms to the relevant water quality guidelines as is required by DWS i.e. South	Refer to mitigation measures
16	Operation	Damming of wetland	Seepage/ discharge from facilities and improper waste management	Contamination of wetland units 1, 2 and 3 which can adversely affect water quality in the area	M	L		Refer to mitigation measures
17	Operation	Site infrastructure	Seepage/ discharge from facilities and improper waste management	Contamination of wetland units 1, 2 and 3 which can adversely affect water quality in the area	M	M		Refer to mitigation measures

18	Operation	Discharge from TSF RWD	Seepage/ discharge from facilities and improper waste management	Contamination of wetland units 1, 2 and 3 which can adversely affect water quality in the area	M	M	African Target Water Quality Range (SA TWQR) for Aquatic Ecosystems (Volume 7), the Resource Quality Objectives (RQOs) for Suikerbosrand (PES: B/C & REC: B) 8. Habitat monitoring as part of the biomonitoring programme should be included (IHIA and SASS Biotopes) 9. Alien and invasive species management as recommended by the Biodiversity Management and Action Plan must be implemented	Refer to mitigation measures
19	Operation	Decanting from stormwater spills pond	Seepage/ discharge from facilities and improper waste management	Contamination of wetland units 1, 2 and 3 which can adversely affect water quality in the area	M	M		Refer to mitigation measures
20	Operation	Heavy machinery and vehicle movement	Presence of compacted soils and hard surfaces	Increased runoff leading to erosion and sedimentation wetland unit 1 and 2. Loss of biodiversity (vegetation)	M	L	1. Frequently monitor wetland areas for incision and sedimentation. 2. Curtailing of sheet runoff from hardened surfaces, artificial drainage lines, access roads and river crossings needs to be implemented. 3. Add flow dissipaters within artificial drainage lines and preferential flow paths.	Refer to mitigation measures
21	Operation	Overgrazing	Presence of compacted soils and hard surfaces	Increased runoff leading to erosion and sedimentation wetland unit 1 and 2. Loss of biodiversity (vegetation)	M	L		Refer to mitigation measures
22	Operation	Heavy machinery and vehicle movement	Presence of levees within wetland	Changes to geomorphology of the wetland leading to flow alteration and loss Changes to geomorphology of the wetland leading to flow alteration and loss of indigenous vegetation in wetland unit 4	M	L	1. Ensure that there is sufficient drainage in order to ensure the flow of water downstream. 2. Habitat monitoring as part of the biomonitoring programme should be included (IHIA and SASS Biotopes) 3. Alien and invasive species management as recommended by the Biodiversity Management and Action Plan must be implemented	Refer to mitigation measures

23	Operation	Damming of wetland	Presence of levees within wetland	Changes to geomorphology of the wetland leading to flow alteration and loss Changes to geomorphology of the wetland leading to flow alteration and loss of indigenous vegetation in wetland unit 5	M	M		Refer to mitigation measures
24	Operation	Decanting from stormwater spills pond	Presence of levees within wetland	Changes to geomorphology of the wetland leading to flow alteration and loss Changes to geomorphology of the wetland leading to flow alteration and loss of indigenous vegetation in wetland unit 6	M	L		Refer to mitigation measures
25	Operation	Decanting from stormwater spills pond	Dewatering for underground mining	Increased abstraction leading to general degradation of wetland unit 3	M	L	Water resources should be managed according to the catchment reserve determination. Through the release of water of an acceptable quality into the watercourse.	Refer to mitigation measures
26	Construction	Decanting from stormwater spills pond	Leeching of pollutants from untreated stormwater	Increased leeching due to PCD south of WRD being unlined	M	L	Adhere to stormwater management plan	Refer to mitigation measures
Hydrology (Refer to Section 4.2.2 and Annexure 8)								

27	Operation	Mine Operation	Surface water runoff from dirty water catchment	Quantity local surface water resources	L	L	There will be a runoff reduction due to the containment of runoff from the dirty water catchments. No additional mitigation measures identified. Ensure compliance to GN 704 especially in terms of clean and dirty water separation.	Refer to stormwater management plan
28	Operation	Mine Operation	Surface water discharge/runoff from TSF RWD into Suikerbosrand Tributary	Quality local surface water resources	H	M	No discharge should take place from the TSF RWD at the TSF unless an exemption is granted. To prevent discharge, excess water from the TSF RWD can be pumped to the mine excess dam where it can be stored and allowed to evaporate.	Refer to management plan
29	Operation	Mine Operation	Underground groundwater discharge into Suikerbosrand Tributary	Quality local surface water resources	H	L	Water can be treated before discharge into the Suikerbosrand Tributary if unacceptable water qualities are measured. Continuous monitoring of the water quality should occur on a monthly basis to provide evidence of compliant water quality from the underground and apply for an exemption.	Refer to management plan
30	Operation	Mine Operation	Dust Suppression	Sediment load	M	L	Daily (5 days a week) dust suppression to manage sediments on the mine roads. Dust suppression should not be so excessive that it results in erosion of the roadways and subsequent deposition of sediment loads in the watercourses.	Refer to management plan
31	Operation	Mine Operation	Surface water runoff from dirty water catchment (WRD)	Quantity local surface water resources	L	L	There will be a runoff reduction due to the containment of runoff from the dirty water catchments. No additional mitigation measures identified.	Refer to management plan
32	Operation	Mine Operation	Surface water runoff from dirty water catchment (WRD)	Quality local surface water resources	M	L	Capture dirty runoff from the WRD in a lined stormwater dam (PCD). Extended areas of the WRD should be suitably lined according the waste classification study results.	Refer to management plan
33	Operation	Plant operation	Deposition on WRD	Contamination of underlying aquifer and/or surface water bodies from infiltration of WRD	M	M	Extensions of the WRD should be lined with appropriate geotextiles. The stormwater dam at the WRD that captures the surface water runoff from the WRD should be suitably lined, if of unacceptable quality.	Refer to management plan

34	Operation	Conveyance Systems	Tailings deposition in TSF	Contamination of surface water and surrounding area from pipeline leakages or pipeline burst	M	M	A brick dam at the top of TSF for slurry to drain into and to allow for pipeline maintenance and emergency repairs. Annual inspection and routine checks along the pipeline. Emergency response plan in case of pipeline failure.	Refer to management plan
35	Operation	Conveyance Systems	Sewage conveyance	Contamination of surface water and surrounding area from pipeline leakages or pipeline failures	M	M	Annual inspection and routine checks along the pipeline as well as maintenance operations. Emergence response plan if pipeline failure.	Refer to management plan
36	Operation	Plant operation	Spills from any PCDs or containments dams (Dam 3, Dam 4 and RWD at Processing Plant)	Contamination of underlying aquifer and/or surface water bodies from spillage of a PCD or containment dam	M	M	If spills occur, immediate mitigation measures should be implemented to limit contamination. Water from the mining activities should be re-used as far as possible or allowed time to evaporate.	Refer to management plan
37	Operation	Mine Operation	Transport, handling and storage of fuels and chemicals.	Contamination of soil surfaces and water resources.	L	L	- Minimise dirty water areas where spills might occur. - Create bunded areas at areas where fuel/oil is stored. - Safely dispose of any captured pollutants. - If spillage occurs, the spills should be cleaned as soon as possible and mitigation measures, such as berms, should be put into place to prevent tailings spreading.	Refer to management plan
38	Decommissioning and Closure	After closure rehabilitation	Tailings storage on TSF	Contamination of underlying aquifer and/or surface water bodies from infiltraion of the TSF	M	L	The TSF should be capped and surfaces re-vegetated to reduce this impact	Refer to management plan
39	Decommissioning and Closure	After closure rehabilitation	Storage of waste rock on WRD	Contamination of underlying aquifer and/or surface water bodies from infiltration of WRD	M	L	The WRD should be capped, reshaped and surfaces re-vegetated to reduce this impact	Refer to management plan
40	Decommissioning and Closure	After closure rehabilitation	Spills from any PCDs or containments dams (Dam 3, Dam 4 and RWD at Processing Plant)	Contamination of underlying aquifer and/or surface water bodies from spillage of a PCD or containment dam	M	L	If spills occur, immediate mitigation measures should be implemented to limit contamination.	Refer to management plan

41	Decommissioning and Closure	After closure rehabilitation	Surface water runoff from dirty water catchment	Quantity local surface water resources	H	L	Rehabilitation of all infrastructure to reduce the area size of the dirty water areas and increase the natural (clean) runoff.	Refer to management plan

5.6 Issues and Responses from Public Consultation Process

Public participation is an essential and legislative requirement for any environmental authorisation process. The principles that demand communication with society at large are best embodied in the principles of the National Environmental Management Act 1998 (Act No. 107 of 1998) (NEMA), South Africa's overarching environmental law.

Section 41 (4) of the NWA provides that the competent authority, the DWS, may, at any stage of the application process, require the applicant to place a suitable notice in newspapers and other media, and to take other reasonable steps as directed by the competent authority to bring the application to the attention of relevant organs of state, interested persons and the general public. The required Public Participation Process (PPP) is outlined in the Government Notice Regulation 267, Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals published in Government Gazette 40713 on 24 March 2017.

As such, the following PPP was undertaken for this IWULA in accordance with GNR.267:

- Erecting of Site Notices;
- Distribution of Background Information Documents (BIDs) to adjacent landowners, the respective local governments and any other Interested and Affected Party (I&AP) that requested said document; and
- Placement of an advertisement in the local newspaper.

Sibanye-Stillwater are committed to establishing and maintaining good working relationships with their neighbours and any Interested and Affected Party (I&AP). As such, the public participation has been viewed as an essential part of the WULA process.

5.6.1 Stakeholder Database

The following stakeholder groups have been identified and informed of the project:

- Adjacent Landowners;
- Lawful occupiers of land;
- Owner or person in control of the land where water use is to take place;
- Local government; and
- Members of the public within the area who requested the documentation.

The full list of stakeholder details will be included in to the final report for submission to the DWS.

5.6.2 Landowner Consultation

Background information documents were distributed to the surrounding landowners in order to inform them of the NWA being undertaken. A signed register showing proof that the BID was received by the surrounding landowners will be attached to the final report for submission to the DWS.

5.6.3 Notification Documents

5.6.3.1 Site Notices

Site notices were compiled for the project area and placed at the following locations:

1. Unnamed Road East of Burnstone: 26°38'15.15"S, 28°42'20.89"E;
2. Burnstone Entrance: 26°38'27.79"S, 28°39'44.95"E;
3. Unnamed Road West of Burnstone: 26°39'53.97"S, 28°36'32.83"E; and
4. Vigne d'Or farm: 33°52'3.02"S, 19° 2'23.40"E.

Refer to Figure 5.5 for the location of each site notices erected and Table 5.21 for pictures showing the placement of each site notice.

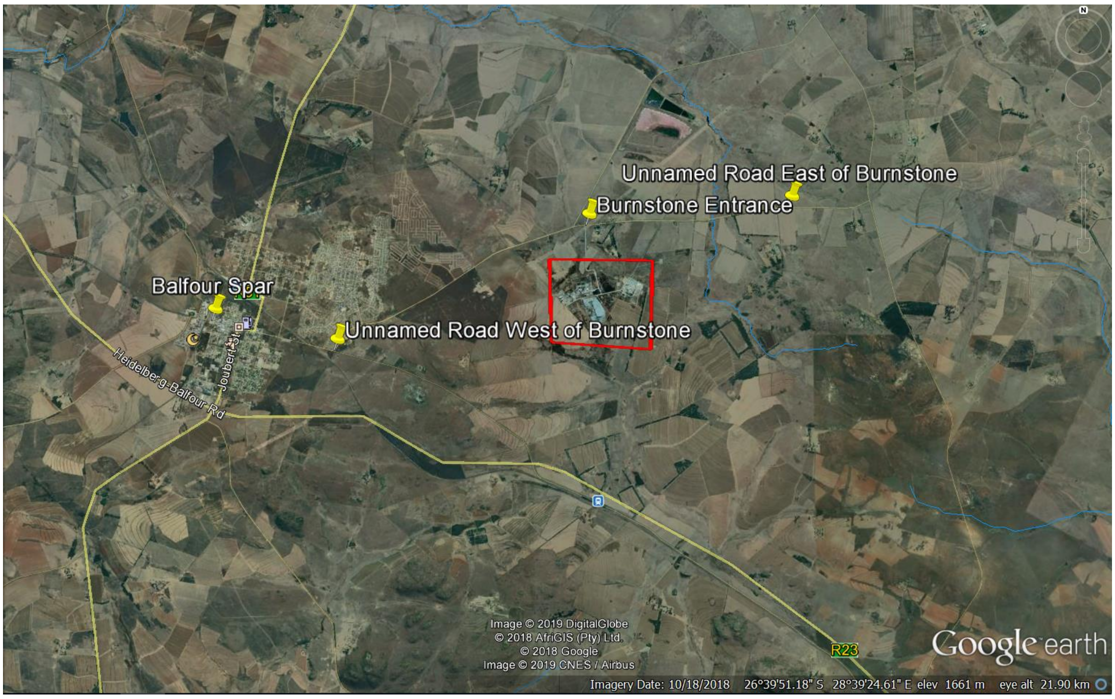


Figure 5.5: Site Notice Locations

Table 5.21: Proof of Site Notice Placement

Unnamed Road East of Burnstone

Entrance to Burnstone

Unnamed Road West of Burnstone

Balfour Spar

5.6.3.2 Background Information Document

Background information documents (BID) were distributed to the surrounding landowners in order to inform them of the NWA being undertaken.

5.6.3.3 Media Advertisement

An advert was compiled for the project area and placed in the Balfour Herald (publication Date 29 March 2019).

5.7 Public Comment Period

The IWULA technical report will be available for comment by I&APs for a 60 day period as per the requirements of the NWA. The public period is from the 28 March 2019 to the 28 May 2019.

5.8 Matters Requiring Attention/ Problem Statement

This section is not applicable to the Burnstone operation.

5.9 Assessment of Level and Confidence of Information

All information contained in this IWWMP was sourced from the specialist studies conducted for the project area. The specialists appointed to undertake the various investigations are considered to be competent in their particular fields. In light of the above, the level of confidence with regards to the information and reports used to compile this document is high.

6 WATER AND WASTE MANAGEMENT

6.1 Water and Waste Management Philosophy

The following philosophies have been created to ensure the correct management of the water at Burnstone's operations.

6.1.1 Process Water

The philosophy with respect to process water management is to:

- Minimise the amount of process water produced (continually investigate emerging technologies for gold processing); and
- Re-use process water for dust suppression if of an appropriate quality for the area (i.e. TSF can be suppressed with any quality of water, preferably dirty water, while the roads will require good quality) where dust suppression occurs and in the process.

6.1.2 Stormwater

The philosophy for stormwater management on site is in keeping with the GN704 principles:

- To keep clean and dirty water separated;
- To contain any dirty water within a system;
- To prevent contamination of clean water; and
- To return clean water to the catchment.

6.1.3 Groundwater

The philosophy for groundwater management at Burnstone is:

- Ensure that all potential groundwater impacts are identified; and
- Ensure that groundwater monitoring is conducted quarterly and that records are kept and a database compiled to identify trends over time.

6.1.4 Waste

The philosophy for the management of the various waste streams on site is:

- Eliminate:
    - Remove the waste source;
    - Substitute for a product that will produce less waste; and
    - Stop poor waste practices.
- Control at the source:
    - Restrict waste: Contain or attenuate the waste source; and
    - Proper maintenance and good housekeeping of plant, equipment and machinery.
- Minimise:
    - Restrict waste. (Admin. controls);
    - Re-use and recycle waste; and
    - Competent on-going supervision is needed to ensure compliance.

6.2 Strategies

6.2.1 Process Water

Process water management will consist of:

- Investigating new alternatives for process water treatment and re-use; and
- Continued, regular monitoring of dirty water dams which contain process water to ensure that the water quality is appropriate for re-use.

6.2.2 Storm Water

A storm water management plan has been developed for Burnstone's operations (refer to Section 5.2.2). Storm water management will comprise of the following:

- Regular monitoring of surface water quality; and
- Regular monitoring and maintenance of stormwater control structures.

6.2.3 Groundwater

Groundwater management strategies will comprise of the following:

- Continued, regular monitoring of groundwater levels and quality; and

6.2.4 Waste

Waste management strategies will consist of:

- Implementation of good housekeeping and best practises;
- Investigating new, cleaner and more cost effective technologies to reduce and manage waste;
- Monitor compliance with best practises; and
- Creating environmental awareness and sensitivity through improvements to the induction programme for employees.

6.3 Performance Objectives/ Goals

The following objectives and strategies are followed in order to achieve the Safety, Health, Environment and Quality Policy:

- Compliance:
  - Identify all applicable legislation and other applicable requirements to the identified environmental aspects and will ensure that the operations remain in compliance with such legislation and requirements.
- Pollution Prevention:
  - Identify the impacts that all operations, processes and products have on the environment and will ensure that pollution on the environment is prevented or minimised.
- Improvement:
  - Set objectives and targets to improve environmental performance and the Environmental Management System and will continually strive to find even better sustainable solutions to problems.
- Competence:
  - Ensure that all people who perform work for or on behalf of Sibanye are competent and understand the impact of their activities on the environment, and their role in the prevention of pollution and the maintenance of the Environmental Management System.
- Communication:

  - Actively communicate this policy to persons working for and on behalf of Sibanye to ensure that they understand the content intent, and will make it available to the public.
- Review:
  - Review the continued sustainability and adequacy of this policy at least annually to ensure it remains valid at all times.

6.4 Measures to Achieve and Sustain Performance Objectives

The IWWMP must clearly demonstrate that they have incorporated all of the above objectives/principles or, alternatively, must clearly motivate why any of the above principles are not relevant.

The water resource can be protected in the following ways by applying water conservation, pollution prevention and minimisation of impacts principles:

- Reduction in the level of contamination of water through implementation of pollution prevention strategies thereby increasing the economic reuse of the water without treatment; and
- Minimisation of impacts through capture, containment, reuse & reclamation of contaminated water thereby preventing discharges/releases.

6.5 Option Analyses and Motivation for Implementation of Preferred Options

Burnstone's mining operation is an existing operation and as such, no alternatives have been investigated as these were previously investigated before the operations were constructed.

6.6 IWWMP Action Plan

An Action Plan provided herein shall provide water and waste management options for issues requiring immediate attention at the Burnstone mine. The broad objective of the Action Plan is to provide robust and sustainable water and waste management practice for the mining operation. The following aspects will be addressed as part of the Action Plan:

- Key performance areas
- Objectives
- Roles and responsibilities
- Timeframes

The compilation of an IWWMP is a long-term commitment in terms of resources requirements including technical investigations that are conducted. These also require disbursing financial resources to implement management measures which can in most cases take months. With this in mind, this IWWMP has been developed for medium term (i.e. first 5 years of operation of the mine), with the Action Plan herein reviewed and updated every year. It is thus the intention of the mine to have yearly interaction with DWS and update the Action Plan accordingly. Refer to Table 6.1 for the Burnstone Gold Mine IWWMP Action Plan.

Table 6.1: Burnstone Gold Mine IWWMP Action Plan

	Action	Implementation Date	Person Responsible
1	Weekly Site Inspections d the Operational Phase Monthly during the development phase	weekly	Environmental Officer
2	Monthly management inspections	monthly	Environmental Superintendent/Manager
3	Groundwater Monitoring	Adhere to monitoring frequencies specified in groundwater monitoring program	Qualified Person
4	Surface Water Monitoring	Adhere to the monitoring frequencies of the surface water monitoring programme (primarily monthly)	Qualified Person
5	Bio-monitoring	Bi-annually	Qualified Professional Aquatic Scientist
6	WUL Audits (Internal)	Annually – alternating internal and external audits per annum, such that only one audit is conducted per annum	Environmental Officer
7	WUL Audits (external)	Annually – alternating internal and external audits per annum, such that only one audit is conducted per annum	Qualified Person
8	Employee Training	New employees and after employees return from leave	Academy

6.7 Control and Monitoring

6.7.1 Monitoring of Change in Baseline (Environment) Information

6.7.1.1 Surface Water

Refer to Section 5.4.1 for the monitoring and control of the surface water at Burnstone.

6.7.1.2 Groundwater

Refer to Section 5.4.2 for the monitoring and control of the groundwater at Burnstone.

6.7.1.3 Bio-monitoring

Refer to Section 5.4.3 for the monitoring and control of the bio-monitoring at Burnstone.

6.7.2 Audit and Report on Performance Measures

Each component within the IWUL (when issued) will have an associated audit and performance review component. Regular review and auditing is important to ensure systems are up-to-date and still relevant for current situations. Evaluation is required to verify its appropriateness and suitability by comparing performance to objectives set. Changes or adjustments to systems are required where review/auditing highlights shortcomings or gaps. Performance should be measured against:

- Annually – alternating internal and external audits per annum, such that only one audit is conducted per annum;
- Annually – alternating internal and external audits per annum, such that only one audit is conducted per annum; and
- DWS reporting (conducted bi-annually).

6.7.3 Audit and Report on Relevance of IWWMP Action Plan

Audits of the water and waste management programmes are undertaken in line with license requirements. They include assessments of performance in relation to the action plan, whilst reviewing the relevance of all provisions or commitments in the plan.

7 CONCLUSION

7.1 Regulatory Status of Activity

The Burnstone Operations have a New Order Mining Right (MR) [Ref. No. MP30/5/1/2/2/(248)MR], valid from 17 February 2009 to 16 February 2027 in respect of an area totalling 13 136 ha, located in the Dipaleseng District Municipality in the Mpumalanga Province of South Africa.

In terms of the requirements of the National Water Act, 1998 (Act No. 36 of 1998) (NWA), Burnstone (under Southgold Exploration Pty Ltd) was issued with a Water Use Licence (WUL) (Licence No**. 27/2/2C221/103/9**) dated the 23rd July 2010 by the Department of Water and Sanitation (DWS). The WUL was issued in compliance with Chapter 4 of the NWA. The following water uses have been authorised as part of the IWUL issued under Section 21 of the NWA:

- Section 21(a) – Taking water from a water resource;
- Section 21(e) – Engaging in a controlled activity identified as such in section 37 (1) or declared under section 38 (1);
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource; and
- Section 21(j) – Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people.

7.2 Statement of Water Uses Requiring Authorisation

As a result of Sibanye proposing to commence with mining at Burnstone, additional water uses have been identified that require authorisation in terms of Section 21 of the NWA. The following additional water uses are required to be licenced for the Burnstone Gold Mine:

- Section 21(a) – Taking water from a water resource;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(f) – Discharging waste or water containing waste into water resource through aa pipe, canal, sewer, sea outfall or other conduit;
- Section 21(g) – 'Disposing of waste in a manner which may detrimentally impact on a water resource; and
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse.

7.3 Section 27 Motivation

7.3.1 Existing Lawful Water Use

An Existing Lawful Water Use (ELWU) is a water use which has taken place at any time during a period of two years immediately before the date of commencement of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) or which has been declared an existing lawful water use in terms of Section 33 of the NWA and which was authorised by or under any law which was in force immediately before the date of commencement of the NWA.

Burnstone was issued with an Integrated Water Use License (IWUL) (Licence No: 27/2/2/C221110319) in 2010. Water uses were authorised in terms of this License as were not classified as ELWUs.

7.3.2 The need to Redress the Results of Past Racial and Gender Discrimination

Sibanye, Burnstone Operations acknowledges the need to reverse the results of past racial and gender discrimination in South Africa. The Employment Equity Act of 1998 is based on the following principles and includes:

- Recognising historic inequalities, Historically Disadvantaged South Africans (HDSAs) and women with recognised potential are afforded special opportunities and additional support to realise their potential;
- To fill each position in the company with a fully performing individual. Thus, we will not create phantom jobs nor make token appointments;
- Diversity is encouraged in the workplace and any form of racism is not tolerated;
- Some employees in management positions may be involuntarily redeployed to make space for HDSAs and women;

- All employees are developed to ensure that they are fully performing in their current jobs and, where applicable, to prepare them for future opportunities; and
- In placing women in jobs, the company will take cognisance of the special risks to which women of child-bearing age, pregnant and lactating women should not be exposed.

Sibanye is committed to the principles and practices of the Employment Equity Act, and plans to recruit, train and develop staff with these objectives in mind. In addition to these general objectives, Sibanye subscribes to the requirement of the Mining Charter to work towards achieving the goal of 40 % HDSAs in management and 10 % participation of women in mining.

As a leading South African company, Sibanye embraces the challenge to transform the composition of the company's workforce and management. This is a business imperative to ensure that Sibanye tap into the entire skills base of the South African population. All efforts in this regard have been aligned with the National Development Plan and the UN Global Goals for Sustainable Development in relation to:

(i) No poverty;
(ii) Zero hunger;
(iii) Quality Education;
(iv) Gender Equality;
(v) Decent Work and Economic Growth; and
(vi) Reduced Inequalities.

Sibanye is committed to promoting HDSA's in its management structure by instituting a framework geared towards local recruitment and human resources development. Vacancies are primarily filled by candidates from local communities. Where specialist skills are not available locally, they are sourced from outside the local communities. The Mine's long term objective is to have these skills shortages addressed via skills development programmes. Employees identified with potential have the opportunity to progress within their chosen career paths and therefore advance within the organisation.

7.3.3 Efficient and Beneficial Use of Water in the Public Interest

Sibanye recognises that water is a scarce resource which belongs to all people and will strive [through adherence to the conditions and provisions of the IWUL and the Integrated Water and Waste Management Plan (IWWMP)] to meet the following principles (as stipulated in Section 2 of the NWA) which form the foundation of the NWA:

- Redressing the results of past racial and gender discrimination;

- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Facilitating social and economic development;
- Protecting aquatic and associated ecosystems and their biological diversity; and
- Reducing and preventing pollution and degradation of water resources.

In addition to the above mentioned, Sibanyer will adhere to Section 19 of the NWA which stipulates that a water user must take all reasonable measures to prevent any pollution of a water resource from occurring, continuing or recurring. By adhering to the provision, Sibanye will ensure that the surrounding water resources are protected and utilised in a beneficial manner.

Accordingly, Sibanye contributes to the efficient and beneficial use of water by adhering to the regulatory provisions as contained in the IWUL and the provisions of the NWA. Water use activities may not commence without an approved water use authorisation. Thus, approval of the water use has indirectly contributed to the beneficial use of water by illustrating that Sibanye is committed to adhere to the regulatory regime governing water use in South Africa. Furthermore, Sibanyer is committed to responsible management of its approved water uses and strives to adhere to the principles of water conservation and demand management. Monitoring of water resources has been implemented to detect any impacts during the early stages and to mitigate these as soon as practically possible.

This project is aimed at the efficient use of water for the good of the local community and the country from a social, economic and environmental perspective. The project complies with National Water Resource Strategy (NWRS) philosophy and requirements with respect to water conservation and demand management, measures to balance supply and demand, resource and source directed measures, and the protection of the Reserve. This will be achieved through the efficient use and management of clean water and the reuse of water.

7.3.4 The Socio Economic Impact

7.3.4.1 Of the water use if authorised

Burnstone is situated within the Gert Sibande District Municipality in the Dipaleseng Local Municipality in the south-eastern part of Mpumalanga Province. The local municipality, covers an area of approximately 2 618km^2 and has a population of approximately 42 390 people (according to Census 2011), most of whom reside in the various urban areas. The municipality consists of 3 towns structured into 6 wards incorporating the following major settlements: Balfour, Siyathemba, Greylingstad, Nthorwane, Grootvlei, Dasville, Sthandiwe and Daspoort. As with many communities in South Africa, the Dipaleseng Local Municipality faces a set of reinforcing development challenges that threaten to create a vicious and inescapable cycle of poverty, unemployment, ill-health, poor social services, ageing infrastructure and low education levels.

Some negative impacts could be caused, such as an increase in the demand for services (housing, water, electricity and sanitation services). An increase in traffic can also be expected. To alleviate the negative impacts, a community engagement forum has been established. The purpose of this forum is for the dissemination of information and consultation between the mine, stakeholders and the community (local and affected community) on matters pertaining to the environment and the impacts of the mine on the community. This forum may also be used to discuss other environmental and social concerns. Key principles for effective engagement between all these parties should include:

- Communication through open and effective stakeholder engagement;
- Transparency through clear and agreed information sharing and feedback;
- Collaboration by actively seeking mutually beneficial outcomes where feasible;
- Inclusiveness by recognising, understanding, and involving communities and stakeholders in decision-making; and
- Engagement that is conducted with mutual respect and trust

Positive impacts by the mine’s operations will include the jobs that will be created in the mining and production activities of Burnstone, skills development, education and health, as well as activities that will be initiated to develop and support small, medium and micro enterprises outside the mining production value chain in the form of local business development and infrastructural provision.

Job opportunities created provide employees and their dependants with a source of income. This income could be used to fulfil the basic needs (and more) of the employees and their households. This income will further improve the tax base of the municipality which will enable the municipality to deliver basic services.

Sibanye has initiated a process of co-operating with Dipaleseng Local Municipality by establishing a Mayoral Mandating Forum. This forum will be supported by the Local Economic Development (LED) implementation Committee which will be established upon approval of the Social Labour Plan (SLP). This implies that Sibanye is actively involved in cooperating with the municipality in the Integrated Development Plan (IDP) and the associated programmes. The company also participated in the local IDP process in order to ensure that the mine’s selection and investment in LED initiatives are linked to the local level development priorities, to the possible extent, all projects that the mine will invest in are relevant to the growth sectors identified in the Dipaleseng Local Economic Development Strategy.

7.3.4.2 Of the failure to authorise the water use or uses

Failure to authorise the water use will impede Burnstone's capacity to:

- Promote BEE;
- Create jobs;
- Develop its people, and in so doing contribute to the transformation of the industry's leadership and skills base; and
- Have a positive impact on the local communities through economic development and sustainable social initiatives;
- Enhance the economy of the surrounding area;
- Implement projects that enhances environmental and social equity.

7.3.5 Any Catchment Management Strategy Applicable to the Relevant Water Resource

According to Chapter 2 of the NWA, the Catchment Management Agency (CMA) for each Water Management Area (WMA) must develop a Catchment Management Strategy (CMS). This CMS must be in harmony with the NWRS and set the principles for allocating water for existing and prospective users, while taking into account the protection, use, development, conservation, management and control of water resources. Any licence application should therefore not be in conflict with the CMS for the relevant WMA.

To date the Upper Vaal WMA does not have an established CMA, and therefore this WMA also does not have a CMS. However, the DWS has developed Internal Strategic Perspectives (ISPs) for each WMA, which have been included in the NWRS. This licence application should therefore not be in conflict with the ISP for the Upper Vaal WMA.

7.3.6 The Likely Effect of the Water Use to be Authorised on the Water Resource and on Other Water Users

An impact assessment for Burnstone Mine was compiled that took into account all mine operations, plant operations and water qualities. From the impact assessment, there is a high risk associated with surface water quality in the stream from surface water run-off captured in the Tailings Storage Facility (TSF) stormwater dam (SWD). This risk is reduced as a result of stormwater management implemented on site. There will be a reduction in local runoff as runoff from dirty water areas are captured and managed in Pollution Control Dams (PCDs) and collection dams. Runoff reduction has a low risk impact. Sediment loads have a low impact risk and dust suppression should be implemented to reduce the impact. Handling and storage of hazardous substances has a low impact risk. Safe handling and storage of hazardous substances to prevent contamination of soil and water resources should be implemented.

7.3.7 The Class and the Resource Quality Objectives (RQO) of the Water Resource

The NWA (Government Gazette No.468) lists the classes and resource quality objectives of water resources for catchments of the Upper Vaal in terms of Section 13(1)(a) and (b) of the NWA. Table 7.1 lists the Resource Quality Objectives (RQO) for river instream habitat and biota. Table 7.2: Resource Quality Objectives for River Riparian Zone Habitat (GN 468). lists the RQO for river riparian zone habitat for the Upper Vaal WMA.

Table 7.1: Resource Quality Objectives for River Instream Habitat and (GN 468).

IUA	Class	River	RU	REC	RQO	Numerical Limits
UH. Suikerbosrand River	II	Suikerbosrand River	60	B/C	Instream habitat must be in a better than moderately modified condition to support the ecosystem.Instream biota must be in a better than moderately modified condition and at sustainable levels.Low and high flows must be suitable to maintain the river habitat for ecosystem condition. Low flows must the sufficient for users.Water quality: The nutrient concentrations must be decreased for ecosystem condition and other users. Temperature and oxygen	Instream Habitat Integrity category ≥ B/C (≥ 78)Fish ecological category: ≥ B/C (≥ 78)Macro-invertebrate ecological category: ≥ B/C (≥ 78)Instream Ecostatus category ≥ B/C (≥ 78)Hydrological category ≥ B/C (≥ 78)Water Quality category:≥ B/C (≥ 78)

Table 7.2: Resource Quality Objectives for River Riparian Zone Habitat (GN 468).

IUA	Class	River	RU	REC	RQO	Numerical Limits
UH. Suikerbosrand River	II	Suikerbosrand River	60	B/C	Instream habitat must be in a better than moderately modified condition to support the ecosystem.Instream biota must be in a better than moderately modified condition and at sustainable levels.Low and high flows must be suitable to maintain the river habitat for ecosystem condition. Low flows must the sufficient for users.Water quality: The nutrient concentrations must be decreased for ecosystem condition and other users. Temperature and oxygen	Instream Habitat Integrity category ≥ B/C (≥ 78)Fish ecological category: ≥ B/C (≥ 78)Macro-invertebrate ecological category: ≥ B/C (≥ 78)Instream Ecostatus category ≥ B/C (≥ 78)Hydrological category ≥ B/C (≥ 78)Water Quality category:≥ B/C (≥ 78)

7.3.8 Investments Already made and to be made by the Water User in Respect to the Water Use in Question

In order to develop Burnstone to become a fully operational gold producing facility, a significant amount has been invested particularly in terms of water-related infrastructure due to the dewatering requirements to allow for mining. Some R 395 million was invested in the development of Burnstone in 2017 (Sibanye-Stillwater Integrated Annual Report, 2017). Of which, a large portion of this was allocated to interception of fissure water to ensure development and mining can occur safely underground. This includes the infrastructure related to the pumping and discharge from underground. Some dirty water facilities have already been developed for the TSF, the waste rock dump area, the plant and shaft areas. However, these were applicable to the development phase only. Therefore, further development in terms of surface water infrastructure in particular is still planned to ensure effective clean and dirty water separation once the mine becomes operational. The designs and layouts for the infrastructure have already been catered for in 2016-7. Annually about R 800 000 to R 1 million is spent on routine water management in terms of the requirements for maintaining the water uses, which includes monitoring and auditing requirements. Additionally, the licensing process incurred costs amounting to approximately R 900 000.

7.3.9 The Strategic Importance of the Water Uses to be Authorised

Water Use for power generation has been declared a strategic water use in the NWRS. This project does not involve power generation activities. However, Burnstone's operations will contribute significantly to the countries' Gross Domestic Profit (GDP).

The mining industry is of strategic importance to South Africa and thus awarding the water use licence will enable Sibanye to actively participate as an essential element of South Africa's economy. As previously stated, Sibanyer directly contributes to the South African economy by means of the following:

- Promoting BEE;
- Creating jobs;
- Developing its people, and in so doing contributing to the transformation of the industry's leadership and skills base; and
- By having a positive impact on the local communities through economic development and sustainable social initiatives.

7.3.10 The Quality of Water in the Water Resource which may be required for the Reserve and for meeting International Agreements

All surface water quality data was received from Sibanye. The laboratories used by Sibanye are not accredited, however, these laboratories use SANAS accredited methods and participates in the SABS laboratory proficiency-testing scheme in which it scores highly. Water quality is compared to the stipulated limits as set out in the WUL (license no. 27/2/2C221/103/9) (Sibanye, 2010). Additionally, the water quality is compared to the SANS 241-1:2015 for Drinking Water and World Health Organisation (WHO) Guidelines for Drinking Water Quality (2011) for comparative purposes.

Locality SW5 represents the unnamed stream tributary of the Blesbokspruit (stream) water quality upstream of the Burnstone Mine. When compared to downstream localities (SW8 and SW10), SW5 indicates better water quality. Water quality in SW6 indicates a possible downstream impact from the processing plant with elevations observed in iron and aluminium concentrations. It must be noted that the processing plant has not been operational since mid-2012. SW7 represents surface water quality upstream of the tributary stream whereas SW9 represents surface water quality downstream of the tributary. When comparing the water quality in SW7 and SW9, a down-gradient impact from SW6 is observed in SW9 as elevated iron and aluminium concentrations are detected.

Groundwater mixed with process water from the underground workings, brine form the reverse osmosis (RO) plant and treated sewage effluent is pumped into Dam 4. The process water is then pumped to the TSF RWD and overflow from the TSF RWD flows to the TSF SWD. Water from the TSF RWD is discharged into the stream. Locality SW8 is located in the stream downstream of TSF RWD discharge locality. SW8 indicates similar water quality to that found in TSF RWD. A downstream impact from the TSF RWD discharge is observed in SW8. Locality SW10 is the farthest downstream monitoring locality situated within the stream. When comparing the water quality of SW5 and SW10, a downstream impact is observed in SW10. However, water quality of SW10 can be influenced by naturally elevated concentrations of aluminum and iron in the surrounding soils, Burnstone Mine and/or Balfour and it is recommended that this sampling point be moved further upstream.

Elevated arsenic concentrations are observed in sampling localities Dam 4 and TSF RWD. Arsenic is a natural element commonly found as an impurity in gold bearing ores. Water quality in Dam 4 and TSF RWD are highly influenced by water from the underground workings and in the future by processing plant operations as well as the TSF operation. It is highly recommended to add arsenic to the water quality parameter list of the updated WUL.

7.3.11 The Probable Duration of any undertaking or which a Water use is to be Authorised

It is recommended that all water uses that are proposed for Burnstone are to be licenced for the LOM period (19 years) with a review period of 5 years.

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