Der Brochen Project Environmental Impact Assessment/Environmental Management Plan:

Surface Water Specialist Report

Report Prepared for

Anglo American Platinum

Report Number 533247/SW_Rev2

Report Prepared by

srk consulting

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Der Brochen Project

Environmental Impact Assessment/ Environmental Management Plan:

Surface Water Specialist Report

Anglo American Platinum

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Executive Summary

SRK Consulting Limited, (SRK) has been appointed by Anglo American Platinum Mines Limited (AAP)-Rustenburg Platinum Mines Limited (RPM) to undertake the surface water specialist study to support the Environmental Impact Assessment (EIA)/Environmental Management Plan (EMP) and Water Use Licence Application (WULA) for the Der Brochen Expansion project in Limpopo Province near the town of Steelpoort in the Groot-Dwars River catchment within quaternary catchment B41G.

This study report covers the proposed underground mining and associated activities for the Der Brochen Expansion Project.

Summary of principal objectives

The objectives of the surface water study are to:

- Characterise the surface water resources in the Groot-Dwars River catchment limited to the sub-catchment areas of the proposed new activities including hydrology, peak flows,floodlines and water quality;
- Develop the water balance for the latest planned infrastructure and revised target tonnages for the Der Brochen Mine;
- Assess the potential impacts of the proposed activities on the surface water resources focusing on hydrological impacts associated with the required stream diversions and crossings (aquatic ecology impacts associated with the diversions and crossings are addressed in the Scientific Aquatic Services (SAS) specialist report, SAS Draft Report 217170, January 2019);
- Develop mitigation measures to minimise the potential impacts; and
- Develop a surface water management plan including stormwater water management measures.

Development of the water balance for the latest planned infrastructure and revised target tonnages for the Der Brochen Mine is covered in a separate Report (SRK Report 533247/02, December 2018).

Outline of work programme

The work programme included.

- Site visit in October 2018;
- Updating the surface water hydrology for the site, including the 1:100 and 1:50 year flood lines in the Dwars River catchment in the area of the proposed activities as undertaken by KP;
- Preparation of water balance scenarios undertaken as part of the feasibility stages of the project;
- Review and collate water management designs and associated hydrology as provided by Knight Piésold Consulting (refer KP Report DB-2018B-09-01, 2019, a summary of which is included in Section 8) including:
  - The recommended route selection for the proposed river diversions taking cognisance of the topography and hydrology;
  - Design criteria for the identified crossings and diversions and required energy dissipation and erosion protection measures; and
  - Sizing of dirty water containment facilities.
- The water management designs and associated infrastructure are included for reference for the Northern Pit, as previously authorised (SRK Report 469113)
- Preparation of a site map that identifies the proposed stream diversion and crossing locations; and
- Assessment of potential surface water impacts and development of a site specific surface water management plan to mitigate the identified potential impacts, including stormwater management measures.

Proposed activities

RPM is considering expanding the Der Brochen Mine Project to include the following mining related infrastructure and associated activities:

- The construction of a buttress wall at the existing Helena TSF under emergency circumstances as well as the development of an additional filter press plant at the existing Mototolo Concentrator Plant;
- The Der Brochen Mine's updated topsoil management procedures;
- The development and operation of the following additional mining related infrastructure as part of the mine's development strategy:
    - One new decline shaft / portal to access new underground mining operation areas that will be mined through the implementation of the bord-and-pillar mining method. This South portal shaft is to be located in close proximity to the previously approved South Open Pit area;
    - Three ventilation shafts that will be associated with the South portal;
    - A Dense Medium Separation (DMS) Plant to be located next to the existing Mototolo Concentrator Plant;
    - A DMS Stockpile area and associated PCDs for which a phased production schedule is proposed;
    - Conversion of the existing Mototolo Chrome Plant to an interstage arrangement;
    - A Run of Mine (RoM) stockpile and silos (located near the existing Mototolo Concentrator);
    - A change house and office complex to be located at the South Shaft area;
    - An explosives destruction bay area to be located near the proposed South portal;
    - Linear infrastructure:
        - Conveyor systems for ore and DMS material;
        - Access and haul roads;
        - Pipelines;
        - Powerlines.
    - Watercourse crossings and diversions associated with the linear infrastructure and DMS Stockpile; and
    - Staff accommodation facilities at the Der Brochen Dam.

The studies are required to consider the expansion in the context of existing and planned activities for which authorisation have been obtained. The open cast North Pit operation and associated infrastructure has been approved previously, however the associated cumulative impacts are also considered in this report.

Environmental authorisation is required by the Department of Mineral Resources (DMR) and a Water Use Licence (WUL) to be issued by the Department of Water and Sanitation (DWS) prior to the development of the project AAP appointed SRK Consulting South Africa (Pty) Ltd (SRK) as the independent Environmental Assessment Practitioner (EAP) to manage and facilitate the environmental authorisation process and associated stakeholder engagement process.

Impact assessment

Potential surface water impacts associated with specific activities related to the Der Brochen underground mining and associated activities were identified and assessed for the construction, operational, and closure/rehabilitation phases. A summary of the identified impacts and the significance both pre- and post-mitigation are presented below.

Table Ex-1-1: Summary of Impact assessment

Phase	Activities	Impact Summary	Significance Pre-Mitigation	Significance Post-Mitigation
Pre-Construction	Site clearing of all footprint areas associated with the proposed project infrastructure. (DMS Stockpile, PCD's and/or other water management infrastructure associated with the Southern Portal, vent shafts, ROM stockpile, DMS Plant, conveyors, haul roads and North Pit).	Increase in erosion from areas of exposed soils during site clearing and grubbing.	Moderate	Low
	Stockpiling of topsoil (stripping and stockpiling of topsoil for DMS stockpile, South Portal and North Pit)	As above	Moderate	Low
		Deterioation of surface water quality due to a localised increase in turbidity resulting from surface runoff from the topsoil stockpiles	Moderate	Low
	Use of existing gravel roads for pre-constuction activities.	Deterioation of surface water quality due to erosion, spillage and accidential discharges at road crossings is likely to be limited as there is seldom water in the water courses.	Low	Low
Construction	Construction of infrastructure (DMS plant, DMS Stockpile area and including terraces, berms and dams (MWSD and PCD's)) as well as staff accommodation and the explosive destruction bay, including the establishment of a contractor laydown area).	Reduction in water quality due to an increase in turbidity as a result of an increase in erosion due to cleared, compacted or hardstanding areas.	Moderate	Low
		Provision of hardstanding areas and compacted areas will reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding. Increased runoff velocity	Low	Low
		Deterioration of surface water quality due to spillages and accidential discharges.	Low	Low
		Alteration in catchment hydrology causing a change change in watercourse functuality and increased risk of flooding and scouring.	Moderate	Low
	Construction of linear infrastructure including • Gravel maintenance roads to the proposed ventilation shafts • Upgrading of existing gravel roads to tar roads to serve as main access roads	Deterioration of surface water quality due to spillages and accidential discharges at conveyor or road crossings	Moderate	Low
		Reduced availability of water to downstream uses due to obstruction of flow at crossings	Moderate	Low
Operational	Depostion of DMS material onto the DMS Stockpile Area	Deterioration of surface water quality due to surface water runoff of leachate from the DMS material.	Moderate	Low
		Impeding the flow in the rivers due to failure of the stockpile	Moderate	Low
	Operation / utilisation of stormwater management infrastructure at South Portal and North Pit, including the PCD's and MWD at the the shaft.	Reduced quality of water due to discharge from the PCD's and/or runoff of water from the mine during operation.	**High**	Moderate

Phase	Activities	Impact Summary	Significance Pre-Mitigation	Significance Post-Mitigation
		Reduced availability of water to downstream users due to containment of dirty water and alteration of catchment hydrology (volume).	Moderate	Moderate
		Erosion and scouring of water courses at diversion outlets due to stormwater runoff from the mine.	Moderate	Low
	Underground mining at South Portal (bord and pillar)	Impact to surface resources are limited to surface insfrastructure as streams are ephermeral (refer to reduction in baseflow in groundwater impact)	Low	Low
	Stockpiling of ore material at Mototolo Concentrator Operation of the Chrome Recovery Inter-stage Plant Operation of the DMS Plant	Surface impacts are the same for all the facilities as these are all located within the existing Mototolo concentrator area.	Moderate	Low
	Dangerous goods storage (including hydrocarbons/chemicals/explosives) Waste Management	Spillages and accidental discharges from dangerous good storage areas and waste management facilities could locally affect the surface water resources.	Moderate	Low
	Linear structures including: 1. Temporary hauling of ore from shafts to Mototolo Concentrator along the corridor associated with the Ore Conveyor System (whilst conveyor system is being constructed) 2. Operation of Conveyor Systems 3. Utilisation of tar access roads 4. Utilisation of gravel maintenance roads associated with the ventilation shafts	Deterioration of surface water quality due to erosion, spillages and accidental discharges at conveyor or road crossings.	Moderate	Low
		Reduced availability of water to downstream users due to obstruction of flow at crossings	Moderate	Low
	Utilisation of staff accommodation near the Der Brochen Dam	Provision of hardstanding areas and compacted areas will reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding	Low	Low
	Insufficient water to sustain mining activities	Limited water available to sustain mine	Moderate	Low
Closure/Rehabilitation	Demolish all surface infrastructure including the removal of all plant equipment, conveyor belt systems and staff accomodation Rehabilitation of the DMS stockpiles and PCDs Closure of the South Portal, underground workings and North Pit	The impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction phase	Moderate	Low
Post-closure	Monitoring and maintanence of DMS Stockpile and rehabilitated areas.	All rehabilitation activities should be monitored until vegetation is well estabiliahed and no further surface	Moderate	Low

Phase	Activities	Impact Summary	Significance Pre-Mitigation	Significance Post-Mitigation
		water quality impacts are deemed likely		

The identified mitigation measures for managing the identified potential impacts are presented below.

Table Ex-2: Identified mitigation measures

Aspect	Mitigation measure
Construction Phase	
Stormwater and runoff controls	Activities should be limited to months of low rainfall/low flow (dry season) to reduce probability of potential impact.
	Stormwater culverts at watercourse crossings should be designed and constructed to accommodate the 1:50 year storm event.
	Stormwater measures should be appropriately designed to allow for free flow of water.
	Clean water diversion bunds should be constructed upstream of the construction site prior to clearing areas for new infrastructure.
	Appropriately placed clean water diversions, designed to handle the 1:50 year storm event, should be constructed to divert water away from the shafts, ROM stockpile and DMS stockpile and return it to the natural environment.
	Flood protection berms should be constructed at the area where the South portal footprint is within close proximity of the 1:100 year floodline.
	Areas disturbed by linear construction activities should be rehabilitated immediately on completion of construction of each area i.e. progressively as construction progresses
	Areas should be appropriately graded to prevent ponding.
Erosion controls	Clearing of vegetation should be limited to the minimum area safe for construction and operation.
	Energy dissipaters should be constructed in areas of concentrated flows e.g. diversion outlets.
	Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction.
	Erosion protection and energy dissipaters should be constructed at the crossings as applicable.
Dirty water controls	Contaminated runoff should be contained and reused as necessary e.g. for dust suppression.
	PCD's should be constructed downstream of the working activities to minimise uncontrolled runoff from the site.
Pollution controls	Hazardous substances and potentially polluting materials should be stored in appropriately bunded areas located outside of the riparian zone. Bunds should be designed for a capacity of 110% of the stored material.
	Contractors should be adequately trained in handling of hazardous substances and potentially polluting materials especially during transport in the vicinity of the riparian zone, e.g. over river crossings.
	Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages.
	Emergency action plans should be drawn up to deal with spillages.
	Chemical toilets should be provided at construction sites.
Operational Phase	
Clean and dirty water separation	Dirty water should be contained in pollution control dams designed to enable settlement of solids and handle the 1:50 year event with a minimum freeboard of 0.8 metres above full supply level.
	Runoff from the catchment should be diverted away from the portal areas, ROM and DMS stockpiles by cut-off channels and diversion berms designed to handle the 1:50 year storm event.
Water use efficiency	The contained dirty water should re-used as process water make-up.

Aspect	Mitigation measure
Pollution controls	Servicing and maintenance of vehicles and equipment should be done outside the riparian zone in appropriate facilities designed for this purpose.
	Routine inspections and maintenance should be conducted on infrastructure including at road crossings.
Inspection and maintenance	Routine inspections and maintenance should be conducted to keep the diversions and crossings free of debris (silt build up, vegetation etc.) and areas suitably graded.
Monitoring	The current surface water quality, and quantity monitoring systems should be revised to include the new infrastructure areas.
Closure Phase	
Measures for the construction phase will apply in the closure phase as will inspection, maintenance and monitoring	

Conclusions and Recommendations

The key findings and recommendations following assessment of the site floodlines, water quality and water balance are as follows:

- The proposed infrastructure is located outside of the 1:100 year floodline but the South Portal and Phase 3 of the new DMS stockpile will be in close proximity to the floodline. Flood protection berms should be constructed at the South Portal and Phase 3 of the DMS stockpile to minimise the potential for flooding;
- Groot-Dwars River water quality in the vicinity of the Der Brochen Project area is generally well within the applicable standards and limits with the few exceptions to the WUL considered to be due to the natural geology and not related to the existing operations. To protect the surface water quality in the project area it is recommended that the proposed measures in this Report be implemented including ongoing monitoring at the existing WUL compliance monitoring points;
- Water balances for the mine have been developed and demonstrate that the mine has limited water available under the current water authorisations to sustain the mine without water conservation and storage of excess water.

Based on the site assessment clean and dirty water separation measures in compliance with Regulation 704 have been developed and include the following:

- Additional dirty water storage has been sized in compliance with Regulation 704. It is recommended that the PCDs be provided with a formal engineered liner system appropriate to the containment of impacted waters for reuse purposes;
- Design criteria for the proposed water course crossings and proposed clean water diversions include appropriate erosion controls and energy dissipation to minimise the potential for erosion and subsequent sediment loads in the Groot-Dwars River; and
- Further design considerations for clean and dirty water separation will need to be informed by recommendations from the detailed survey and geotechnical, biodiversity and other specialist studies as appropriate.

The identified potential surface water related environmental impacts associated with the proposed activities range from medium–high to very low significance in the absence of appropriate mitigation measures. The identified impacts can be largely mitigated reducing the significance to low-medium to very low. The proposed mitigation measures have been incorporated into a surface water management plan for the project area. The plan includes applicable best practices and requirements related to inspection, maintenance, monitoring and management of incidents. This plan should be further developed as more detailed project information becomes available.

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Disclaimer

The opinions in this Report are provided in response to a specific request from Anglo American Platinum (APP) - Rustenburg Platinum Mines Limited (RPM) to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this Report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

List of Abbreviations

AAP	Anglo American Platinum Limited
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
DMS	Dense Media Separation
EC	Electrical conductivity
EcoSpec	Ecological Specifications
EIA	Environmental Impact Assessment
EMP	Environmental Management Program/Plan
EMPr	Environmental Management Program Report
EWR	Ecological Water Requirement
IWWMP	Integrated Water and Waste Management Plan
ktpm	Kilo tonnes per month
MAR	Mean annual runoff
MAP	Mean annual precipitation
mamsl	Metres above mean sea level
MPRDA	Mineral and Petroleum Resources Development Act, Act No. 28 of 2002
MSWD	Mine Service Water Dam
NEMA	National Environmental Management Act, Act 107 of 1998
NEMWA	National Environmental Management: Waste Act, Act 59 of 2008
NMAR	Natural Mean Annual Runoff
NWA	National Water Act, Act 36 of 1998
PCD	Pollution Control dam
RWD	Return water dam
ROM	Run of Mine
RPM	Rustenburg Platinum Mines Limited
SANS241: 2015	South African National Standard for drinking water
SAWQG	South African Water Quality Guidelines
SAS	Scientific Aquatic Services
SD	Slurry Density
TDS	Total dissolved solids
TSF	Tailings storage facility

UG2	Upper Group 2
WUL	Water Use Licence
WULA	Water Use Licence Application

1 Introduction and Scope of Report

SRK Consulting Limited, (SRK) has been appointed by Anglo American Platinum (APP) - Rustenburg Platinum Mines Limited (RPM) to undertake the surface water specialist study to support the Environmental Impact Assessment (EIA)/Environmental Management Plan (EMP) for the Der Brochen Project in Limpopo Province near the town of Steelpoort in the Groot-Dwars River catchment within the Olifants quaternary catchment B41G.

This Report deals with the surface water aspects of the project.

2 Background and Brief

Rustenburg Platinum Mines Ltd, a wholly owned subsidiary of Anglo American Platinum Limited, is the owner of the Der Brochen Project.

Exploration (prospecting and trial mining) for platinum group metals has been carried out for the Der Brochen Project since 2001 from the UG2 reef located on the southern most portion of the Eastern Limb of the Bushveld Complex.

2.1 Existing Authorised activities

The Der Brochen Project is authorised under an approved Consolidated Environmental Management Programme (EMPr) and a number of Water Use Licences (WULs). The current and planned activities and infrastructure approved by the Consolidated EMPr and WULs at the Der Brochen Mine project are as follows:

Existing facilities and activities:

- Mototolo Concentrator;
- Helena TSF and two associated Return Water Dams (RWDs);
- Raising of the Helena TSF;
- Mine offices (old farm house) and access roads;
- Monitoring weirs (five) with four of the weirs up and downstream of the two authorised wellfields currently monitored;
- Prospecting activities comprising of site preparation, drilling of prospecting boreholes, site rehabilitation and monitoring;
- Trial mining area on the Richmond farm (activity is completed, and the soil stockpile and waste rock dump are well vegetated);
- Abstraction from existing lawful use boreholes,
- Monitoring of surface and groundwater.

Planned activities previously authorised (those unlikely to be developed in future are underlined):

- Abstraction from Der Brochen Dam;
- The Helena and Richmond wellfields (only two of the authorised boreholes per well field currently in use);
- Helena and Richmond shafts and associated waste rock dumps;
- Two Open Pits (Northern and Southern Pits) and associated waste rock/overburden dumps and pollution control dam (PCD);
- Re-routing of a 132 kV powerline;
- A Co-Disposal Facility (tailings disposal with a rock embankment in the north pit).

Activities under construction:

- Mareesburg TSF and associated RWD are under construction with the first phase of deposition commencing on 28 November 2018;
- Mareesburg tailings pipeline servitude to Mototolo Concentrator.

The Helena TSF and Mototolo Concentrator Plant are part of the Mototolo Joint Venture (MJV)[1].

2.2 Der Brochen's Expansion Project

It is the intention of RPM to amend/expand the Der Brochen Mine's approved Consolidated EMPr and associated Environmental Authorisation (EA) including updating their WUL to include the following:

- The construction of a buttress wall at the existing Helena TSF under emergency circumstances as well as the development of an additional filter press plant at the existing Mototolo Concentrator Plant;
- The Der Brochen Mine's updated topsoil management procedures;
- The development and operation of the following additional mining related infrastructure as part of the mine's development strategy:
    - One new decline shaft / portal to access new underground mining operation areas that will be mined through the implementation of the bord-and-pillar mining method. This South portal t is to be located in close proximity to the previously approved South open pit area;
    - Three ventilation shafts that will be associated with the south portal;
    - A Dense Medium Separation (DMS) Plant to be located next to the existing Mototolo Concentrator Plant;
    - A DMS Stockpile area and associated PCDs for which a phased production schedule is proposed;
    - Conversion of the existing Mototolo Chrome Plant to an interstage arrangement;
    - A Run of Mine (RoM) stockpile and silos (located near the existing Mototolo Concentrator);
    - A change house and office complex to be located at the South Shaft area;
    - An explosives destruction bay area to be located near the proposed South portal;
    - Linear infrastructure:
        - Conveyor systems for ore and DMS material;
        - Access and haul roads;
        - Pipelines;
        - Powerlines.
    - Watercourse crossings and diversions associated with the linear infrastructure and DMS Stockpile; and
    - Staff accommodation facilities at the Der Brochen Dam.

Refer to Figure 2-1 for the location of the proposed activities as detailed above and locality of the existing and planned infrastructure.

2.3 Nature of the brief

This Report deals with the surface water study for the proposed activities. This study is limited to the surface water management aspects associated with the proposed new activities.

[1] Prior to 1 November 2018, the Mototolo Mine was operated as a 50/50 joint venture between RPM and a partnership between Glencore Operations South Africa Proprietary Limited (Glencore) and Kagiso Platinum Ventures Proprietary Limited's (Kagiso). With effect from 1 November 2018, RPM acquired both Glencore's 40.2% interest and Kagiso's 9.8% interest in the MJV, resulting in the Mototolo Mine becoming a wholly-owned operation of RPM. The Mototolo Mine WUL has not yet been transferred to RPM.

2.4 Data Sources

This Report is based on the information provided for the previous surface water specialist study in 2014 (SRK 469113/SW, 2014), information as provided in the IWWMP of 2018 (SRK 533247, 2018) as well as additional data sources as referenced in Section 13. The designs and stormwater management plan for the DMS stockpiles and South portal was provided by Knight Piésold Consulting (KP).

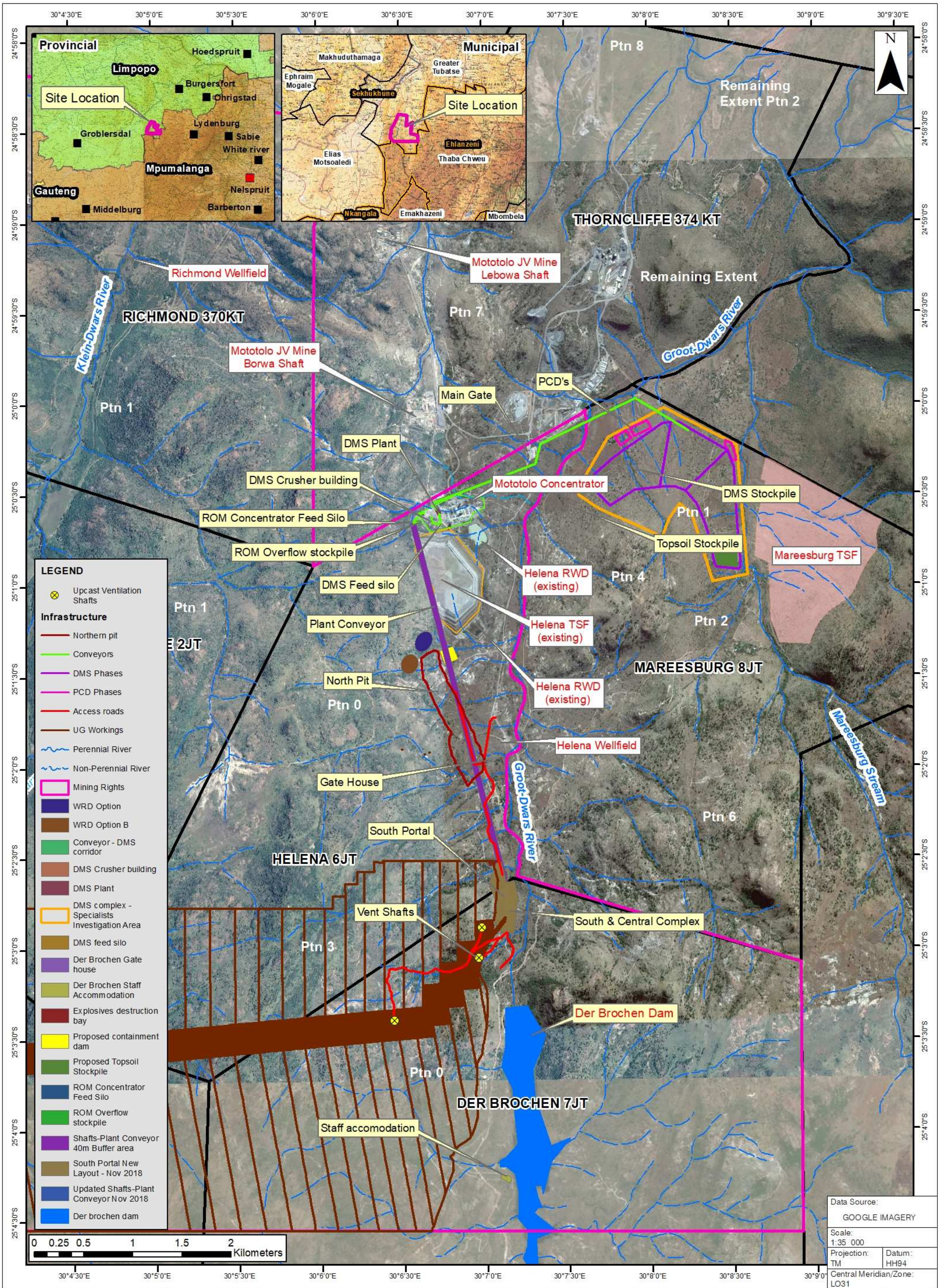
The locality of the proposed infrastructure and rainfall data for stations located within the general area were provided by Anglo American. Additional rainfall data for the site gauges were obtained from the Der Brochen Project Land Manager.

Water quality monitoring data and flow records at the weirs were provided by Groundwater Consulting Services (GCS) for the period ending December 2018.

The following data limitations are noted as pertaining to this study:

- Floodlines are included based on the 2014 EMP submission with an update on the Dam break analysis provided by KP. The floodlines for the general area are assessed on the basis of 1 in 5 contour spacing. KP provided a further update based on LIDAR survey data for the small section of the Groot-Dwars River located adjacent to the proposed DMS stockpiles. This resulted in a narrower floodline than that based on the 1 in 5 m survey (KP Report DB-2018B-09-01, 2019). KP also noted that the new bridge at the Mareesburg pipeline has not been modelled, and may cause a restraint upstream of the bridge;
- Drawings received from KP were not supplied with georeferenced data and have therefore been provided as an inset to the figures;
- Crossing consolidation is still pending.

KP Report DB-2018B-09-01, 2019 noted that the design and modelling was done on a survey showing 5 m contour, as no aerial survey site was available. Therefore, the accuracy of the measurements is not very high. The slopes and the sizes of the drainage and solution channels are also influenced by the accuracy of the survey used.



srk consulting

DER BROCHEN

LOCALITY PLAN

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3 Programme Objectives and Work Programme

3.1 Programme objectives

The objectives of the surface water study are to:

- Characterise the surface water resources in the Groot-Dwars River catchment limited to the sub-catchment areas of the proposed new activities including hydrology, peak flows, floodlines and water quality;
- Develop the water balance for the latest planned infrastructure and revised target tonnages for the Der Brochen Mine:
- Assess the potential impacts of the proposed activities on the surface water resources focusing on hydrological impacts associated with the required stream diversions and crossings (aquatic ecology impacts associated with the diversions and crossings are addressed in the Scientific Aquatic Services (SAS) specialist report, SAS Draft Report 217170, January 2019);
- Develop mitigation measures to minimise the potential impacts; and
- Develop a surface water management plan including stormwater water management measures.

Development of the water balance for the latest planned infrastructure and revised target tonnages for the Der Brochen Mine is covered in a separate Report (SRK Report 533247/02, December 2018).

3.2 Work programme

The work programme included:

- Site visit in October 2018;
- Updating the surface water hydrology for the site;
- Including the 1:100 and 1:50 year flood lines in the Dwars River catchment in the area of the proposed activities as undertaken by KP;
- Preparation of water balance scenarios undertaken as part of the feasibility stages of the project;
- Review and collate water management designs and associated hydrology as provided by Knight Piésold Consulting (refer KP Report DB-2018B-09-01, 2019 a summary of which is included in Section 8) including:
  - The recommended route selection for the proposed river diversions taking cognisance of the topography and hydrology;
  - Design criteria for the identified crossings and diversions and required energy dissipation and erosion protection measures; and
  - Sizing of dirty water containment facilities
- Preparation of a site map that identifies the proposed stream diversion and crossing locations; and
- Assessment of potential surface water impacts and development of a site specific surface water management plan to mitigate the identified potential impacts, including stormwater management measures.

3.3 Project team

The project team is presented in Table 3-1.

Table 3-1: SRK Project team

Team Member	Role	Specialist area	Expertise
Peter Shepherd	Project Director and Reviewer	Water management and hydrology	BSc (Hons) in Hydrology with more than 25 years in hydrology and water management. Professional registration with SACNASP number 400104/95.
Simon Bruton	Project scientist (Site work & original Reporting)	Hydrology (Water Balance)	MSc in Hydrology with more than 10 years experience in hydrology and hydrological modelling. Professional registration with

Team Member	Role	Specialist area	Expertise
			SACNASP number 400570/14 (Water Resources Science).
Sarah Skinner	Project scientist (Update/ Report revision)	Water management & utilisation	MSc in Water Utilisation with more than 20 years experience in various water fields and water management. Professional registration with SACNASP number 400016/01 (Geological Science).
Dennis Mulaudzi	Project scientist (Update/Report revision)	Water Management and Hydrology	BSc (Hons) in Hydrology and Water Resources with more than 2 years in hydrology and hydrological modelling. Professional registration with SACNASP number 118668/18 (Water Resource Science).
Christie Terrell	Project scientist (Report revision)	Water Resources and Contamination management	BSc Environmental Science (Chemistry Stream) with more than 10 years experience in water resource management and contaminated land assessments. Professional registration with SACNASP number 117756/18 (Water Resource Science).

4 Legal Review

4.1 National Legislation

National legislation applicable to surface water management in the context of this study includes:

- **Constitution of the Republic of South Africa, 1996 (No. 108 of 1996) –** The Bill of Rights states that everyone has the right to an environment that is not harmful to their health or well-being.
- **National Water Act, Act 36 of 1998 (NWA) –** Provides for the protection of the quality of water and water resources in South Africa and provides for the establishment of Water Management Areas to be managed by Catchment Management Agency's. The strategy, guidelines and regulations under the NWA applicable to this study are described in the remainder of this section.
- **Water Services Act, Act 108 of 1997 –** Provides for the regulation of water boards and the setting of national water quality standards.
- **National Environmental Management Act, Act 107 of 1998 (NEMA)** – This Act sets out the duty of care principle (Sections 28 (1) and (3) of NEMA), which is applicable to all types of pollution and must be taken into account in considering any aspects of potential environmental degradation. Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment. The listed activities in terms of NEMA Government Notices (GN) numbers GN R982, R983, R984 and R985, December 2014are of particular relevance to the EIA and EMP Amendment process.
- **National Environment Management Act: Waste Management Act, Act 59 of 2008 (NEMWA) –** Provides for the regulation of waste and the prevention of pollution from the waste generated at a specific site. NEMWA follows the principle that waste generation should be avoided, or if it cannot be avoided, that it is reduced, re-used, recycled or recovered, and as a last resort treated and/or safely disposed of. The waste management activities which require a Licence and those that require a Basic Assessment (Schedule 1 of the NEMWA) have been reviewed. Although the Minister of Mineral Resources is the licensing authority for residue stockpiles and residue deposits, their management must be in accordance with the NEM:WA Regulations as prescribed by the Minister of Environmental Affairs (DEA). The list of Waste Management Activities that may require licensing in terms of NEM:WA has been revised as follows:
  - on 29 November 2013 (Government Notice (GN) 921, Government Gazette No 37083) and exclude treatment of effluent, wastewater or sewage,

- on 2 May 2014 (GN332, Government Gazette No. 37604) to exclude remediation of contaminated land, now covered under Norms and Standards;
- on 24 July 2015 (Government Gazette GG 39020, GN: R633) to include residue stockpiles and residue deposits..

- **Mineral and Petroleum Resources Development Act, Act 28 of 2002 (MPRDA) -** Provides for equitable access to and sustainable development of South Africa's mineral resources. The MPRDA requires that the environmental management principles set out in NEMA shall apply to all mining operations and serves as a guideline for the interpretation, administration and implementation of the environmental requirements of NEMA.
- **Promotion of Access to Information Act, Act 2 of 2000 –** Gives effect to the constitutional right to access information held by the State, such as information on water resources.

4.2 National Water Resource Strategy

The Department of Water and Sanitation (DWS)[2] has developed the National Water Resource Strategy (NWRS) to give effect to Section 5 of the NWA. The second edition of the NWRS (NWRS2, DWA 2013) is the primary mechanism to manage water across all sectors towards achieving national government's development objectives. The water sector vision for the NWRS2 is "Sustainable, equitable and secure water for a better life and environment for all" and is aligned with the vision of South Africa 2030. Towards achieving this vision, the overall goal is: "Water is efficiently and effectively managed for equitable and sustainable growth and development". The NWRS2 strives to achieve three main objectives (DWA, 2013):

- Water supports development and the elimination of poverty and inequality;
- Water contributes to the economy and job creation; and
- Water is protected, used, developed, conserved, managed and controlled sustainably and equitably.

4.3 Regulation 704

Section 26 (1) of the NWA provides for the development of regulations that:

- Require that the use of incoming and discharging water from a water resource be monitored, measured and recorded;
- Regulate or prohibit any activity in order to protect a water resource or in-stream or riparian habitat;
- Prescribe the outcome or effect that must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited into or allowed to enter a water resource.

Regulation 704 (GN704) (Government Gazette 20118, 4 June 1999) was drawn up to address these issues in relation to mining activities. The principal conditions are:

- Condition 4 describes the location of infrastructure and mining activities. Any residue deposit, dam, reservoir, together with any associated structure must not be located within the 1in100-year floodline or within 100 m of any watercourse or borehole;
- Regulation 5: Restriction on use of any residue or substance which causes or is likely to cause pollution of a water resource for the construction of any dam or other impoundment or any embankment, road or railway, or for any other purpose which is likely to cause pollution of a water resource;
- Condition 6 deals with capacity requirements of clean and dirty water systems. Clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated such that these systems do not spill into each other more than once in 50 years; and

[2] DWS was previously Department of Water Affairs (DWA)

- Condition 7 describes the measures which must be taken to protect water resources. All dirty water or substances which cause or are likely to cause pollution of a water resource either through natural surface flow or by seepage must be contained.

4.4 Anglo Standards

Anglo American has developed Technical Standards (e.g. AA TS 602 001) and Guidelines that define the minimum requirements for the siting, safe design, operation and closure of all mining and mineral process wastes or by-products, storage facilities and deposits, as well as water containment and diversion structures. The standards and guidleines apply at either greenfield or brownfield projects and operations, including those facilities/deposits that are either removed, relocated or being reprocessed. The AA TS 602 001 also covers the requirements of the preparation and implementation of Surface Flooding Risk Management Plans (SFRMPs).

4.5 Other Water Management Guidelines and Standards

Other guidelines and standards applicable to surface water management in the context of this study, are described below.

- Water quality monitoring data are compared to the WUL quality limits, South African water quality guidelines (SAWQG) (DWAF, 1996) for general fitness for use and the South African National Standard for drinking water (SANS241:2015) to assess potential health impacts if the water were to be used for drinking purposes. The quality component of the ecological specifications (EcoSpecs) provided for the Ecological Water Requirement (EWR) Site 9 located on the Steelpoort River downstream of the confluence with the Dwars River as provided in the reserve determination for the water resources for the Olifants and Letaba Catchments (Government Gazette No 41887, No 932, 2018) is included for comparison.
- Best Practice Guidelines for the mining sector, DWAF 2006, 2008, dealing with the following:
    - Integrated mine water management ;
    - Aspects of the DWS water management hierarchy, namely, pollution prevention and minimisation of impacts, water reuse and reclamation and, as a last resort, water treatment;
    - General water management strategies, techniques and tools which could be applied cross – sectorial and deal with storm water management, water and salt balances, water monitoring systems, impact prediction; and
    - Specific mining activities,addressing the prevention and management of impacts from small scale mining, water management for mine residue deposits, PCDs, water management for surface mines, and water management for underground mines.

5 Site Description

This section provides an update of the information provided in the the previous Surface water specialist Report (SRK 469113/SW, 2014), as applicable.

5.1 Regional Description

The Der Brochen project area is situated in quaternary catchment B41G (Olifants River Water Management Area B4) approximately 30 km south-southwest of the town of Steelpoort (approximately 40 km by road) and 35 km west of Mashishing (Lydenburg) (approximately 65 km by road), in the Fetakgomo-Greater Tubatse Local Municipality and Greater Sekhukhune District Municipality of the Limpopo Province. The Der Brochen mining area is characterised by rugged topography with prominent north-south trending mountain ranges (the Steenkampsberge) extending across the mining area.

The highest elevation of 2 300 mamsl is located to the extreme south of the project area, and the lowest elevation of 1 035 mamsl is located to the northern drainage path of the Groot-Dwars River.

The proposed activities are located within the following farms:

- Mareesburg 8 JT (PTN 1, 2 and 4) which includes the DMS Stockpile, Topsoil Stockpile and 3 PCD’s;
- Helena 6 JT (Ptn 3, Ptn 0) which includes the conveyors, vents, south portal and the proposed activities in and near the Mototolo Concentrator Plant; and

- Der Brochen 7 JT (southern portion of the South Portal, 3 of the vents and Staff Accomodation).

5.2 Climate

5.2.1 Regional climate

The Der Brochen project area falls within the Highveld climatic region. This climatic region is associated with warm temperature and summer rainfall. The average daily maximum temperature for the region is 27°C in January and 17°C in July, with extreme averages of 38°C and 26°C respectively. Average daily minimal for the region vary from 13ºC in January to 0ºC in July, while extremes reach 1ºC and minus 13ºC, respectively.

The prevailing wind directions on the site are north-westerly and south-easterly due to the topographical orientation of valleys and ridges in the area. The average surface wind speed is 2.5 m/s, with a maximum observed wind speed of 7.9 m/s.

5.2.2 Rainfall and evaporation

The rainfall pattern for the Der Brochen Project area has been obtained from the South African Weather Service (SAWS) for station 593419 (Maartenshoop: Lat. 24°98', Long. 30°23'). This station is the closest of the national weather stations. Rainfall data from the SAWS station 554516 (Beetgeskraal: Lat. 24°06', Long. 30°18'), located 19.7 km from the project area, has also been obtained (Knight Piésold Report DB-2018B-09-01, 2019). Information on these two regional rainfall stations is provided in Table 5-1.

Table 5-1: Regional Rain station information

Name of rainfall station	Rainfall Station number	Distance (km)	Latitude	Longitude	Record (years)	Record period	MAP (mm)
Maartenshoop	593419	12	24°98'	30°23'	40 (	1915-1999	682
Beetgeskraal	554516	19.69	25° 06'	30° 18'	42	NR[3]	697

There are, in addition, five manual rainfall stations located in and around the Der Brochen Project area from which rainfall has been captured since September 2015 (refer Table 5-2). Rainfall and evaporation are also recorded at the Helena TSF. The manual gauges are located as follows:

- Der Brochen dam wall;
- Top House yard;
- Office;
- Mareesburg house; and
- Anglo house – Richmond;

Monthly rainfall and evaporation data are presented in Table 5-2 and data for the wettest ten years are presented in 5-3.

[3] NR: The record period was not provided by KP for Beetgeskraal. Evaporation data record for this station is indicated as 1972-2001, (SRK Report 469113, 2014).

Table 5-2:Site rainfall (mm) for 2017 and 2018

Year	Der Brochen stations						Mototolo
	MBH	GOA	DW	RMH	TH	Average	Helena TSF
	Mareesburg house	Geology Office	Der Brochen dam wall	Anglo house Richmond	Top House Yard		
2017	605	883	685	867	709	749	683
2018	410	516	435	404	522	460	563

The average annual rainfall for this climatic region varies from 900 mm in the east to 680 mm in the west and the average annual rainfall for the Maartenshoop and Beetgeskraal stations is 687 mm and 697 mm, respectively. This aligns with the ten-year average recorded at the Helena TSF of 624 mm (2010-2018). The average rainfall for 2018 based on the five site rainfall gauges was 460 mm compared to much higher rainfall of 749 mm in 2017. This range is similar to that observed at the Helena TSF of 683 mm in 2017 and 560 mm in 2018. Rainfall occurs mostly in the summer (85%) from October to March, with a maximum in December. Monthly data in Table 5-3 show that a net water loss prevails in the region.

Evaporation data were obtained from the Station B4E003 (SRK 527471, 2018 and KP Report DB-2018B-09-01, 2019) which is the closest evaporation station to the site. The average annual S-pan evaporation is 1 703 mm. Evaporation data for the integrated water balance (SRK 533247 WB, 2018) was obtained from WR2012 for the Quaternary catchment (B41G) and provided a similar average annual S-Pan evaporation of 1 601 mm. The water balance model includes monthly evaporation factors and a conversion of the S-Pan data to lake evaporation, in line with best practice. This is presented in Table 5.3 below.

Table 5-3: Rainfall and evaporation data

	Rainfall data (mm)							Evaporation record						
Month	Station WB 593419 (Maartenshoop) (1915-1999) [4]			Average for site stations		Site record at Helena TSF[5]		Station B4E003 (1972 to 2001)		Quaternary B41G[1]	Model input[1]		Helena RWD (A-Pan) [3]	
	Average	Maxi-mum	Mini-mum	2017	2018[6]	2017	2018	A-pan	S-pan	S-Pan (mm)	Evaporation factor	Lake evaporation (mm)	2017	2018
January	112.2	447.0	0	176.8	62.5	225	58	224	183	176	0.84	148	200	160
February	89.5	365.7	0	247.8	65.0	142	113	196	157	147	0.88	129	295	148
March	79.8	217.5	0	44	97.8	85	91	188	150	145	0.88	127	224	118
April	44.8	169.0	0	34	36.3	7	45	159	123	111	0.88	98	155	86
May	14.1	108.6	0	0	5.5	45	32	143	108	94	0.87	82	193	92
June	6.8	54.5	0	0	0	0	2	125	92	76	0.85	65	86	158
July	6.0	74.5	0	0	0	0	5	133	99	83	0.83	69	141	166
August	7.3	61.8	0	0	0	0	0	158	122	110	0.81	89	98	168
September	22.4	121.5	0	0	0	0	0	193	154	143	0.81	116	233	150
October	58.8	245.5	0	75	28.9	34	15	214	174	173	0.81	140	170	150
November	117.8	319.0	2.5	36	47.6	12	69	204	165	163	0.82	133	189	144
December	122.7	306.5	26.2	135.7	116	134	Pending	216	176	179	0.83	149	144	Pending
Totals	**682**			**749**	**460**	**683**		**2153**	**1703**	**1601**		**1348**	**2128**	

[4] Data based on the hydrological year commencing in October and ending September the following year. Data period simulated up to September 2017. Intergrated Water Balance Report, SRK 533247, 2018.
[5] Data received from Fraser Alexander for the station at Helena TSF.
[6] Data received from Mr B Redmead of AngloAmerican, 24 January 2019.

Table 5-4: Rainfall and evaporation data (mm) (data obtained from SRK 469113, 2014)

The wettest years from 1915-1999	Wettest Year		Wettest 6 Months		Total evaporation for six months (Station B4E001)	Relevant Year
	Year	Total Rainfall for wettest year	Year of wettest six months	Total rainfall for wettest six months (Station 593419)		
Wettest Year	1938	1 185.5	1917	1002.1	1137	1972/73
2nd wettest	1929	1 120.3	1938	1058.4	1132	1991/92
3rd wettest	1917	1 103.5	1929	957.4	1120	1982/83
4th wettest	1922	982.4	1922	927.8	1114	1985/86
5th wettest	1924	948.6	1979	885.5	1093	1976/77
6th wettest	1979	945.0	1936	843.7	1069	1975/76
7th wettest	1959	926.9	1924	822.4	1053	1974/75
8th wettest	1956	913.7	1959	818.5	1043	1992/93
9th wettest	1936	909.8	1920	812.7	1033	1977/78
10th wettest	1954	891.8	1999	788.7	1030	1983/84

The design rainfall was determined using the program *Design rainfall estimation in South Africa* (Smithers and Schulze 2002) and is presented in Table 5-5. The rain per recurrence was similarly estimated but using the SAWS station 554516 (KP Report DB-2018B-09-01, 2019) and is presented in Table 5-5 for comparison.

Table 5-5: Adopted design rainfall

Duration	Station WB 593419 (Maartenshoop)[7] Return Period Rainfall (average in mm)							Station B4E003 (Beetgeskraal)[8] Rain per Recurrence Interval (mm)						
	2	5	10	20	50	100	200	2	5	10	20	50	100	200
24 hour	62	85	102	119	142	161	181							
1 day	54	74	88	103	123	140	157	50	66	78	90	108	123	139
2 day	66	91	109	127	152	172	194	64	85	100	115	138	156	175
3 day	75	103	123	143	172	194	219	73	97	115	133	159	181	204
4 day	81	112	133	155	186	211	237							
5 day	87	119	142	166	199	225	253							
6 day	91	125	150	175	209	237	267							
7 day	95	131	156	183	219	248	279	96	128	150	174	206	233	261

5.3 Water management area

The site falls within the Dwars River catchment within the B41G quaternary in Water Management Area B4. The Der Brochen project area is characterised by rugged topography with prominent north-south trending mountain ranges (the Steenkampsberge) extending across the project area. Two deep valleys extend in a north-south direction between the Steenkampsberge mountain ranges and the Groot-Dwars River (in the east) and the Klein-Dwars River (in the west) are contained within these

[7] Data obtained from SRK Report 469113, 2014 and SRK Report 533247, 2018
[8] Data obtained from KP Report DB-2018B-09-01, 2019

valley floors. The main sub-catchments in the Der Brochen Project area are the Groot-Dwars River sub-catchment and Mareesburg stream sub-catchment. These are presented in Figure 5-2.

Surface water from the Der Brochen Project area flows via a number of unnamed ephemeral tributaries and drainage lines into the perennial Groot-Dwars River. These rivers all drain to the north and are reportedly associated with major north / south striking fault zones (SRK 527471, 2018).

The Der Brochen dam is situated on the Groot-Dwars River upstream of the Der Brochen project area. The main tributary of the Groot-Dwars River in the project area is the Mareesburg Stream. The proposed DMS Stockpiles and associated PCDs are located to the east of the Mareesburg Stream and the Mareesburg TSF (currently under construction) located to the west of this stream.

The Groot-Dwars River together with the Klein-Dwars River joins the Dwars River on the farm Dwarsrivier 372 KT approximately 10 km north-northwest of Der Brochen. The Dwars River then joins the Steelpoort River (also known as the Tubatse River), which in turn flows into the Olifants River.

There are a number of small drainage lines and tributaries associated with the proposed South Portal, similar to that identified previously for the open pit section (SRK, 2014), and the Mareesburg TSF area. The DMS Investigation area is situated on the watershed between the Groot-Dwars and Mareesburg stream sub-catchments whilst the North pit area, conveyor and Mototolo Concentrator are all located within the Groot-Dwars sub-catchment.

Catchments identified by KP are included as insets in Section 8. None of the proposed surface activities associated with this specialist study are located within the Klein Dwars River sub-catchment.

The reserve determination for the water resources for the Olifants and Letaba Catchments was, published in September 2018 (Government Gazette No 41887, No 932). The present Ecological Status (PES) for B41G is Class C. The quality component of the ecological specifications (EcoSpecs) provided for the Ecological Water Requirement (EWR) Site 9, located on the Steelpoort River downstream of the confluence with the Dwars River (in the B41J catchment).

5.4 Wetlands

A wetland delineation was undertaken for the 2002 EMPr. No wetlands were identified on the Der Brochen project area in 2002 but significant wetlands were noted south and up-gradient of the mine area but largely falling outside the Dwars River catchment area. A re-evaluation of wetlands according to the wetland and riparian area delineation guideline (DWAF, 2005) was undertaken in 2014 (SAS, 2014) and 2018 (SAS, Draft April 2018). No priority wetlands were identified in this catchment for the reserve, (Government Gazette 41887, September 2018).

The main findings from the 2014 study remain current and are as follows:

- The National Freshwater Priority Areas (NFEPA) database does not map the entire extent of the wetland system found in the study area but those that are mapped by NFEPA are considered to be artificial. The site assessment revealed numerous non-perennial drainage lines originating from the Groot Dwars River, Mareesburg Stream, and mountainous areas within the study area. Several artificial dams were also identified on the Mareesburg farm portions;
- The NFEPA database indicates that there are no Ramsar[9] wetlands within the study area;
- The NFEPA database indicates that the wetland system within the study area is not within 500 m of an International Union for Conservation of Nature threatened frog point locality, or within 500 m of a threatened water bird point locality;
- According to the NFEPA database, the aquatic resources within the study area are not considered important on a macro scale for fish migration or breeding habitat; however, based on observations made during the biomonitoring programme, the Groot Dwars River and Mareesburg Stream are important migratory corridors and breeding grounds for a variety of fish species, with specific mention of the confluence of the Groot Dwars River and Mareesburg Stream;

[9] The Ramsar Convention on Wetlands was signed in Ramsar, Iran in 1971 and is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of the identified wetlands of international importance. The list of Ramsar wetlands is periodically reviewed and revised.

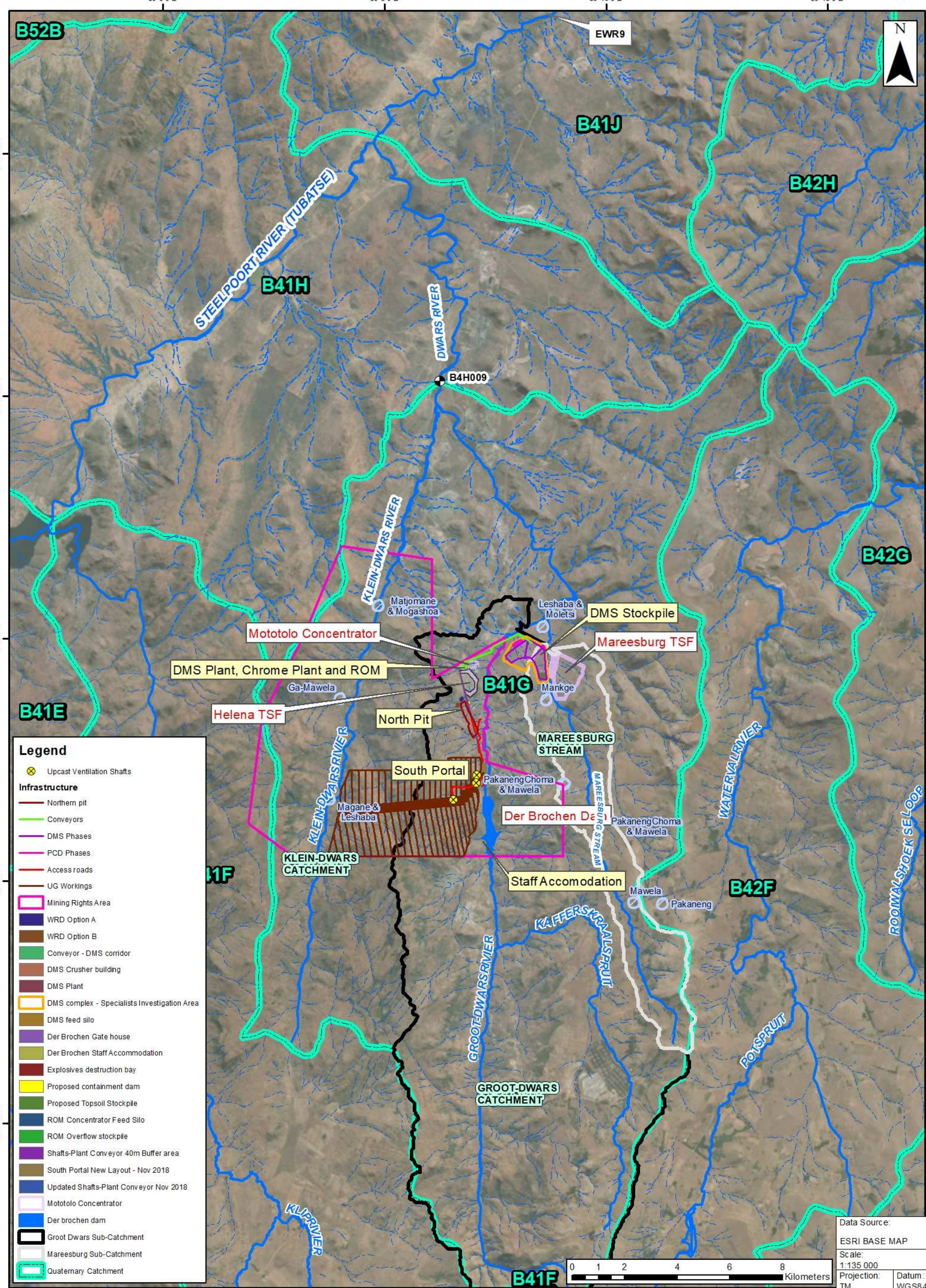
- The delineation study identified two main feature types present within the study area: drainage lines, some of which are perennial although the majority are seasonal or ephemeral, and riparian features (Groot Dwars River and Mareesburg Stream). These features or hydrogeomorphic units classify as rivers, namely a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- One channelled valley bottom wetland (other than the upstream Der Brochen Dam) was identified south-west of the Mareesburg TSF and has developed due to an artificial dam (old farm dam);
- Some hillslope seep and bench wetlands were identified within the greater study area but none were identified directly in or within 500 m of the areas identified for development of the proposed mining infrastructure, and were therefore not assessed in detail;
- It is noted that the latest stormwater design report (Redco, 2019) has described a wetland area downgradient of the clean water diversion outlet that may be associated with seepage from the Helena TSF. The SAS studies note hillslope and bench wetlands in the general area but none related to proposed future activities.

The identified features were assessed to determine importance in terms of function and service provision as well as the ecological status of the systems. Details are provided in SAS Draft Report 217170, January 2019).

5.5 Surface water use

Surface water in the Mototolo and Der Brochen areas supports a wide diversity of sensitive aquatic species and is used by game, for limited cattle farming and for domestic supply to Top House on Der Brochen farm (alternative borehole supply is under investigation, (SRK 527471, 2018)). The Der Brochen dam situated on the Groot Dwars River on Der Brochen farm upstream of the Der Brochen Project area provides water to downstream mines and irrigators. In terms of the 2011 WUL, the operation is authorised to abstract 75 040 m^3/annum from Der Brochen dam. An amended WUL was issued for relocation of the dam abstraction point downstream for the period July 2017 to December 2018 to provide water during construction of the Mareesburg TSF.

Communities on the neighbouring farms may utilise surface water for domestic purposes, although borehole water is typically used for potable domestic use. The Leshaba family, located downstream of the Der Brochen Project area and the proposed DMS Stockpile uses water from the Groot Dwars River for domestic purposes (SRK Report 469113, March 2015). The locality of the communities is indicated on Figure 5-1.



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DER BROCHEN

HYDROLOGICAL SETTING

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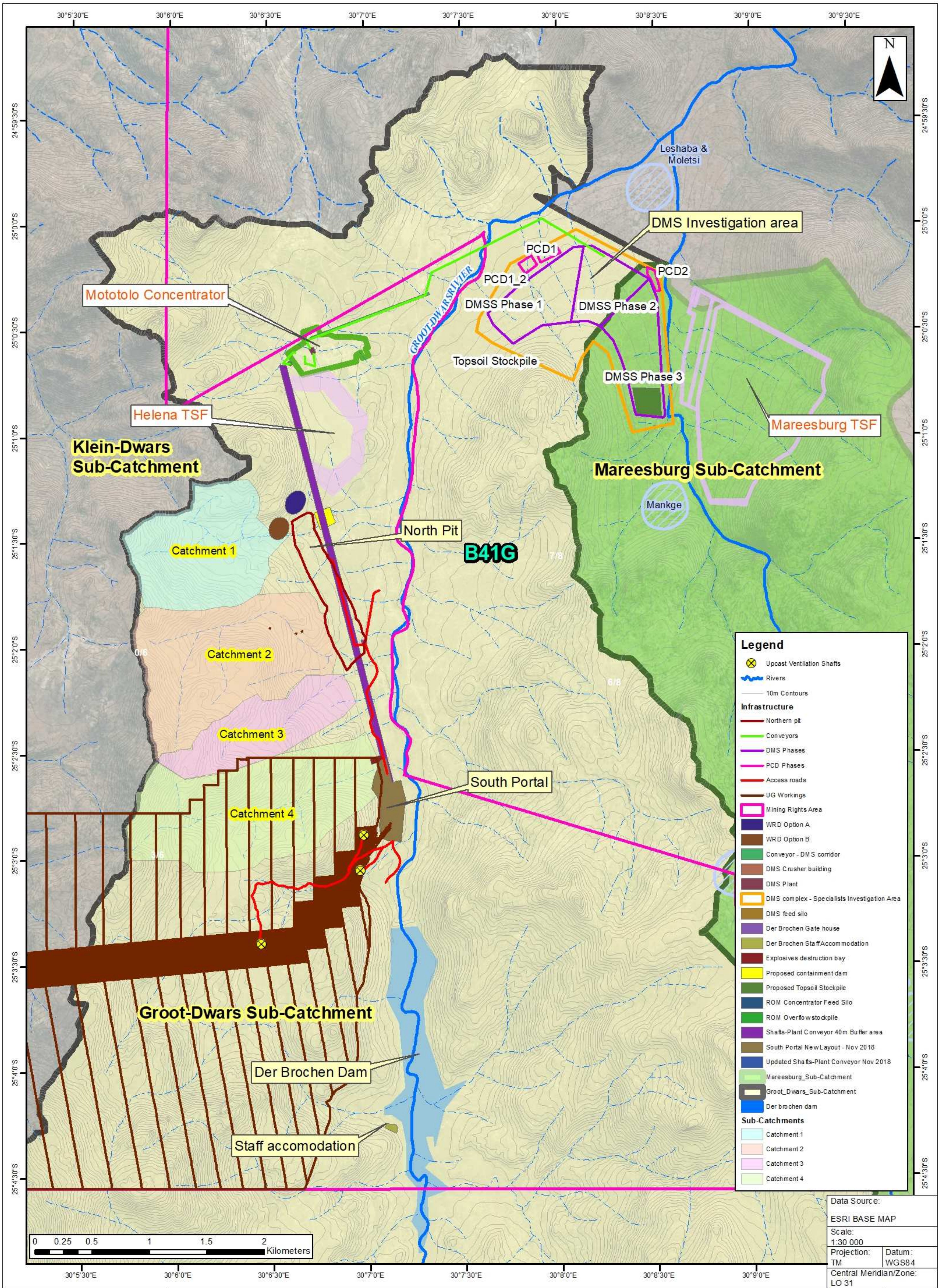

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Projection: TM | Datum: WGS84

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Project No. 533247 | Fig No. 5-2

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DER BROCHEN

SUB-CATCHMENT AREAS

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6 Surface water hydrology

6.1 Normal dry weather flow

The normal dry weather flow is defined as the flow that occurs 70% of the time in the three driest months (June, July, and August). The dry weather flow is based on the MAR as presented in Table 6.1.

Table 6-1: Dry weather flows within and downstream of the area

Catchment	Dry weather flow (m^3/month)
Groot Dwars River catchment	107 947
Mareesburg catchment	19 510
Klein Dwars River catchment	60 304

Flood peaks for the 1:20, 1:50, 1:100 and 1:200 year storms were determined using the Rational method, with the final selected peak being the most representative value based on best experience. Flood volumes for the same return periods were calculated using the Soil Conservation Service method. The 1:50 and 1:100 year flood peaks used in floodline modelling year flood peak used in floodline modelling for Der Brochen Dam were determined using Regional Maximum Flood (RMF) method with a K region of 4.

Table 6-2: Summary of Catchment Characteristics

Catchment description	Area (km^2)	Longest watercourse (km)	10-85 slopes (m/m)	Time of concentration (hrs)
Groot Dwars River Catchment	176.5	27.9	0.017	4.1
Der Brochen Dam Catchment	150	24	0.034	2.81
Mareesburg sub-catchment	31.9	17.57	0.04	1.9
Klein Dwars River	98.6	20.0	0.047	2.2

The definitions of the terms described above are listed below:

- 10-85 slopes denote the slope of the catchment from a point, 10% from the end point and 85% of the distance to the furthest point.
- Time of concentration denotes the length of time it takes for a raindrop to travel from the furthest point of the catchment to the outlet point.
- Longest watercourse denotes the longest length of the watercourse from the furthest point of the catchment to the outlet.

6.2 Flow measurements

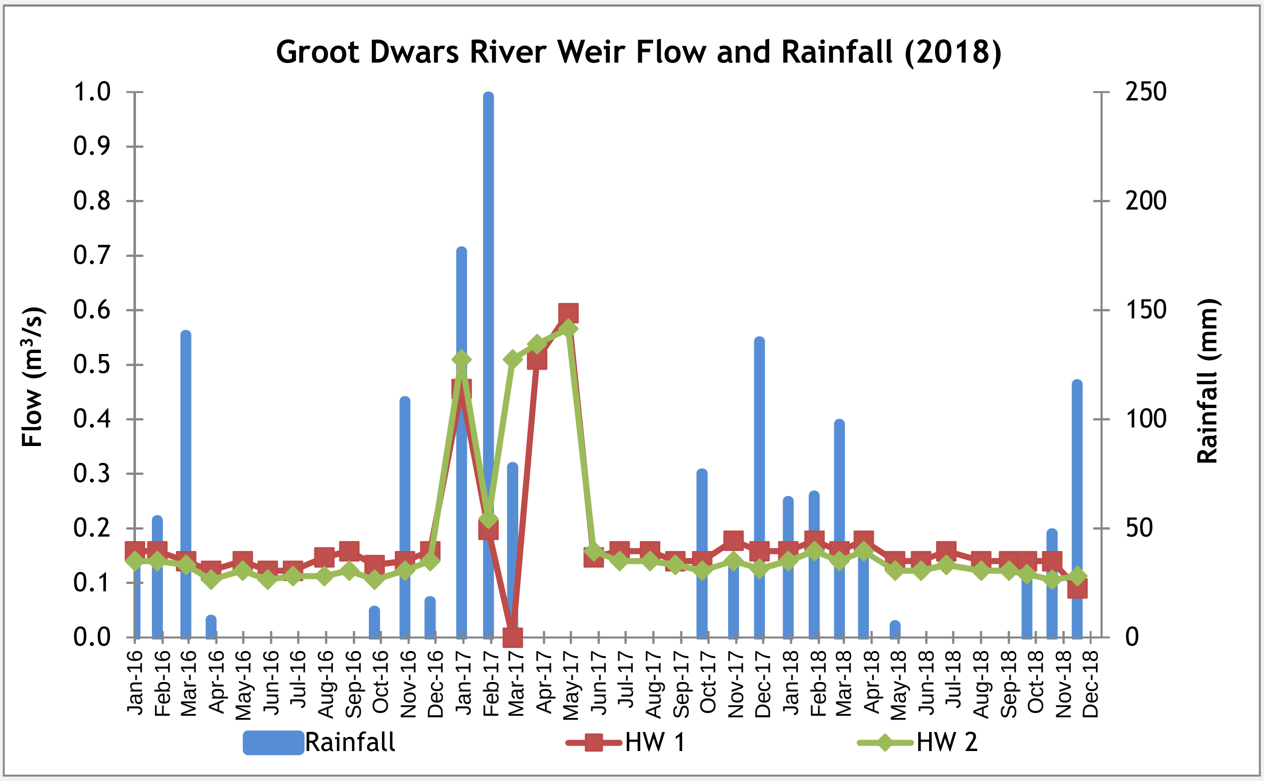
Natural river flow is measured at two monitoring weirs located up-stream (HW1) and downstream (HW2) on the Groot-Dwars River by taking a manual reading once a month[10]. The flow monitoring weirs have been installed to assess the impact on flow due to the Helena wellfield development for the Der Brochen Project which has not been yet been fully developed[11]. The weir locations are provided in Table 6-3 and presented in Figure 6-3. The trend graphs of the flow data, utilising the data reported by GCS in 2017 and 2018 are presented in Figure 6-1.

[10] The flow meters were equipped with automatic dataloggers but the system malfunctioned in late 2010 and re-instatement is deferred due to delays in the development of the Der Brochen mine. Flow meters are also established for the Richmond wellfield on the Klein-Dwars River but this is outside the scope of the proposed activities.
[11] Groundwater abstraction is currently limited to “pilot scale” of one borehole.

The average flow volume at the DWS B4H009 gauging station have similarly decreased from 65.6 Mm^3/a in 2017 to 11.6 Mm^3/a in 2018. A graph of the monthly and average flow volumes at the DWS B4H009 gauging station (obtained from the Delta-H Report, Delta-H, 2019) is included for reference in Figure 6-2. This point is located in the Dwars River downstream of the B41G catchment after the confluence with the Groot-Dwars and Klein-Dwars Rivers. Delta-H, 2019, noted that the average annual flow has increased in this weir over the last decade (2009-2018) with an average flow of 24 Mm^3/a compared to the annual longer term average (around 50 years) of 18 Mm^3/a, potentially due to influences from developments in the catchment.

Table 6-3: Positions of flow metering points

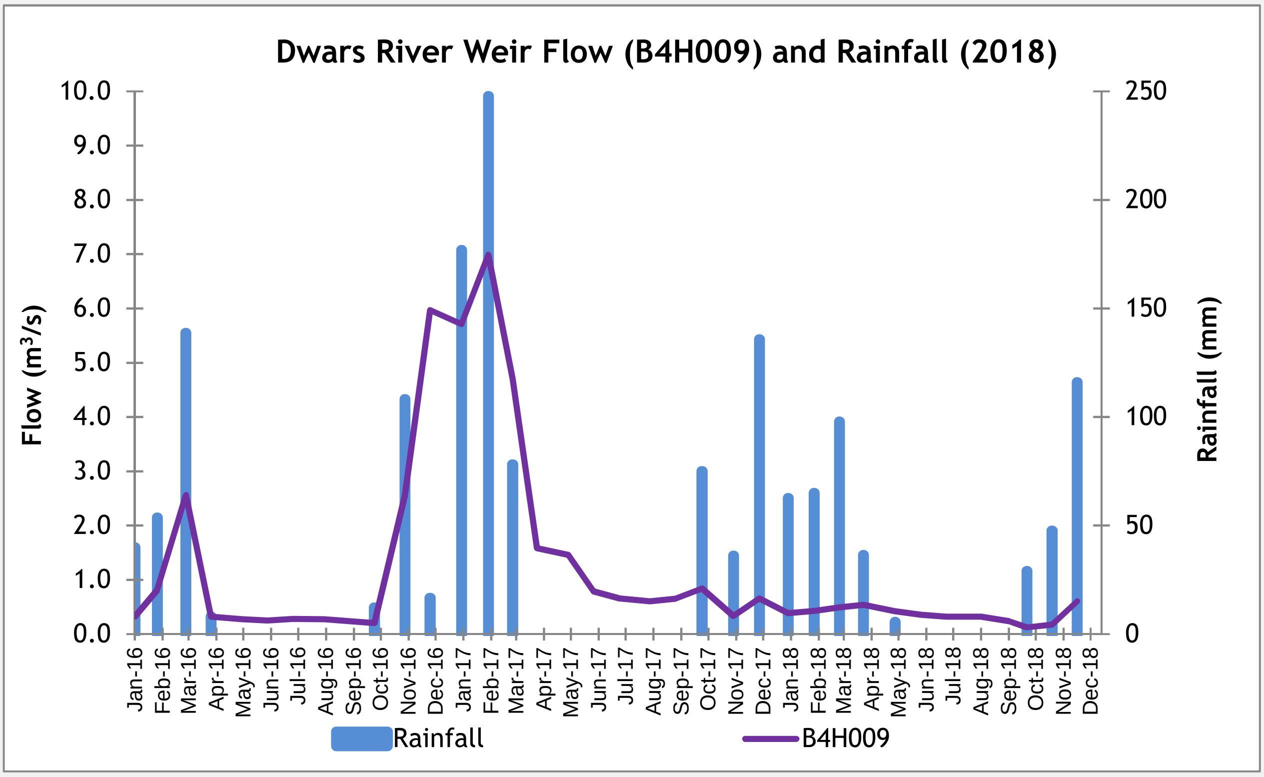
Site Name	River Name	Latitude (X co-ord)	Longitude (Y co-ord)	Site description (new points are indicated with date of initiation)
Groot-Dwars Catchment				
HW1	Groot-Dwars River	-25.04964	30.12057	Groot Dwars upstream at weir HW1 (but downstream of the Der Brochen Dam). Located Upstream of the Proposed Southern Portal Portal. Water quality monitoring is carried out at this point (G_Drs2)
HW2	Groot-Dwars River	-25.03126	30.12105	Weir HW2 (Flow data only). Located downstream of the Helena Wellfield as well as the proposed Southern Portal.
Dwars River (DWS monitoring station)				
B4H009	Dwars River	-24.91205	30.10327	DWS Gauging Station located after the confluence of the Groot-Dwars and Klein Dwars Rivers



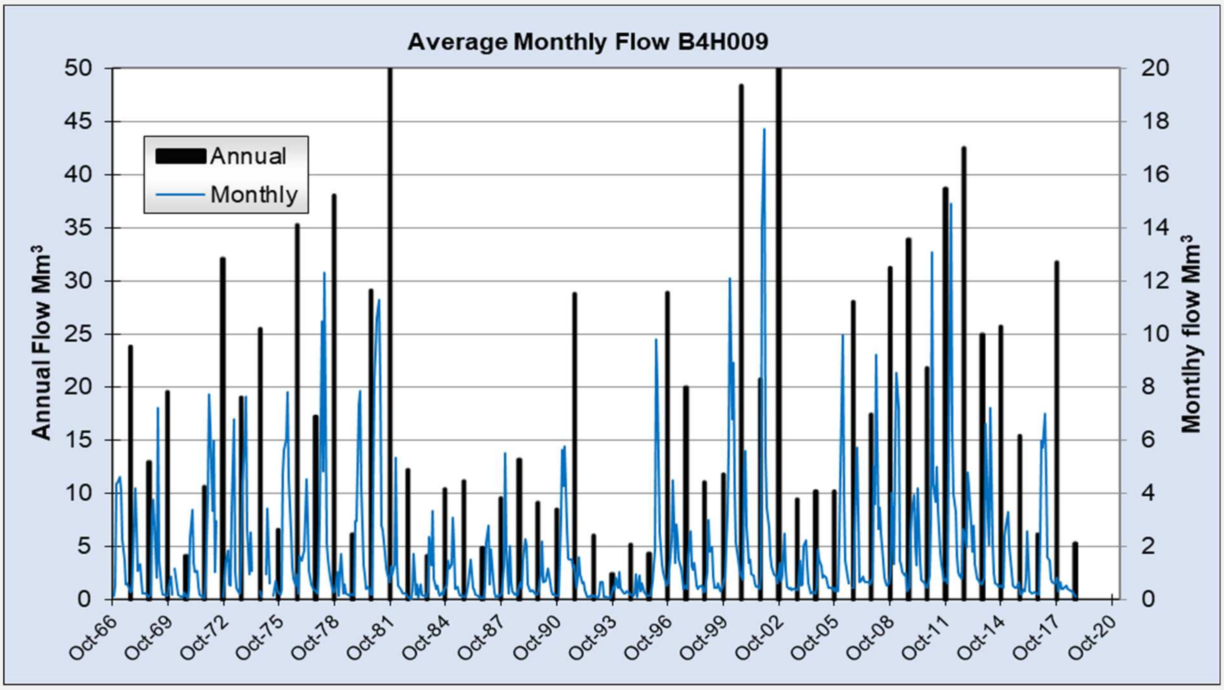
Manual flow measurements at HW1 and HW2 in the Groot Dwars River, database and template provided by GCS, 2019

srk consulting	**DER BROCHEN** METERED FLOWS IN GROOT-DWARS RIVER	Project No. 533247

Figure 6-1: Graphs of Flow at weirs in the Groot-Dwars River



Flow measurements at gauging station at B4H009, Dwars River. (Database and template provided by GCS, 2019 and from DWS website)



Monthly and annual measured flow volumes at gauging station B4H009, extracted from Delta-H, 2019

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Figure 6-2: Graphs of Flow at the DWS gauging station B4H009 .

6.3 Floodlines

The 1:50 and 1:100 year natural floodlines were previously determined for the Groot and Klein-Dwars Rivers and Mareesburg Stream, the main tributary of the Groot-Dwars River in the Der Brochen project area. There is a gap in the floodline data where the Groot-Dwars River turns east upstream of the confluence of the Mareesburg Stream. This section of the river was assessed by KP (Report DB-2018B-09-01, 2019) on the basis of the flood break scenario and is included in Figure 6-3 (yellow line). A raised floodline estimated around Der Brochen Dam also included in the figure.

The floodlines indicate the following:

- The proposed DMS stockpiles and PCDs will be located immediately adjacent to but outside the 1:50 and 1:100 year floodline of the Groot-Dwars. Similarly, the eastern edge of the DMS (Phase 3) is located outside of the floodline of the Mareesburg Stream, as indicated in Figure 6-3 below;
- The eastern boundary of the Southern Portal Investigation falls within the 1:50 and 1:100 year floodline and 100 m distance from the watercourse edge but the infrastructure has been designed to be located outside of this area;
- The Staff accommodation which is located west of Der Brochen Dam will be located outside the the 1:50 and 1:100 year floodline of the Der Brochen Dam;
- The remaining infrastructure will be developed within or immediately adjacent to the Mototolo Concentrator Plant located to the west of the Groot-Dwars River and outside the floodline extent. A small drainage line historically ran through this area to the Groot-Dwars River but is diverted upstream;
- The DMS conveyor crosses the Groot-Dwars River floodline to the north. Both the DMS and the ore conveyor are outside the floodline area elsewhere.

As noted by KP; following detailed design of potential crossings (pipeline, powerlines, conveyorsand roads), the floodlines for the post-development situation should be updated. This has particular relevance to the Southern portal and the DMS stockpile, which currently fall within the natural (pre-development) riparian zone.

6.4 Mean annual runoff

The Total Reserve determined for the upper reaches of the Dwars River prior to mining impact at the Ecological Water Requirement (EWR) Site 9 (Steelpoort River), located on the Steelpoort River downstream of the confluence with the Dwars River in the B41J catchment, is 26.4% of the Natural Mean Annual Runoff (NMAR) estimated as 137.5 Mm^3/month (GN 130, Gazette No. 41887, 07 September 2018).

Catchment areas within the Der Brochen Project area and the mean annual runoff (MAR) for each river in the current and proposed project areas are presented in Table 6-4.

Current loss of MAR due to containment of dirty water runoff at the existing concentrator, Helena TSF and the Mareesburg TSF (assumed full operational area) is included in the table but the planned activities that are likely to be commissioned are included for reference. The pre-authorised North Open Pit area has also been included for reference. The activities that are unlikely to be commissioned such as the Co-disposal dump and Southern Open Pit areas (refer Section 2-1) are excluded. The cumulative loss of MAR will increase due to development of the Der Brochen Project.

Table 6-4: NMAR (from WR90, Midgley, Pitman and Middleton, 1994) and loss of MAR due to rain water containment

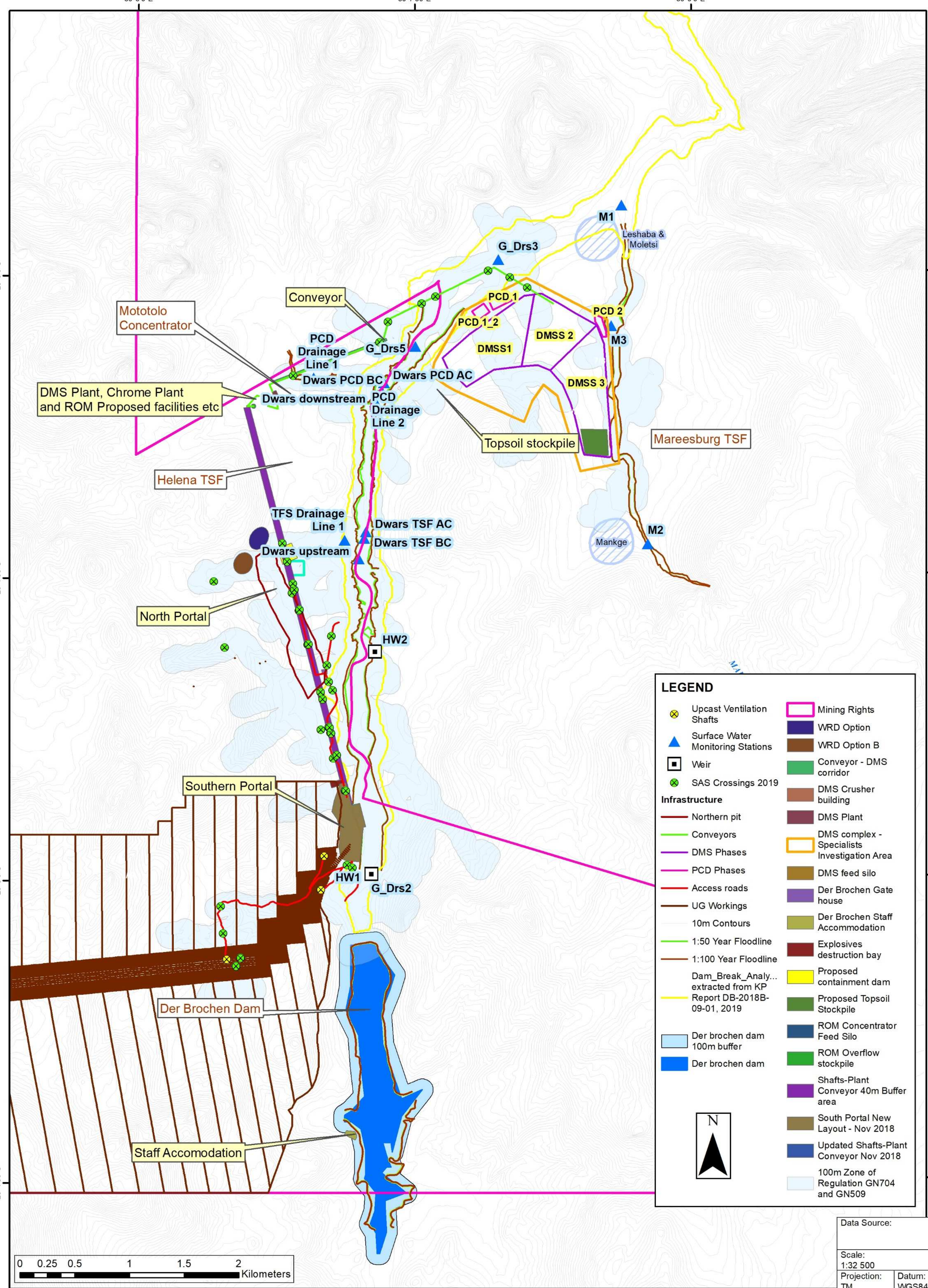
Catchment	Area (km^2)	MAR (Mm^3)	Infrastructure area (km^2)		Loss of MAR (%)
Existing Infrastructure					
Groot-Dwars River catchment	176.5	11.6	Mototolo Concentrator & St Helena TSF complex	0.79	0.45
Mareesburg catchment	31.9	2.1	Mareesburg TSF (larger area)	1.49	4.67
Proposed and Planned Infrastructure					
Groot-Dwars River (proposed)	176.5	11.6	South Portal, converyers, staff accomodation, DMS investigation area	1.54	0.87
Groot-Dwars River (planned)	176.5	11.6	North Pit	0.31	0.17
Mareesburg Catchment (proposed)	31.9	2.1	DMS Investigation area	0.63	1.99
Groot Dwars River Catchment Cumulative loss of MAR	176.5	11.6	Existing & proposed infrastructure	2.64	1.50
Mareesburg Catchment Cumulative loss of MAR	31.9	2.1	Existing & proposed infrastructure	2.12	6.66
Total B41G Quaternary Catchment	442	29.17	Existing & proposed infrastructure	4.77	1.08

*Area considers the larger Mareesburg TSF and previous existing infrastructure so loss of MAR is the maximum anticipated.
The DMS investigation area is used as a conservative estimate since it is larger than the individual stockpiles and PCD's.

The stormwater flowing off the DMS stockpile (including the Topsoil stockpile) and from the Southern portal will be contained in PCDs rather than allowed to flow downstream thus decreasing MAR. The proposed Southern portal will have a smaller loss of MAR than the southern open pit initially proposed (2014 application) but there will be an additional loss of MAR from the DMS area. The greatest loss of MAR is contributed by the Mareesburg TSF under construction.

Water from upstream of the portal and the DMS stockpile will be diverted around the infrastructure to ensure it remains clean and continues to contribute to the catchment. The proposed stormwater controls have been designed by KP and are included for reference in Section 8.

The cumulative loss of MAR to the B41G Quaternary Catchment is 1.1%. This loss is calculated due to containment of rainwater that falls on mine infrastructure, including the existing concentrator, Helena TSF and Mareesburg TSF (assuming full extent) and the propsed new infrastructure.



Data Source:	
Scale: 1:32 500	
Projection: TM	Datum: WGS84
Central Meridian/Zone: LO 31	
Date: 01/08/2019	Compiled by: SCHB
Project No. 533247	Fig No. 6-3

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DER BROCHEN

FLOODLINES AND MONITORING POINTS

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7 Surface water quality

Monthly surface water quality monitoring is undertaken in the Der Brochen project area by Groundwater Consulting Services (GCS). Additional information was provided by Delta-H, 2019 and GCS, 2019. The monitoring point locations are indicated in Table 7-1 with the relative locality of the monitoring points in the area of the proposed infrastructure indicated. G-Drs 5 is located at the upstream flow monitoring weir HW1. The downstream monitoring station (G-Drs3) is located in line with the proposed DMS stockpile. The position of the DWS monitoring station (B4H009) is indicated in Figure 7-1.

Three new surface water monitoring points (M1, M2 and M3) were included on the Mareesburg Stream in 2017, in compliance with the 2017 WUL, to monitor any impacts associated with current construction and future operation of the Mareesburg TSF. These are also located up and downstream of the proposed DMS Stockpile.

Table 7-1: Surface water monitoring points from south (upstream) to north (downstream) of the Der Brochen Project Area

Site Name	River Name	Latitude (X co-ord)	Longitude (Y co-ord)	Site description (new points are indicated with date of initiation)
Groot-Dwars Catchment				
G_Drs2	Groot-Dwars River	-25.04964	30.12057	Groot Dwars upstream at weir HW1 (but downstream of the Der Brochen Dam). Located Upstream of the Proposed Southern Portal.
Dwars upstream		-25.02360	30.11963	Surface water upstream of current operations and Helena TSF drainage line. (West of North Open Pit and downstream of HW2)
TSF Drainage Line 1	TSF Drainage line	-25.02206	30.11835	Downstream (south) of the Helena TSF along the Der Brochen access road; initiated June 2015. Drainage line is located to the north of the planned North Open Pit.
Dwars upstream TSF BC	Groot-Dwars River	-25.02192	30.12013	Surface water upstream of TSF drainage line; initiated October 2016
Dwars downstream TSF AC		-25.02137	30.12029	Surface water downstream of TSF drainage line; initiated October 2016
Dwars downstream		-25.01064	30.12122	Surface water downstream of existing operations (Helena TSF etc) but upstream of PCD drainage line at the Mototolo Concentrator
PCD Drainage Line 1	PCD Drainage Line	-25.00864	30.11565	Surface water drainage line downgradient of the existing PCD at the Mototolo Concentrator; initiated June 2015
PCD Drainage Line 2		-25.00888	30.12093	Surface water drainage line downgradient of the existing PCD at the Mototolo Concentrator; initiated June 2015.
Dwars upstream PCD	Groot-Dwars River	-25.00998	30.12193	Surface water upstream of PCD drainage line; initiated October 2016. (Upstream of the Mototolo Concentrator activities)
Dwars downstream PCD AC		-25.00907	30.12201	Surface water downstream of PCD drainage line; initiated October 2016. (Downstream of the Mototolo Concentrator activities)
G_Drs5		-25.00608	30.12488	Groot Dwars River downstream of the Mototolo Concentrator. (Immediately downstream of proposed Topsoil stockpile but pstream of proposed DMS stockpile and the proposed PCD's)
G_Drs3		-24.99895	30.13244	Downstream of G_Drs5 before the confluence of the Groot Dwars River and the Mareesburg Stream. (Located adjacent to the proposed DMS stockpile)
G_Drs4		-24.96257	30.13767	Groot Dwars about 5.2 km downstream of confluence with the Mareesburg Stream
Mareesburg Catchment				
M1	Mareesburg Stream	-24.99450	30.14362	Mareesburg Stream before the confluence with the Groot Dwars River. Downstream of the Mareesburg TSF.
M3		-25.00446	30.14262	Immediately downstream of the Mareesburg TSF and RWD, within the Mareesburg Stream. (Adjacent to the proposed PCD2 for Phase 3 of the DMS Stockpile)
M2		-25.02252	30.14583	Upstream of the Mareesburg TSF and RWD, within the Mareesburg Stream. (Also located upstream of the proposed DMS Stockpile)
Dwars River (DWS monitoring station)				
B4H009	Dwars River	-24.91205	30.10327	DWS Monitoring Station located after the confluence of the Groot-Dwars and Klein Dwars Rivers

Note: Monitoring positions on the Klein-Dwars River are excluded from the above table as the proposed activities are located within the Groot-Dwars and Mareesburg Stream catchments

7.1 Water quality guidelines and limits

Water quality monitoring data are compared to the WUL quality limits, SAWQG (DWAF, 1996) for general fitness for use and SANS241:2015 to assess potential health impacts if the water were to be used for drinking purposes.

The quality component of the EcoSpecs provided for EWR Site 9, located on the Steelpoort River downstream of the confluence with the Dwars River, as provided in the reserve determination for the water resources for the Olifants and Letaba Catchments (Government Gazette No 41887, No 932, 2018), is included for comparison. These limits are presented together with the median and 95th percentile of the surface water quality data obtained in Table 7-2.

7.2 Pre-mining quality data

The pre-mining baseline water quality data is extracted from the IWWMP Report, (SRK 527471, 2018). The pre-mining surface water quality was determined through sampling at various locations along the the Groot Dwars River. The general water quality profile in the site area, obtained during surveys in 2001 and 2002, was described as very good with pristine conditions prevailing. The water is suited for all uses if compared against the SAWQG (DWAF, 1996) and the SANS 241, 2015 for drinking water (excluding bacterial content). The water quality profile also revealed limited temporal variation over these periods (Eco-Risk and ERM, March 2006).

7.3 Long term and current data

The water quality upstream of mine activities in the Groot-Dwars River,as represented by the water quality at the monitoring points G_Drs2 and Dwars Upstream (u/s), remains of good quality with all concentrations Reportedly below the guidelines and limits used for comparison.

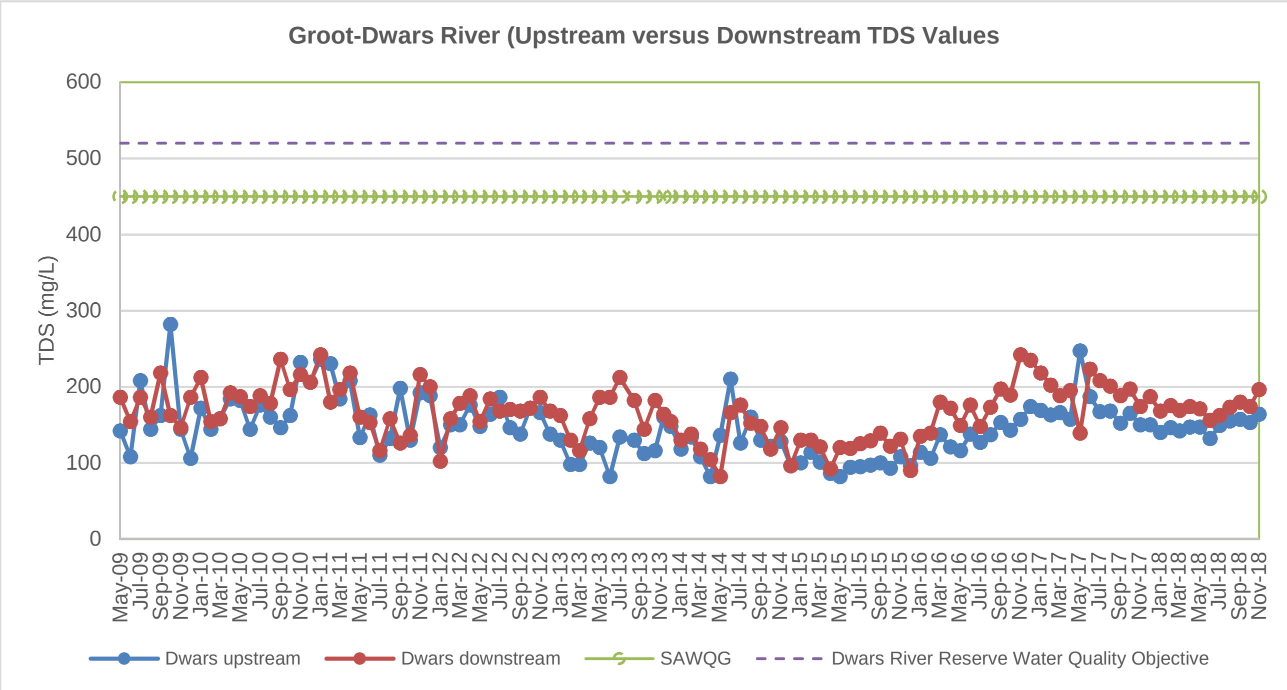
The water quality upstream of the Mareesburg TSF, represented by the water quality at the monitoring point M3, comprises naturally higher concentrations of calcium magnesium and alkalinity. Whilst concentrations of calcium (95th percentile) are elevated above the WUL limit; these concentrations are well below the SANS 241-2015 and EWR 9 PEC and REC concentrations. The calcium/magnesium dominance for the cations is most likely due to the underlying geology with magnesium and calcium rich gabbroic norites (Delta-H, 2019). Due to the low concentrations observed in the rivers, and based on the selected analyses considered, these concentrations are unlikely to represent a risk to water users.

The long term trends are presented in the Annual Water Quality Report submitted to DWS in March/April each year (GCS, 2018) and the median and 95th percentile data provided in Table 7-2 below. The data range is also provide in the table. Total dissolved solids (TDS), as a general indicator of overall water quality, has been assessed over the long term (May 2009 – November 2018) for the existing operations. The long term trend for TDS is provided in Figure 7-1. The spatial trend for total dissolved solids (TDS) along the Groot-Dwars River up and downstream of the proposed and existing operations is presented in Figure 7-2.

The assessment of the annual median water quality for 2018 against the WUL limits provided similar observations to thosse noted in 2017 as follows:

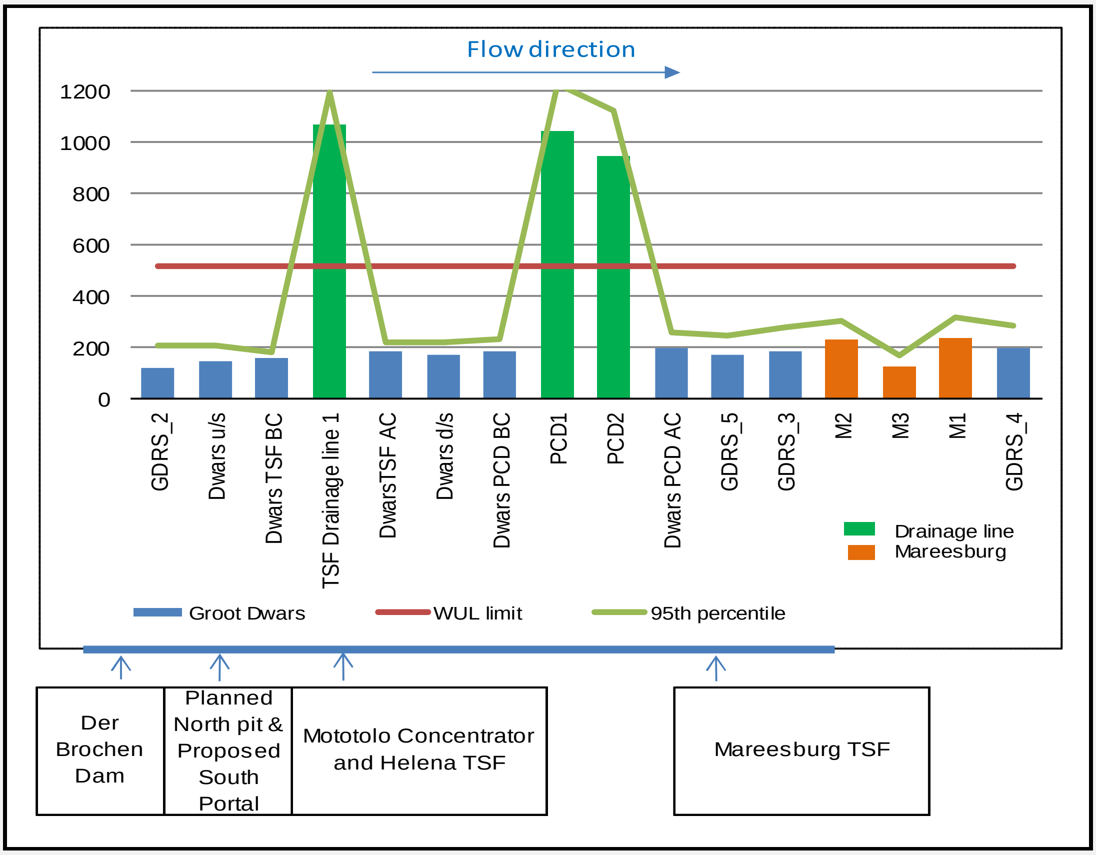
- Calcium, and occasionally magnesium, concentrations are naturally elevated above the WUL limit for calcium and magnesium of 25 mg/l but the 95th percentile data does not exceed the EWR 9 concentrations of 80 mg/l for calcium and 70 mg/l for magnesium.
- Sodium (95th percentile) concentrations exceed the WUL limit of 9 mg/l in the Mareesburg Stream (M2 and M3) and in the Groot-Dwars river following the confluence of the TSF Drainage line (Dwars River TSF AC, Dwars River Downstream (d/s), Dwars River PCD BC, G_Drs 5, G_Drs_3 and G_Drs4).
- Elevated concentrations were observed locally in the drainage lines downgrade of the the Mototolo Concentrator (PCD Drainage line 1 and 2) and the Helena TSF (TSF Drainage Line 1) which, although not included in Table 7-2, comprise higher concentrations of salinity (TDS of around 1 110 mg/l) due to elevated concentrations of sodium, chloride, sulfate, and nitrate. The low flows of the tributaries are largely assimilated into the Groot Dwars River but it is noted that salinity is slightly higher after the respective confluences (95th percentile for TDS of <210 mg/l at Dwars u/s compared to around 280 mg/l as G_Drs3). This is presented by the TDS profile along the river in Figure 7-2.

Delta-H, 2019, sourced data from the DWS gauging station B4H009 located on the Dwars River downstream of the confluence of the Groot-Dwars and Klein-Dwars rivers. Delta H stated that: "The deterioration of water quality observed at the DWS B4H009 gauging and water quality monitoring station downstream of the B41G catchment can be attributed to a number of mining related sources within the catchment. Both nitrate and sulfate are associated with contaminants emanating from mine residue deposits, PCDs and other process water facilities, which also tend to increase chloride (evaporative and/or the discharge of deeper mine water). The long-term trend for nitrate, sulfate and chloride, supplied by Delta H, are included in Figure 7-3 for reference.



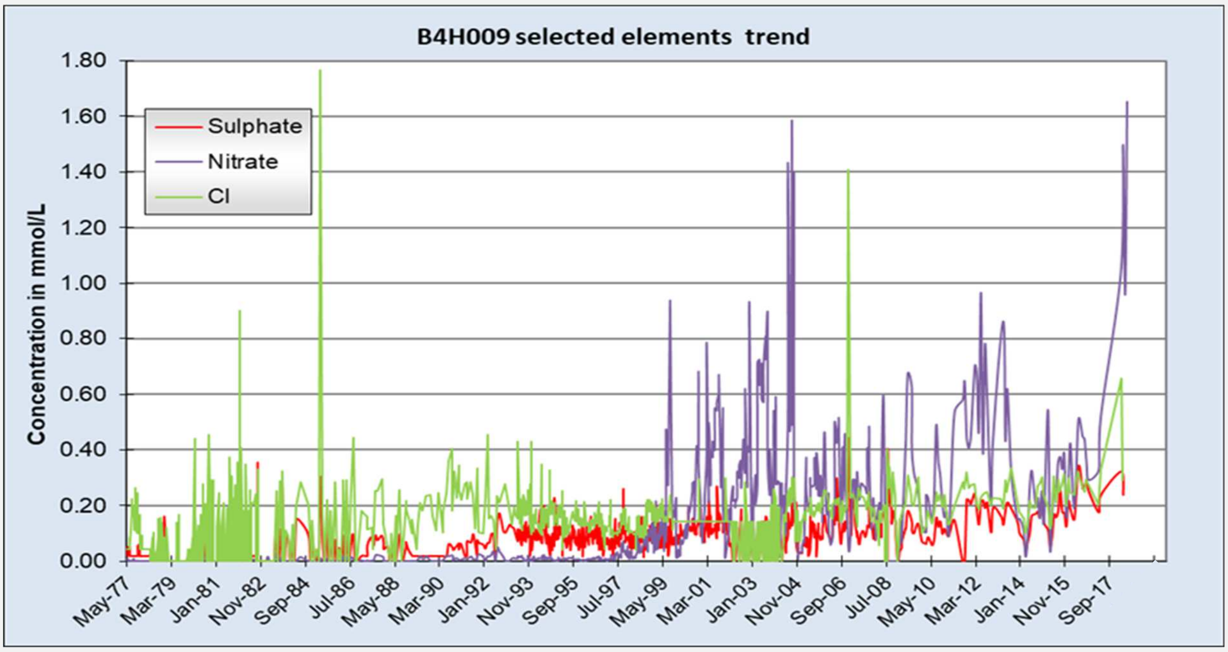
srk consulting	**DER BROCHEN** LONG TERM TREND FOR TDS UP- AND DOWNSTREAM OF CURRENT ACTIVITIES	Project No. 533247

Figure 7-1: Long term trend for TDS up and downstream of current activities (Mototolo Concentrator)



srk consulting	**DER BROCHEN** SPATIAL TREND FOR MEAN TDS IN MG/L ALONG THE GROOT-DWARS RIVER	Project No. 533247

Figure 7-2: Spatial trend for the median and 95th percentile of TDS in mg/l along the Groot-Dwars River



srk consulting	**DER BROCHEN** LONG TERM TREND FOR NITRATE, SULFATE AND CHLORIDE DOWNSTREAM OF THE B41G CATCHMENT	Project No. 533247

Figure 7-3: Long term trend for nitrate, sulfate and chloride at B4H009 downstream of the B41G catchment, graph extracted from Delta h, 2019

Table 7-2: Surface water quality for the Groot Dwars and Mareesburg Stream

Analytical Variable (mg/L unless specified)	Limits and Guidelines				Mareesburg Stream						From upstream (left) to downstream (right) along the Groot-Dwars River																	
	SAWQG Target Values	SANS 241-2015	EWR 9 Steelpoort EcoSpec: PES and REC	WUL Limit (Appendix V, 5.1, Table 7)	M3		M2		M1		G_Drs 2		Dwars River u/s		Dwars River TSF BC		Dwars River TSF AC		Dwars River D/s		Dwars River PCD BC		Dwars River PCD AC		G_Drs 5		G-Drs 3		G-Drs 4	
					Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th	Median	95th
					Dec16- Dec18		Dec16-Dec18		Feb07-Dec18		Feb07-Dec18		May09-Dec18		Sep16- Nov18		Sep16-Nov18		May09-Dec18		Sep16-Nov18		Sep16-Nov18		Jun09-Dec18		Feb07-Dec18		Feb07-Dec18	
pH Value @ 20°C	6.0-9.0	5.0-9.7	5 to 10*	5 - 9.5	8.3	8.6	8.4	8.7	8.3	8.7	8.0	8.4	8.2	8.5	8.3	8.5	8.3	8.6	8.1	8.5	8.3	8.6	8.3	8.6	8.2	8.6	8.1	8.5	8.2	8.6
Conductivity mS/m @ 25°C	70	170	≤ 85 mg/L	NLG	20	30	39	49	35	52	18	23	21	28	24	27	26	33	25	32	26	36	27	39	25	35	27	39	29	42
Total Dissolved Solids	450	NLG	NLG	520	125	168	230	305	240	317	124	206	144	209	161	182	189	222	170	218	185	232	196	259	174	246	188	278	199	286
Calcium, Ca	32	NLG	≤ 80 mg/L	25	19	26	31	40	26	**37**	18	23	21	26	25	27	29	34	25	31	28	37	29	40	25	32	26	36	26	35
Magnesium, Mg	30	NLG	≤ 70 mg/L	25	16	22	**39**	**52**	28	51	11	14	13	16	14	16	16	19	15	18	16	20	17	22	15	20	16	22	19	29
Sodium, Na	100	200	≤ 115 mg/L	9	6	8	9	11	8	12	5	7	6	9	6	7	7	10	7	10	7	10	8	12	7	12	7	12	7	12
Potassium, K	50	NLG	NLG	46.0	0.6	1.5	0.7	1.6	0.5	1.6	0.7	2.1	0.8	1.8	1.0	2.1	1.0	1.7	0.8	1.9	0.9	1.4	1.0	1.8	0.7	1.7	0.8	1.7	0.7	1.7
Total Alkalinity as $CaCO_3$	NS	NLG	NLG	NLG	121	164	225	294	180	281	92	121	106	138	121	136	127	141	112	146	129	144	129	149	114	148	117	152	133	185
Chloride, Cl	100	300	≤ 175 mg/L	62	4	6	6	8	5	10	3	7	3	7	4	6	7	11	5	9	6	11	7	14	6	14	6	15	6	14
Sulfate, SO_4	200	500	≤ 250 mg/L	70	4	8	9	14	9	17	4	8	6	14	7	13	19	34	13	25	15	30	20	47	14	29	14	31	12	29
Nitrate as N	6.0	11.0	< 4 mg/L of TIN**	6.0	0.3	1.1	0.4	1.2	0.4	1.6	0.4	1.2	0.5	1.6	0.5	1.0	0.5	1.0	0.5	1.3	0.5	0.9	0.6	1.1	0.5	1.9	1.4	5.2	1.0	4.3
Fluoride, F	1.0	1.5	≤ 3.52 mg/L	NLG	0.3	0.3	0.3	0.3	0.2	0.7	0.1	0.4	0.1	0.6	0.3	0.3	BD	0.2	0.1	0.7	0.3	0.3	BD	BD	0.1	0.5	0.1	0.6	0.1	0.6
Chemical Oxygen Demand		NLG	NLG	NLG	25	77	27	69	24	79	20	62	42	60					48	72					25	71	22	72	26	67
Suspended Solids	NLG	NLG	NLG	NLG	8	30	14	29	10	55	8	31	5	16					6	41					9	63	9	46	9	111
Iron	0.1	NLG	NLG	NLG	0.05	0.1	0.02	0.02	0.15	0.52	0.07	0.3	0.08	0.2					0.08	0.2					0.08	0.2	0.08	0.3	0.1	0.3
Managenese	0.05	NLG	NLG	NLG									0.01	0.08	0.01	0.01			0.01	0.04			BD	BD						

Shaded: exceeds WUL **Bold:** exceeds SANS241:2015 **Red:** exceeds EWR 9 (none) **NGL:** No limit given **BD:** Below detection **Blank cells**: No data

NOTE: The Steelpoort River Ecological Water Requirement (EWR) (Olifants EWR9 – Steelpoort) EcoSpec: PES and REC limits are based on the 95th percentile for all except pH which the range is indicated as between the 5th to 95th percentiles and nitrate where the EWR is provided for 50% percentile of TIN (Total Inorganic Nitrogen)

Data Sourced from emailed information provided by email from GCS (2019).

8 Water management structures

This information was extracted from KP Report DB-2018 B-09-01, 2019 (referred hereafter as KP Report, 2019). Additional information was obtained from Redco, 2018 and AAP, Nov 2018.

The natural topography at **South Portal** is quite steep as the shaft location is at the base of a mountain on the western side and the Groot-Dwars River on the eastern side. Waste rock will be used to create a level platform for shaft infrastructure and will be structured to locate all shaft infrastructure outside the 100-year flood line. The dams, Trackless Mobile Machinery (TMM) parking, storage yards and silt traps are planned on the first terrace which, although outside the 1:100 year floodline, will be within 100 m of the Groot Dwars River and the Zone of Influence (ZOI) of the Dam Break Analysis. The zone of influence was determined for a combined break of Der Brochen Dam and Booysendal TSF (KP, 2019).

The haul road and conveyor corridor running from South shaft, past the North Open Pit to the concentrator will also accommodate overland piping (raw water and excess mine water pipelines), electrical overhead line and stormwater channel. A section of the stormwater channel will be incorporated into the existing clean water diversion at the Helena TSF. The pipelines will be supported by means of concrete plinths and guides. The haul road will remain in place as a services road once the conveyor is constructed.

The DMS Stockpile is located south of the Groot-Dwars River and to the west of the Mareesburg Spruit. The PCDs are located downslope of the DMS stockpile and, although outside the 1:100 year floodline and/or ZOI of the Dam Break Analysis, PCD 2 will be within the 100 m of the Mareesburg Spruit.

Separation of clean and dirty water areas must take place in line with the requirements of Regulation 704. The proposed stormwater management systems at the shafts cater for both clean and dirty water where “clean” areas include the offices and public parking areas.

The design specifications for the water management structures were provided by KP and are summarised in the various areas in the Figures below which include:

- DMS Stockpile area (Figure 8-1 and 8-2);
- DMS Plant and ROM Stockpile (Figure 8-3);
- South Portal (Figure 8-4).

The following are specified by KP for all the relevant structures:

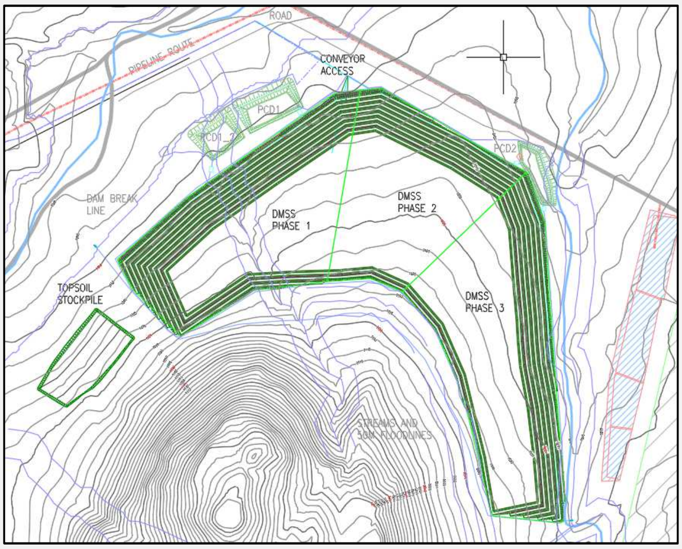
- The diversion channels are all to be lined with 100 mm grouted stone pitching (DMS area);
- Based on the available information, KP have assessed that the the channels should have sufficient freeboard according to the SANRAL Drainage Manual (SANRAL, 2013), and gabions where the velocities are above 2 m/s. The slopes and gabion detail should be confirmed following a detailed survey of the area. KP notes that the velocities are based on the average slope between the start elevation and the end elevation, therefore incorporating gabion structures will reduce the velocities and therefore the proposed 100 mm grouted stone pitching is regarded as sufficient. The slopes and gabion detail should be confirmed following a detailed survey of the area. If portions of the channels, still have high velocities after the detail survey has been applied, the 100 mm thickness could be increased where required;”
- Drawings of typical structures are provided by KP in Figure 8-5.

The following additional information is provided from AAP, Nov 2018:

- A cut-off drain (clean water diversion) has been allowed for at both shafts to divert clean stormwater back into the Groot-Dwars River. A series of stormwater channels have been allowed for on the terrace to divert clean stormwater to the river.
- Clean water upstream of the plant area will be directed around the perimeter into the natural streams by means of cut off earth berms and/or trenches. The site drainage will be designed for a 1 in 50 year Recurrence Interval and 24 hour event (AAP, Nov 2018).
- Dirty stormwater will be collected in concrete lined (AAP, Nov 2018) channels located in strategic places inside the shaft area. The dirty stormwater channels will drain to the settling pond from where the settled water will flow to the mine services water dam. The general layout of the stormwater systems at the South Portal is discussed below. Stormwater collected from concrete

bunded areas will be discharged into oil separators. The treated water will then be discharged into the dirty water dam system for reuse as process water (AAP, Nov 2018).

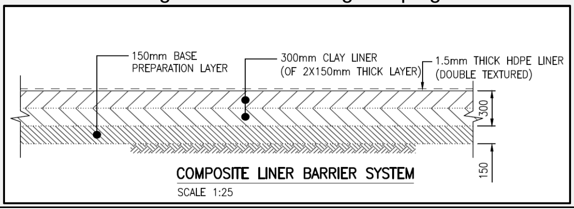
- The PCD design is based on a 1:50-year flood event with a spillway to allow for a storm greater than a 1:50-year flood event to spill over into the river. The spillway will be constructed with energy dissipaters to prevent erosion during overflows. The PCD barge pump will be set to start pumping when the dam level reaches 20%. The pumps have been designed to empty a full PCD within 24 hours. A standby pump will also be available.
- Both the mine services water dams and PCDs will be lined with 2 mm HDPE lining (although this is indicated by KP in Figure as 1.5 mm as this is based on the preliminary design). The mine services water dam will receive water ingress from underground and surface water run-off. The PCD will only receive water from the mine services water dam when the mine service water dam reaches capacity. This will typically only happen during a major storm event. The management principle of the PCD should follow that this be empty at all times to accommodate up to a 1:50-year flood event.
- Stormwater collected from concrete bunded areas will be discharged into oil separators. The water will then be discharged into the dirty water ponds for reuse as process water.



Layout of the DMSS (Refer Figure 6-4 KP Report, 2019)

DMS Stockpile was designed to be underlain by a Barrier system that is equivalent to a Class C type barrier system. KP provided a proposed system that includes:

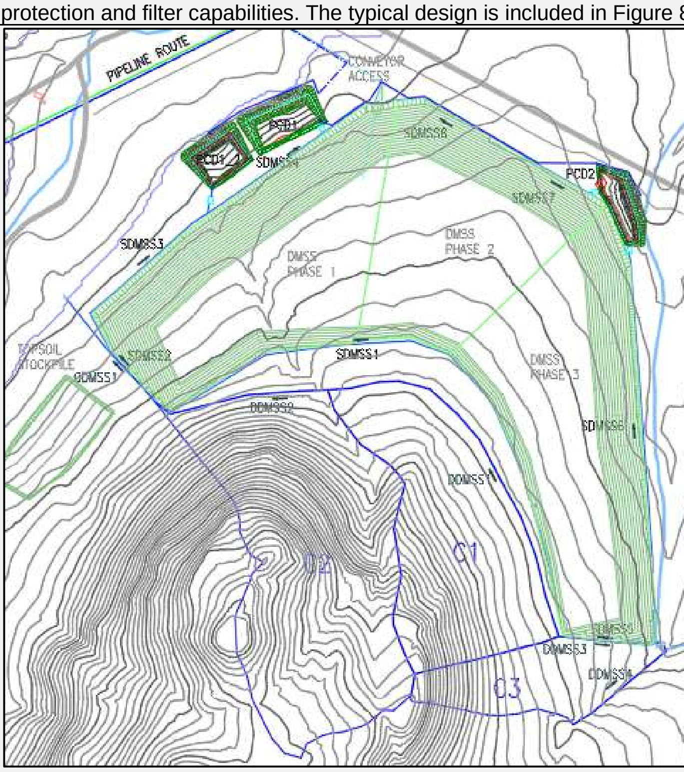
- Re-worked in-situ clay to provide an equivalent 300 mm clay layer for the low permeability soil liner. If clay is not available, alternative sealing materials such as geosynthetic clay liners (GCL's) will have to be incorporated
- A 300mm thick protection cover over the liner is proposed. KP note that this could be constructed from Mareesburg tailings or geofabric with equivalent performance. The stability analysis will be affected by replacing a sand layer with tailings material,
- 500mm cover of DMS discard to be placed by truck to avoid damage to the liner during dumping.



Proposed barrier system (Refer Figure 6-16, KP Report, 2019

As quoted from KP Report, 2019: A drainage system will be provided at the downstream end of the stockpile, just before the starter wall, to intercept any water flowing down the liner. The calculation showed that the expected volumes are relatively low and a single 160 mm slotted corrugated pipe would be sufficient.

Typically, the drain will have to be covered by a filter system consisting of 300 mm of 19 mm stone, 200 mm of 6 mm stone, 300 mm of filter sand and a geofabric protection layer on top of the sand. The DMS material is expected to have a grading ranging between 2 and 20 mm, which is similar to the filter system, therefore it is proposed to place 300 mm of 19 mm stone around the pipe and then place DMS material on top of the 19 mm stone. The 19 mm stone layer is recommended to prevent the finer DMS material from entering the openings of the slotted HDPE pipe.Tailings from Mareesburg and DMS material need to be tested to determine the protection and filter capabilities. The typical design is included in Figure 8-4 below.



DMS Diversion Channels (Refer Figure 6-23 of KP Report, 2019)

Diversion channels will be provided upstream of the DMS Stockpile to divert stormwater around the Stockpile, while solution channels will be provided around the Stockpile to catch side slope run-off and seepage water from the under-drainage system for containment in the PCDs..

Diversion Channels

Parameter	Unit	DDMS S1	DDMS S2	ODM SS1	DDM SS3	DDM SS4
Catchment	-	C1	C2	C2	C3	C3
Channel Length	m	1 064	428	425	290	325
Channel Slope	1:H	212.8	42.8	12.1	10.4	10.8
Average velocity, V	m/s	1.16	2.76	4.4	3.35	3.28
Channel capacity Q	m^3/s	2.41	6.95	6.9	1.99	1.95
Required Capacity	m^3/s	2.30	6.83	6.8	1.89	1.89
Channel Depth proposed	m	1	1.2	1	0.5	0.5
Gabion structures required	-	0	10	35	28	30

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Figure 8-1: Water Management structures at the DMS Stockpile, extracted from KP Report, 2019

PCD's

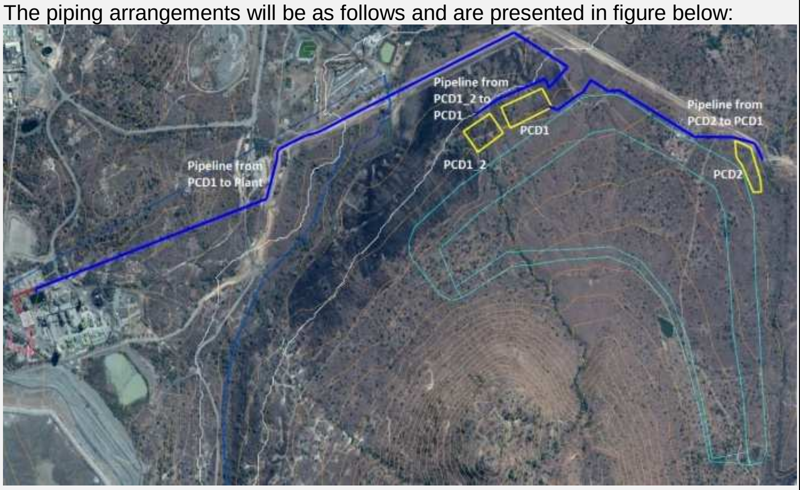
A PCD of approximately 96 000 m[3] is required where three compartments are envisaged due to the limited space where construction can also be phased as for the DMS Stockpile. None of the PCD's will have a storage capacity exceeding 50 000 m³ and although their walls will be higher than 5 m, the dams will not require an Approved Professional Person (APP) appointment. The PCD volume requirements are included in the table below.

- A typical double liner and leak detection system is proposed by KP (Refer to Figure 8-4 below).
- The PCD's will be provided with an emergency spillway and have 800 mm freeboard.
- PCD1 will be constructed with DMS Stockpile Phase 1 and PCD2 when DMSS3 is implemented.
- PCD1 will be pumping back to the PCD at the plant (Mototolo Concentrator area).
- PCD2 and PCD1_2 will pump to PCD1.
- PCD1_2 will also be provided with an overflow channel into PCD1

Volume requirements, pump and pipelines (refer Table 6-6 and 6-7 of KP Report, 2019)

PCD Name	Volume Required (m³)	Final Volume (m³)	Typical Pump Type	Power required (kW)	Nominal flow (m³/h)	Nominal / Static head (m)	Pipe Type / Diameter(mm) / Length (m)
PCD1	42 000	42 633	MegaCPK 250-200-500	110	396	72.5 / 52	HDPE lined steel / 250 / 2 691
PCD2	48 000	20 663	Etanorm 200-150-315	37	396	23 / 15	HDPE lined steel / 200 / 1 046
PCD1_2		32 835	Etanorm 150-125-200	11	216	12 / 3	HDPE / 125 / 367

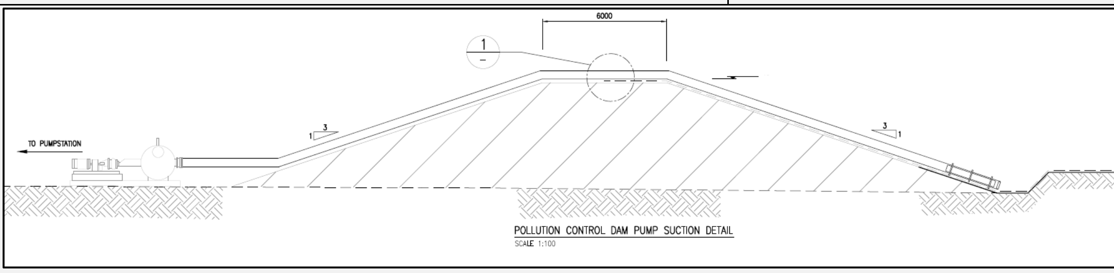
The PCD's could be provided with a self-priming pump and pipeline back to either the Return Water Dam at the Helena TSF or the PCD at the plant; alternatively a barge pump system could be used as discussed for the PCD's.
The piping arrangements will be as follows and are presented in figure below:



Piping arrangements (Refer Figure 6-25 of KP Report, 2019, 2019)

Silt trap: PCD's will be provided with a double compartment silt trap to catch silt from the solution trenches. The two-compartment silt traps will allow for one compartment to be on standby for cleaning. The standby compartment can be left to dry and cleaned out by TLB or similar equipment. Maintenance of these traps is the key factor to efficient operation. Refer Figure 8-7 for a plan view of the Siltl trap. The sizes of . the silt traps are presented below

Parameter	Unit	DMSS PCD1	DMSS PCD1_2	DMSS PCD2
Length	m	11	8	19
Width (one compartment)	m	6	4	4
Total Area	m²	321	208	475



Schematic section showing the Pump suction detail, Refer Figure 6-24 of KP Report, 2019)

Diversions and Solution Trenches

Parameter	Unit	Diversion Channels					Solution Trenches							
							Bottom					Top and sides		
		DDMS S1	DDMS S2	ODMS S1	DDMS S3	DDMS S4	SDMS S3	SDMSS 4	SDMSS6	SDMS S7	SDMS S8	SDMS S1	SDMS S2	SDMS S5
Catchment		C1	C2	C2	C3	C3								
Channel Length	m	1 064	428	425	290	325	538	394	1 163	260	615	1 582	304	334
Channel Slope	1:H	212.8	42.8	12.1	10.4	10.8	119.6	131.3	72.7	32.5	41.0	121.7	11.3	12.8
Average velocity, V	m/s	1.16	2.76	4.4	3.35	3.28	0.75	0.94	1.12	0.95	1.10	0.55	1.20	1.12
Channel capacity Q	m3/s	2.41	6.95	6.9	1.99	1.95	0.22	0.56	0.49	0.11	0.23	0.08	0.08	0.08
Required Capacity	m3/s	2.30	6.83	6.8	1.89	1.89	0.21	0.42	0.40	0.08	0.22	0.06	0.06	0.01
Channel Depth proposed	m	1	1.2	1	0.5	0.5	0.3	0.5	0.5	0.2	0.3	0.2	0.2	0.2
Gabion structures required	-	0	10	35	28	30	0	0	0	0	0	0	0	0

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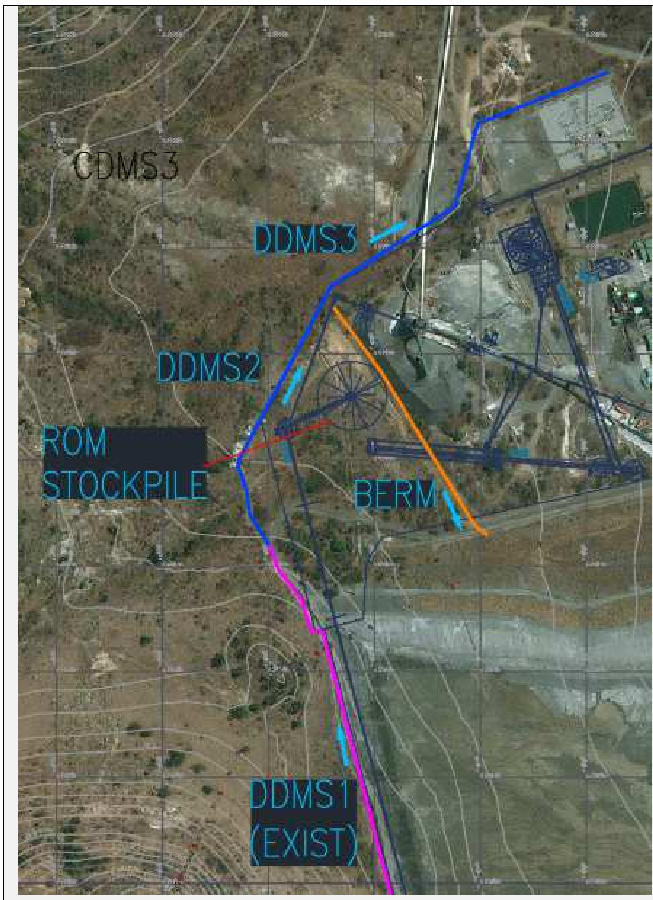
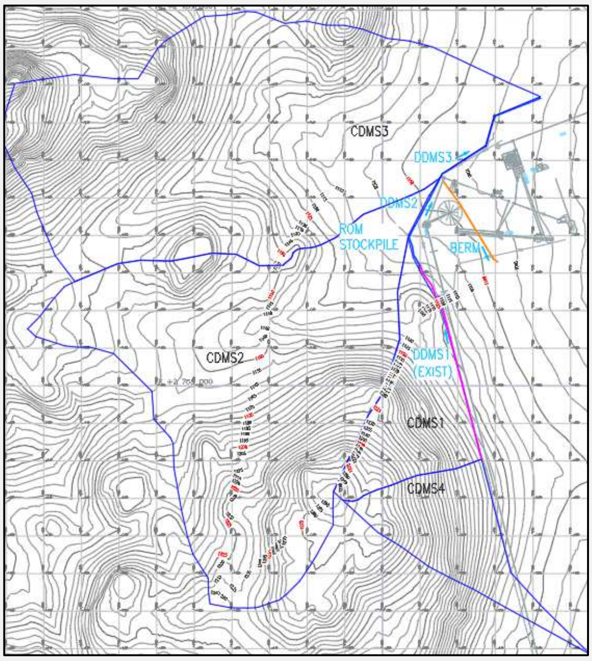
Figure 8-2: Water Management structures at the DMS Stockpile PCD's, extracted from KP Report, 2019



Concentrator Area Layout (refer Figure 7-1, KP Report, 2019)



DMS Plant Area catchments (100 m grid, 5 m contours) (after Figure 7-2 in KP Report, 2019)

Additional diversion structures are required in the area where the new ROM stockpile will be placed (refer Figure 7 1 of KP Report, 2019 included above for reference). Helena TSF already has diversion channels on its upstream side. The following additional stormwater management measures are recommended by KP:

- Connect the existing Helena TSF clean water diversion channel (DDMS1) into the proposed clean water channel (DDMS2).
- Provide a new channel (DDMS3) from the corner of the proposed DMS Plant area to the north of the Eskom yard, from where it can be released through necessary erosion control structures. The exact alignment will be governed by the contours.
- Sufficient erosion control and energy dissipaters will be provided in the channels
- Provide a 300 mm diversion berm to direct the small volume of surface run-off of the ROM Stockpile area to the existing dirty water channel.
- Similarly, to the diversion channels at the DMS Stockpile, the diversion channels will be lined with 100 mm grouted stone pitching.

The following diversion channels are provided for reference but no further action will be required for them due to the existing SWM controls at the Mototolo Concentrator.

Diversion Channels (Refer Table 7-1 of KP Report, 2019)

Parameter	Unit	DDMS1	DDMS4	DDMS5
Catchment	-	CDMS1	CDMS2	CDMS2
Channel Length	m	661	117	246
Channel Slope	1:H	17.4	23.4	492.0
Average velocity, V	m/s	2.78	3.56	1.14
Channel capacity Q	m^3/s	2.00	7.87	7.83
Required Capacity	m^3/s	1.88	7.78	7.78
Channel Depth proposed	m	0.6	1.2	2
Gabion structures required	-	-	5	0

A PCD is not required as water can be managed within the existing stormwater management controls at the Mototolo Concentrator and Helena TSF.

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Figure 8-3: Water Management structures for the DMS plant and ROM stockpile (adjacent to the Mototolo Concentrator and Helena TSF),extracted from KP Report, 2019

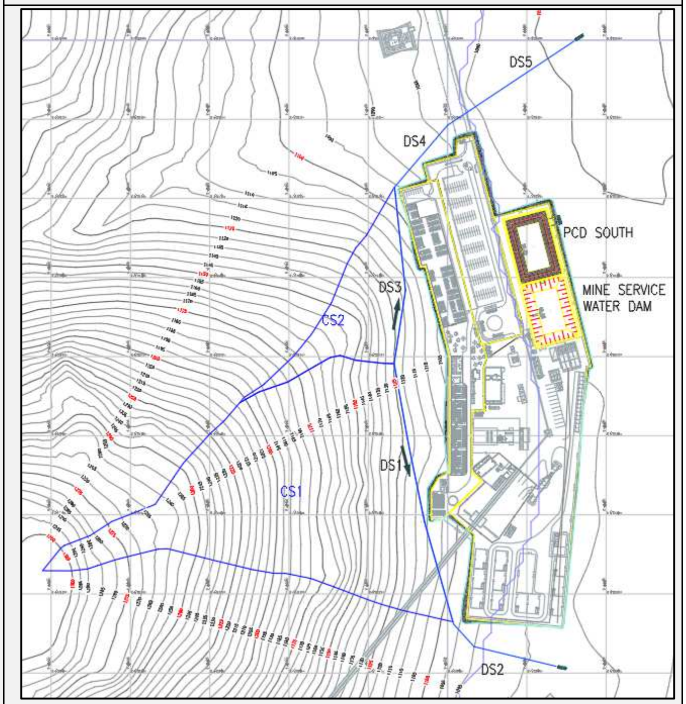
South Portal Layout (after Figure 7-6 of KP Report, 2019)

South Portal will be built on terraces. The terrace levels range from 1 089 to 1 099 mamsl. The offices and change houses are in excavation in the west, while the eastern side of the terrace is built on fill. The dam break flood line runs through the site at 1 089 mamsl.

The layout shows a MSWD and PCD with associated silt trap on the site as indicated in the adjacent figure (refer to KP Figure 7 6). The entire terrace (minus the office areas and the boxcut) is approximately 8.3 Ha.

The volume of the PCD provided on the layout is measured at 8 154 m³. It was assumed that the MSWD would be full, and the full 1:50 year storm volume needs to be catered for in the PCD.
The PCD will be provided with a barge pump and pipeline back to the North Portal water system.
The PCD should be provided with a double compartment silt trap to catch silt from the solution trenches.

Silt traps have been provided on the layout. The total area of the silt traps is approximately 730 m².



South Portal catchment and channels (100 m grid, 5 m contours) (refer Figure 7-7 of KP Report, 2019)

South PCD volume requirements

Unit	Flood volume	Freeboard volume	Spillway volume	Total volume
m³	7 586	3 138	1 308	12 032

South Portal diversion channels

Parameter	Unit	DS1	DS2	DS3	DS4	DS5
Catchment	-	CS1	CS1	CS2	CS2	CS2
Channel Length	m	376	112	225	140	161
Channel Slope	1:H	10.7	14.0	7.8	8.8	23.0
Average velocity, V	m/s	3.44	3.12	2.7	2.55	1.80
Channel capacity Q	m³/s	2.30	2.30	0.7	0.62	0.60
Required Capacity	m³/s	2.30	2.30	0.6	0.58	0.58
Channel Depth proposed	m	0.6	0.6	0.4	0.4	0.4
Gabion structures required	-	35	8	29	16	0

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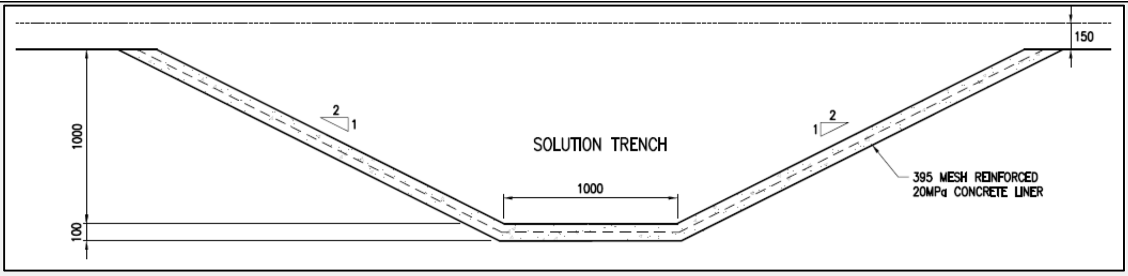
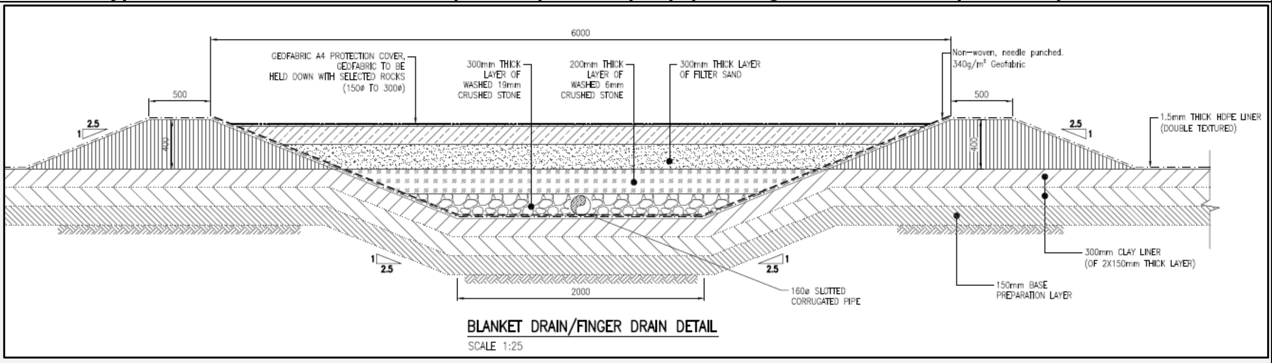
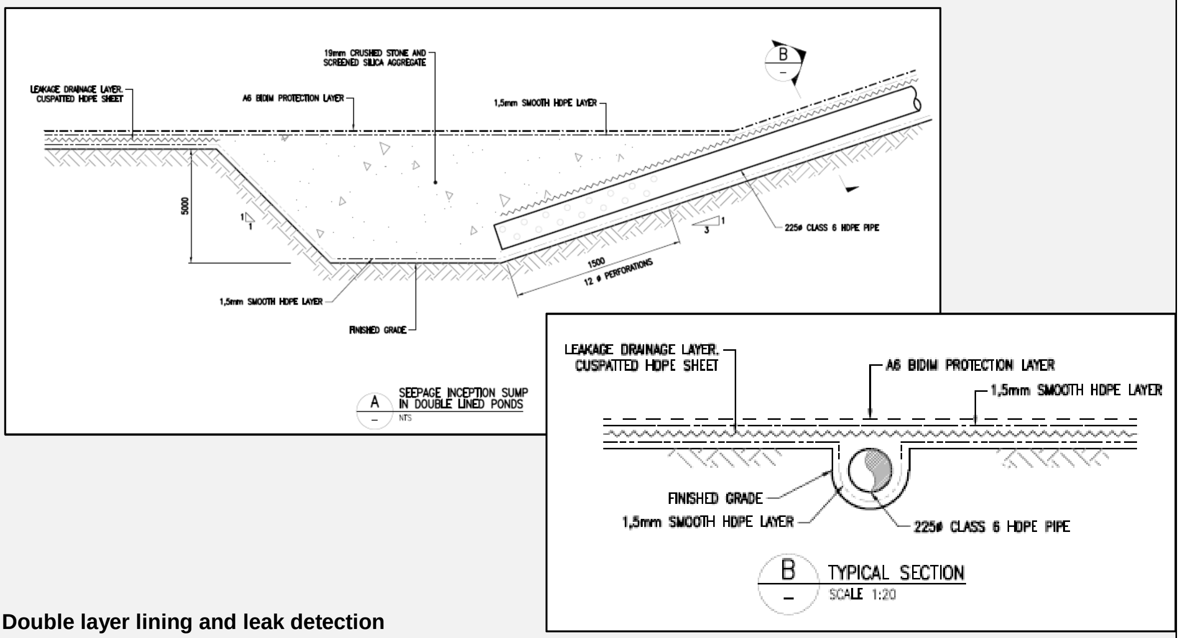
Figure 8-4: Water Management structures at the South Portal, refer KP Report, 2019



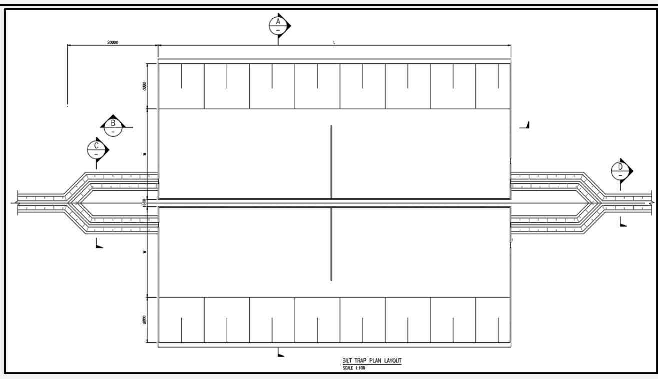
Typical cross section of a channel (side slope @1:2 (V:H), (refer Figure 6-27 in KP Report, 2019)



Typical cross section of drainage system (refer Figure 6-17 in KP Report, 2019)



Double layer lining and leak detection
(Refer Figure 6-23, KP Report, 2019)



Plan view of a typical silt trap with divider wall, (refer Figure 6-28 KP Report, 2019)

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Figure 8-5: Typical design drawings, extracted from KP Report, 2019

9 Water balance

An integrated water balance was compiled in 2017 and updated in 2018 to include current and future water use at the mine. The water balance utilises Goldsim software. The water balance report (SRK 533247/02-WB, 2018) is incorporated directly into this Report. An updated water balance for the 2019 proposed layout (including the North Pit) is underway, for completion at the end of 2019.

The water balance in this Report follows the format outlined in the Best Practice Guideline (G2) Water and Salt Balances (DWA, 2006), and is based on the principle of the conservation of mass.

Key assumptions used in the preparation of the water balance are listed in Table 9-1. The current larger surface area of 649 700 m^2 has been used and not the final area at increased height (1 145 mamsl) as this area will be confirmed on completion of the extension design.

9.1 Site input data

9.1.1 Mine infrastructure input data and constants

Table 9-1 details key input variables and constants, which were used in the calculation of the water balance covering both the current and future mine phases. With regards to the Slurry Density (SD), which fed the water future demand scenarios, 1.6 tonnes/m^3 is the design specification for conventional slurry at Mototolo, with 1.8 tonnes/m^3 being within range for thickened paste. 2.0 to 2.1 tonnes/m^3 SD is within typical ranges for filter cake, but with the residual moisture being a more important measure of the cake water content than the SD (and is typically at around 15%).

9.1.2 Meter data

Operating within a water scarce region, water use management and optimisation at the mine is informed by an extensive meter network, however the monitoring and maintenance of some of these meters appears inconsistent. Much of the meter data covered internal process at the concentrator plant, which wa not required of the water balance model. Table 9-2 outlines the key meter data used during development of the water balance, either as driving data or for model calibration purposes.

Where gaps in the records were encountered, these were infilled with average values from adjacent periods of the measured record.

Table 9-1: Constants and assumptions used in the Goldsim Water Balance Model

Variable/Constant	Measurement
Specific gravity – dry solids (tonnes/m^3)	3.23
Historical average slurry density of tailings (tonnes/m^3)	1.46
DMS slurry density (tonnes/m^3)	2.91
Helena Tailings Storage Facility Area (TSF) (m^2)	234 757
Capacity of Helena Return Water Dam A (m^3)	160 900
Surface area of the Helena RWD A (m^2)	41 100
External catchment area of the Helena RWD A (m^2)	81 441
Capacity of Helena Return Water Dam B (m^3)	33 200
Surface area of the Helena RWD B (m^2)	24 500
External catchment area of the Helena RWD B (m^2)	0
Mareesburg Tailings Storage Facility Area (m^2) (Max deposition area during life of facility)	621 929
Tailing pool as a percentage of the tailings dam	10%
Tailing wet beach as a percentage of the tailings dam	20%
Tailing dry beach as a percentage of the tailings dam	70%
Tailings dam seepage rate (m/s)	0.00000005
Interstitial Storage coefficient	0.33
Capacity of Mareesburg Return Water Dam (m^3)	230 000
Surface area of the Mareesburg RWD (m^2)	70 000
External catchment area of the Mareesburg RWD (m^2)	0
Area of DMS stockpile (m^2)	952 683
Area of DMS PCD (m^2)	40 000
Operational capacity of DMS PCD (m^3)	100 000
External catchment area of DMS PCD (m^2)	0
Northern shaft PCD area (m^2)	75 000
Northern shaft PCD volume (m^3)	5 116
Northern shaft PCD area (m^2)	59 000
Northern shaft PCD volume (m^3)	3 984
Capacity of Mototolo Concentrator Plant PCD (m^3)	11 000
Plant catchment area for PCD (m^2)	21 000
Runoff factor for PCD catchment	0.25
Capacity of Mototolo Concentrator Plant Raw Water Dam (m^3)	7 700
Area of Mototolo Concentrator Plant Raw Water Dam (m^2)	2 200

RWD A design capacity is 170 000 m^3 and RWD B design capacity is 35 000 m^3. The water balance caters for a dead storage volume for the water volume that cannot be used.

Table 9-2: Key flow meter data used during development of the water balance model

Meter Number	Meter name	Comment
Helena TSF / RWD & Mototolo concentrator plant		
445FIT102	Helena RWD outflow	Ensure consistent reading
445FIT230	Additional tailings to process water tank	Ensure consistent reading
445FIT008	Lebalelo offtake pipeline	Ensure consistent reading
441DIT111 / 441FIC108	Tailings slurry density	Data gaps. Ensure consistent reading
440DIT269 / 440FIC268	Chrome slurry	Ensure consistent reading
445LIT302	Plant PCD/SW Dam to Raw Water Dam	Meter readings inconsistent and not used by plant staff – figure estimated
445FIT014	Lebalelo offtake pipeline to Borwa / Lebowa	Does not match sum of Glencore Borwa / Lebowa supply below
Glencore Borwa / Lebowa shafts		
N/A	Borwa Lebalelo supply pipeline	Sum of these meters does not match Lebalelo offtake above (445FIT014)
N/A	Lebowa Lebalelo supply pipeline	

During the first simulation run of the current water balance, monthly records of SD were used whilst hourly values of SD were then obtained dating back to December 2011, but with key gaps, particularly in 2016 (further detail is provided in Appendix A of the SRK Report 533247-WB, 2018). Once the hourly SD data were inputted, the simulation improved markedly. This was in part due to the improved resolution of hourly data, but also due to the monthly records displaying higher variation and more extreme SD values in comparison to the hourly data, potentially pointing to processing or exporting errors (discussed below).

The following key actions are recommended regarding the meter system:

- The discrepancy between the measured volume of water exiting the raw water dam at the concentrator and what Glencore measure, as arriving at the Borwa and Lebowa shafts, should be investigated, and the volumes reconciled. The new Mototolo meter (Feb 2016) is likely more accurate, but the large discrepancy should be investigated;
- A number of key measures are estimated despite meters being in place, due to operational impracticalities which need to be addressed; and
- Monthly figures received for SD were highly variable. The record of hourly SD subsequently received showed significantly less variation with less extreme low or high values. The method employed by the mine for calculating the monthly SD values should be checked.

Where water flows were not measured or the records not utilised in monthly mine balances, the flows were calculated or assumptions made, including the following:

- Shaft water usage and losses for the current mine phase were assumed equal to the water draw from the Lebalelo water supply pipelines to the shafts, given that shaft return water is reutilised and no water is returned to Mototolo; and
- Sewage flows were calculated, based on a daily usage relating to the number of staff and offices.

9.2 Develop and solve balances for the respective units

All data and information required as inputs into the water balance was collected from AAP, KP, DeltaH, DRA, Mototolo or Glencore staff.

The Der Brochen infrastructure added included the following;

- DMS plant;
- DMS stockpile and PCD; and,
- Southern portal.

Figure 9-5 illustrates the schematic of the water balance developed to include the future Der Brochen mine infrastructure. The dynamic water balance was set up to enable the user to update rainfall, evaporation and meter data, as well as simulate management scenarios to determine the change in make-up water required. The calibration of the Goldsim water balance has been Reported upon in the 2017 model and is not repeated in the document. The 2019 water balance report update is underway, for completion end of 2019.

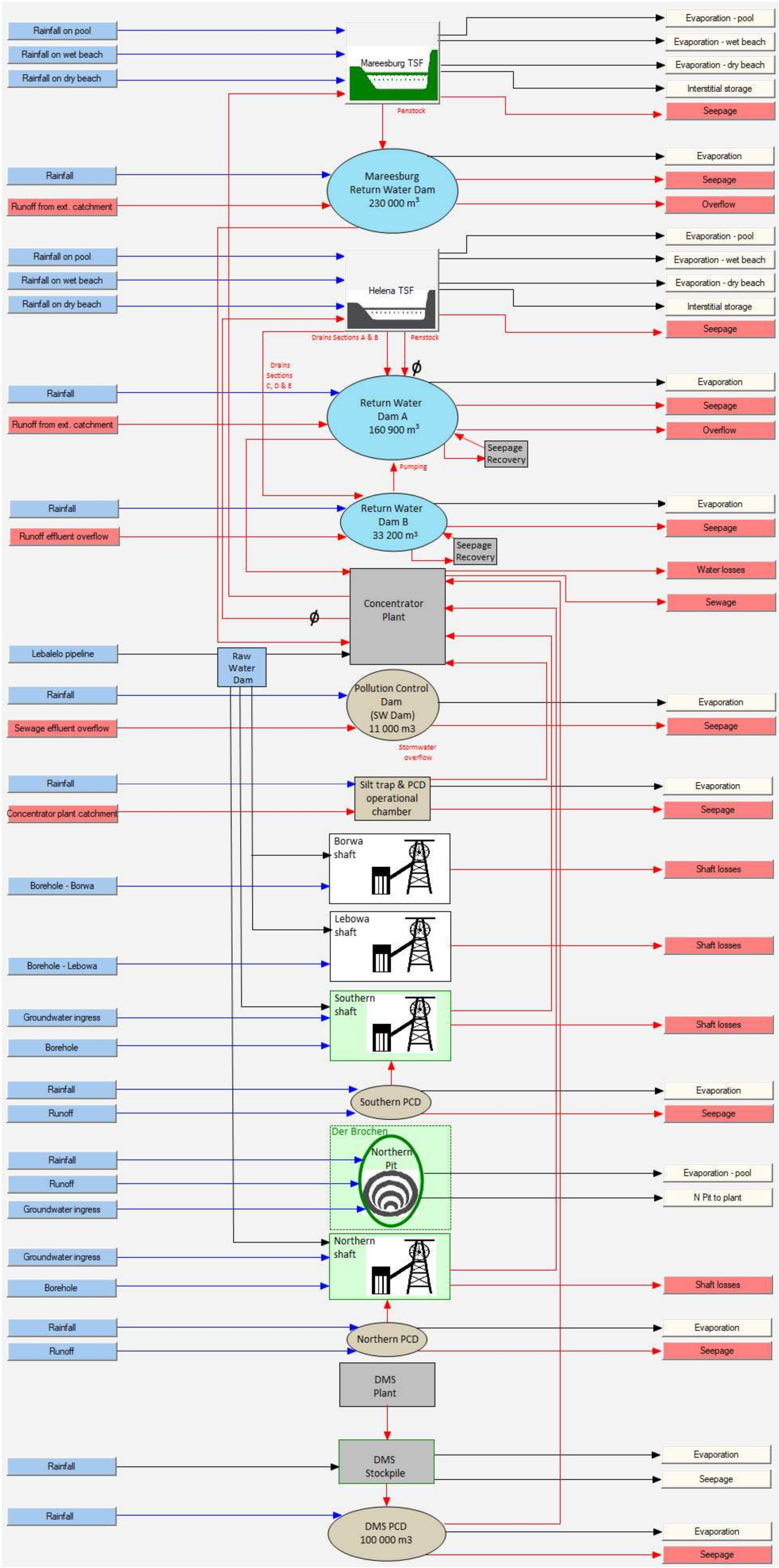

Figure 9-1: Water balance schematic covering the planned Der Brochen mine infrastructure

9.3 Make-up water requirement for 240 ktpm plus 80 ktpm DMS with lined stockpile (Scenario one)

Given the nature of water supply and demand within the region of the mine, additional water for the Der Brochen phase is limited, with further reliance on water supplied through the Lebalelo Water Supply Scheme having knock-on effects on other mining projects or water users. The site-wide water balance of current infrastructure was updated to simulate the current water uses and efficiencies, in order that future water demand for the Der Brochen Mine phase could be interrogated, based on various infrastructure options and operational management scenarios.

The dimensions, capacities and design specifications of the following additional infrastructure and processes were accounted for, where necessary, in expanding the water balance to cover the Der Brochen Mine:

- Mototolo silt trap and PCD;
- Mototolo Concentrator expansion capacity, including the new DMS plant;
- Mareesburg TSF;
- Mareesburg RWDs;
- DMS Stockpile and associated PCDs; and
- Northern and Southern Shafts and associated infrastructure.

Figure 9-2 illustrates the integrated water balance for the existing and future Der Brochen Mine infrastructure, for an average rainfall year under Scenario 1 of 240 kilo tonne per month (ktpm) with a lined DMS (80 ktpm).

Table 9-3 and Figure 9-3 display Make-up requirement for scenario one, modelled for the period (2018 – 2099). The box and whisker plots of Figure 9-4 reveal the variation in make-up water requirement during the period of 2018 to 2099 simulation period for scenario one.

The first scenario that was modelled was where 240 (ktpm) of ore was treated through the concentrator and 80ktpm of ore was processed through the DMS plant and placed onto a lined DMS Stockpile. The results show:

- The average Make-up for this scenario is 2.7 Ml/d (2712 m^3/d), but is highly variable, especially in the summer months where the rainfall amount significantly changes the water requirements;
- The variability of the Make-up water is significant and make up water is minimal during the wet season but during drought conditions the full water requirement may be required from alternative sources;
- Generally, the Make-up water is consistent during the winter period, but variable during the wet season and is dependent on rainfall as to how much make up water is required; and
- In order not to spill from the system, a buffer facility (RWD A and RWD B) where included, as additional buffer storage into the model and this excess water was then used as Make-up when appropriate.

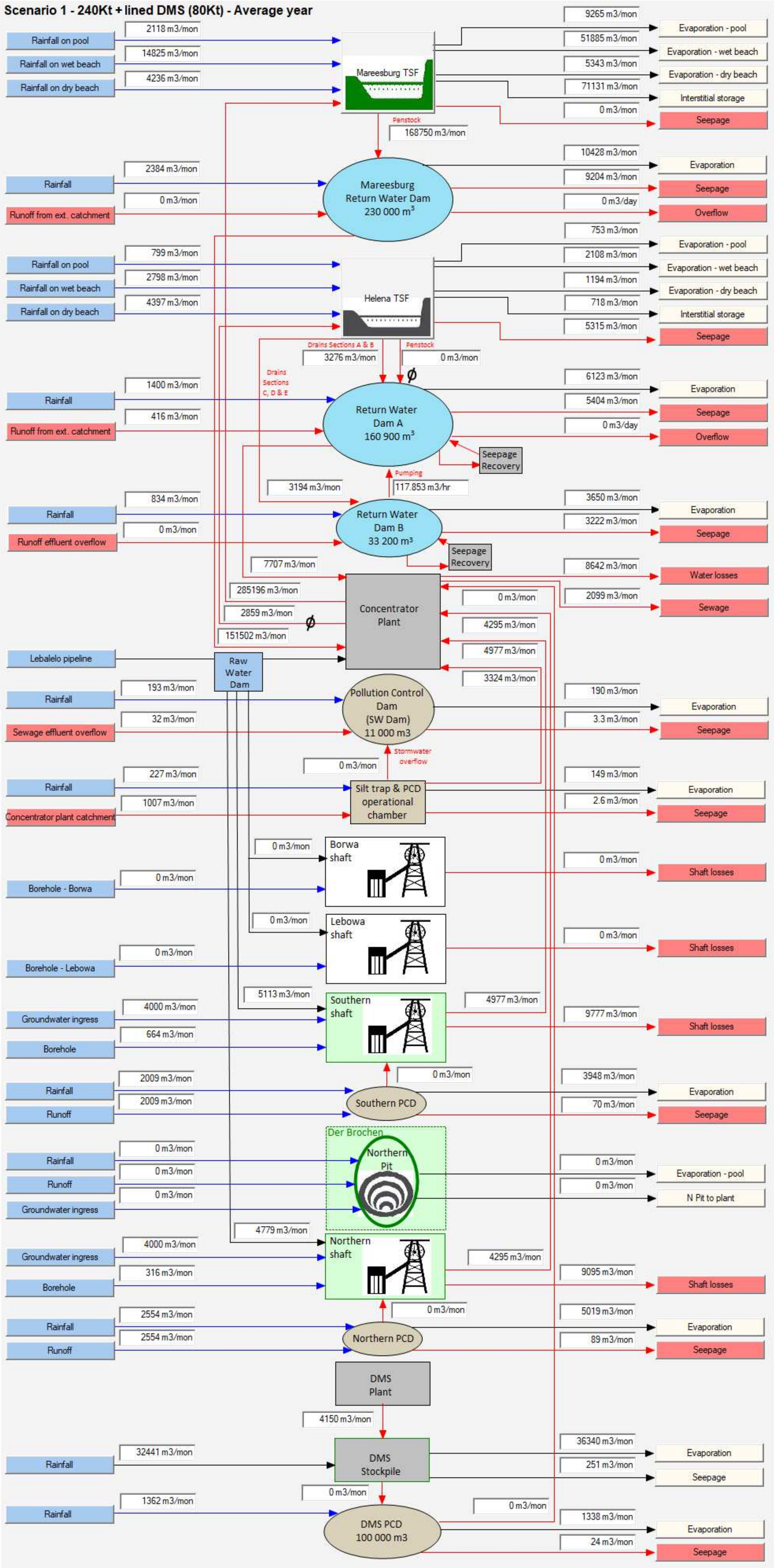

Figure 9-2: Der Brochen Integrated Water Balance – Scenario one (240 ktpm and lined DMS 80 ktpm) - average rainfall year

Table 9-3: Maximum minimum Average and Percentiles of monthly make-up water requirement for Scenario one (m3/day)

		October	November	December	January	February	March	April	May	June	July	August	September	Annual Average
Maximum		4708	4521	5918	9210	9432	9432	9432	9432	9432	6934	4311	4512	
Minimum		0	0	0	0	0	0	0	0	764	0	1945	0	
Average		2717	878	1223	2046	1990	2306	3223	4014	3520	3333	3712	3591	2712
Percentile	**10%**	463	0	0	0	0	0	0	2398	2884	3123	3184	2072	
	30%	2176	0	0	0	0	0	1635	3400	3300	3435	3766	3644	
	50%	3045	0	0	525	934	2063	2991	3649	3437	3506	3845	3838	
	70%	3798	1218	2027	3226	2978	3514	3825	3728	3440	3508	3846	4180	
	90%	4237	3225	4022	6683	6492	5637	6782	6669	3708	3740	3967	4342	

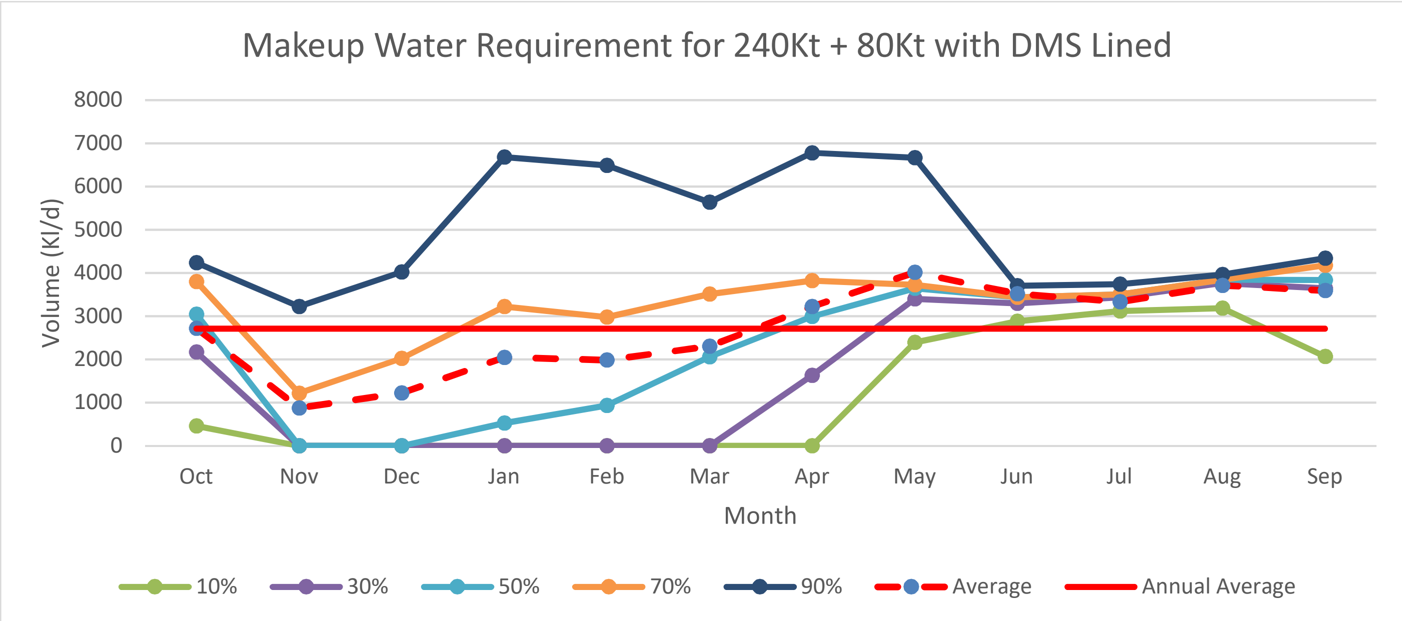

Figure 9-3: Average, annual average and percentiles of monthly make-up water requirement for Scenario one (m^3/day)

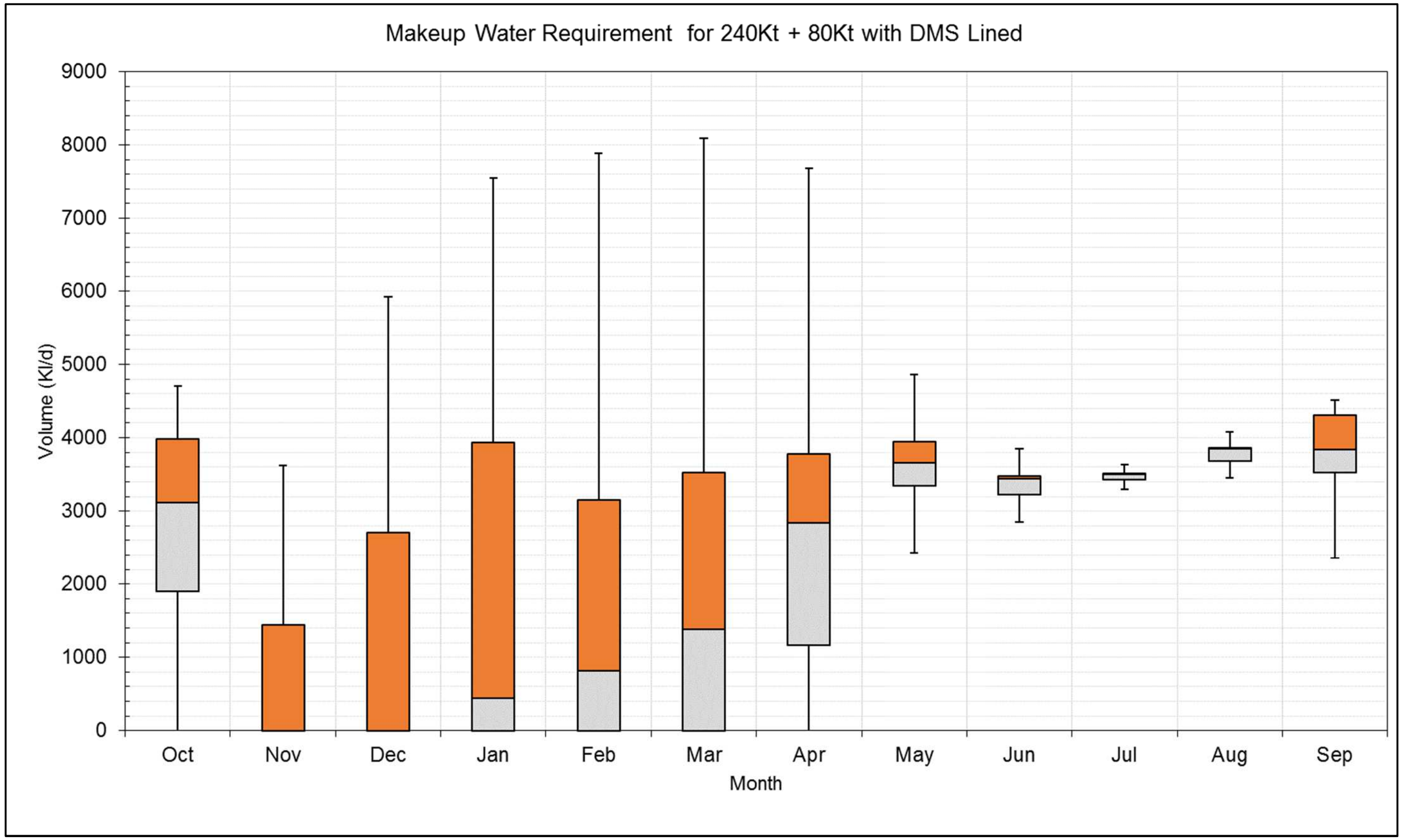

Figure 9-4: Box and whisker plots for Scenario one

9.4 Make-up Water Requirement for 240 ktpm plus 80 ktpm DMS with Unlined Stockpile (Scenario two)

Figure 9-5 illustrates the integrated water balance expanded to include the future Der Brochen Mine infrastructure for an average rainfall year under Scenario two of 240 ktpm with an unlined DMS (80 ktpm).

Table 9-4 and Figure 9-6 display make-up requirement for Scenario two, modelled for the period (2018 – 2099). The box and whisker plots of Figure 9-10 5. Several variations in make-up water requirement during the period of 2018 to 2099 simulation for 240 ktpm plus 80 ktpm with DMS unlined.

The following scenario was simulated where 240 ktpm of ore was treated through the concentrator and 80 ktpm of ore was processed through the DMS plant and placed onto an unlined DMS Stockpile. The following should be noted from the graphs and tables:

- The average Make-up for this scenario is 2.8 Ml/d (2803 m^3/d) and similar variability is expected for this scenario as in Scenario 1; and
- From a water loss point of view, it is recommended that alternative means of containing the seepage from below the DMS be investigated during the feasibility stage and be incorporated into the risk study. The losses are not as substantive as in the TSF and alternative measures to collect and contain the groundwater plume may be beneficial.

The main water supply risk to this mine is the variability of water supply as per the description for Scenario 1.

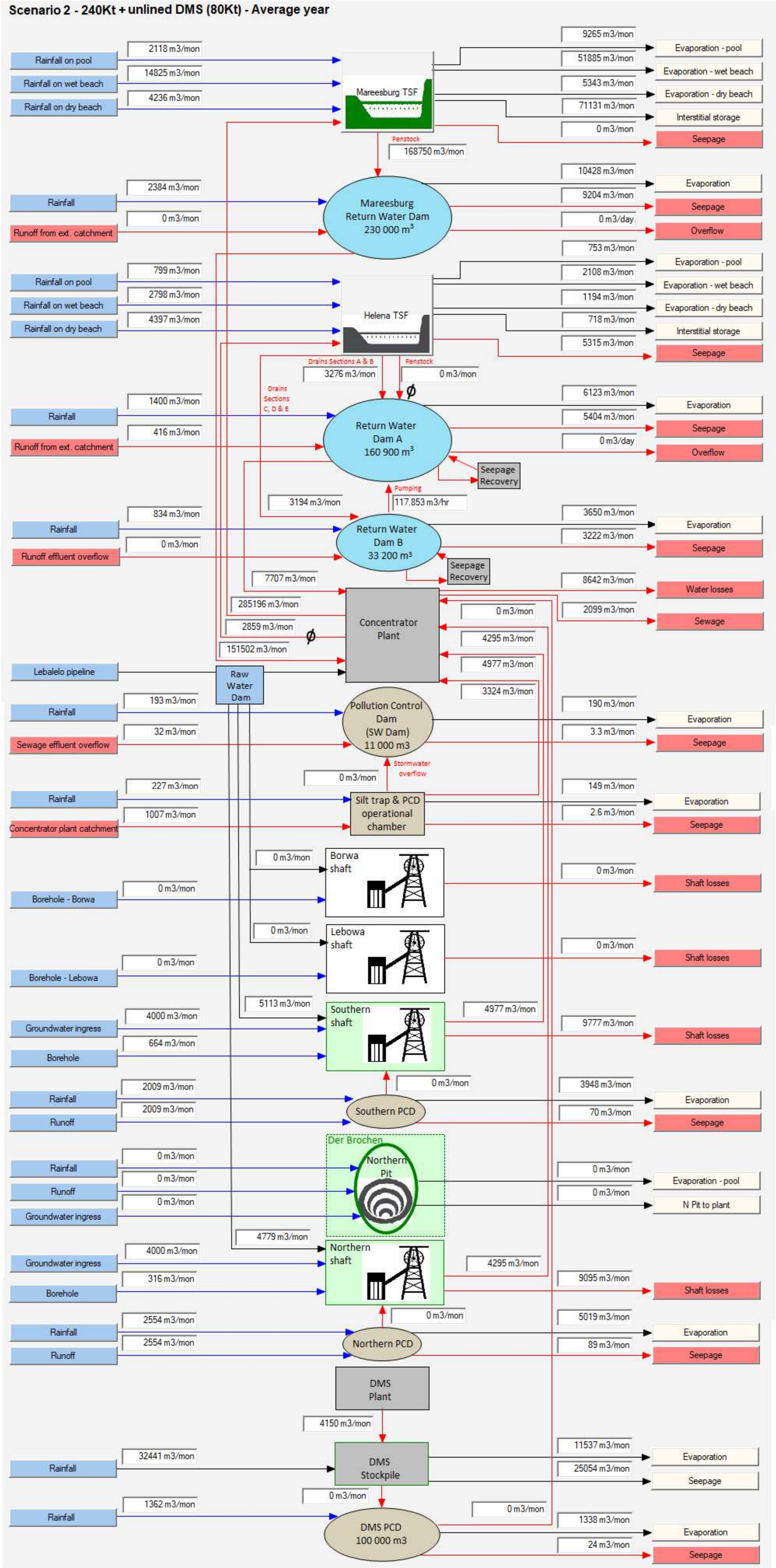

Figure 9-5: Der Brochen Integrated Water Balance – Scenario two (240 ktpm and unlined DMS 80 ktpm) - average rainfall year

Table 9-4: Maximum minimum Average and Percentiles of monthly make-up water requirement for Scenario two (m3/d)

		October	November	December	January	February	March	April	May	June	July	August	September	Annual Average
Maximum		4708	4521	5545	8293	9432	9432	9432	9432	9432	3781	4092	4512	
Minimum		0	0	0	0	0	0	0	609	1564	335	2444	0	
Average		2953	1134	1622	2287	2135	2633	3195	3636	3343	3336	3718	3666	2803
Percentile	**10%**	1263	0	0	0	0	0	455	2525	2828	3117	3217	2586	
	30%	2709	0	0	0	0	0	2329	3358	3229	3440	3767	3644	
	50%	3153	458	745	1741	1773	2660	3001	3574	3436	3506	3846	3863	
	70%	3792	2018	2862	3450	3101	3541	3703	3727	3440	3508	3846	4180	
	90%	4237	3227	4538	5573	4453	6062	6047	3972	3691	3625	3965	4342	

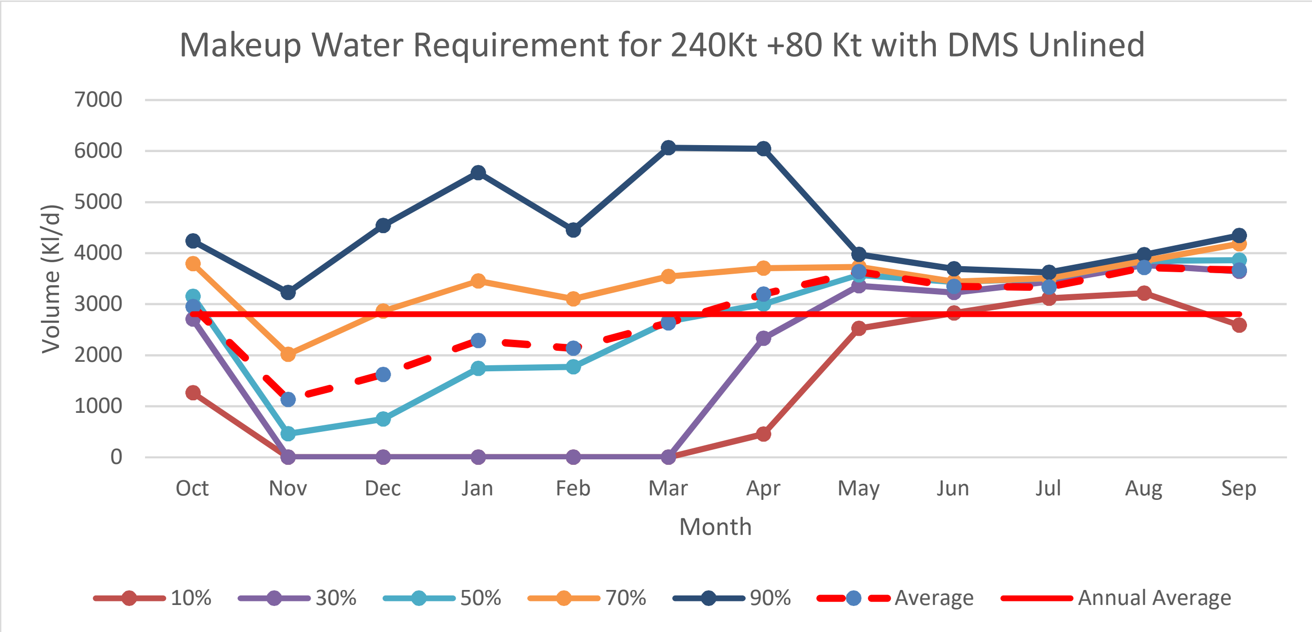

Figure 9-6: Average, annual average and percentiles of monthly make-up water requirement for Scenario two

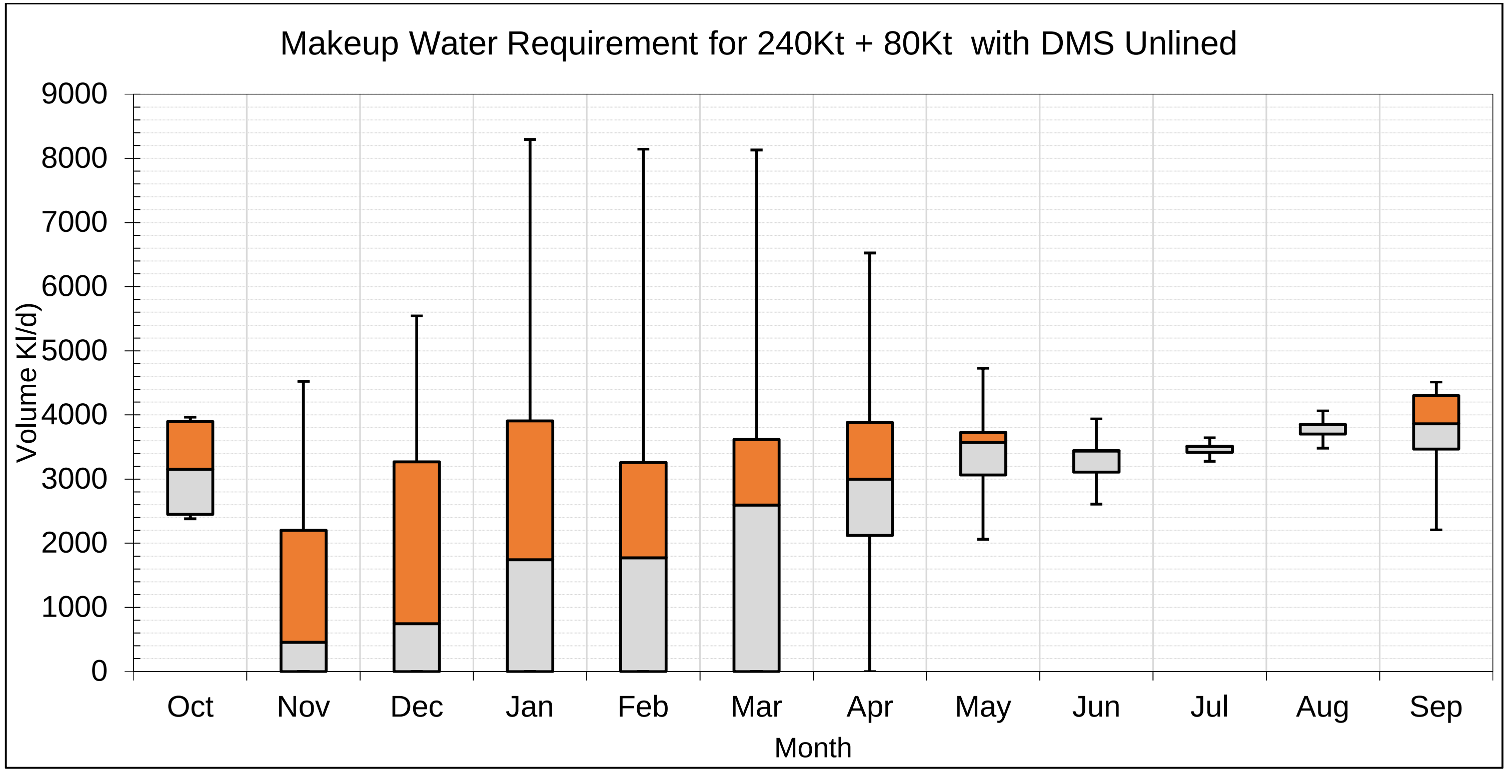

Figure 9-7: Box and whisker plots for Scenario two

9.5 Make-up Water Requirement for 240 ktpm with no DMS (Scenario three)

Figure 9-8 illustrates the integrated water balance expanded to include the future Der Brochen Mine infrastructure for an average rainfall year under Scenario 3 of 240 ktpm with no DMS.

Table 9-5 and Figure 9-9 display Make-up requirement for Scenario 3, modelled for the period (2018 – 2099). The box and whisker plots of Figure 9-10 reveal the variation in make-up water requirement during the period of 2018 to 2099 simulation period for scenario 3.

The following was simulated for the scenario where 240 ktpm of ore was treated through the concentrator and there is no DMS:

- The average Make-up for this scenario is 2.6 Ml/d (2575 m^3/d); and
- This simulation does not include the DMS and therefore there is no storage facility to capture additional rainfall during the wet season. What this means for the make-up requirement is the variability in the summer season is less and there will be a higher makeup requirement in the winter months.

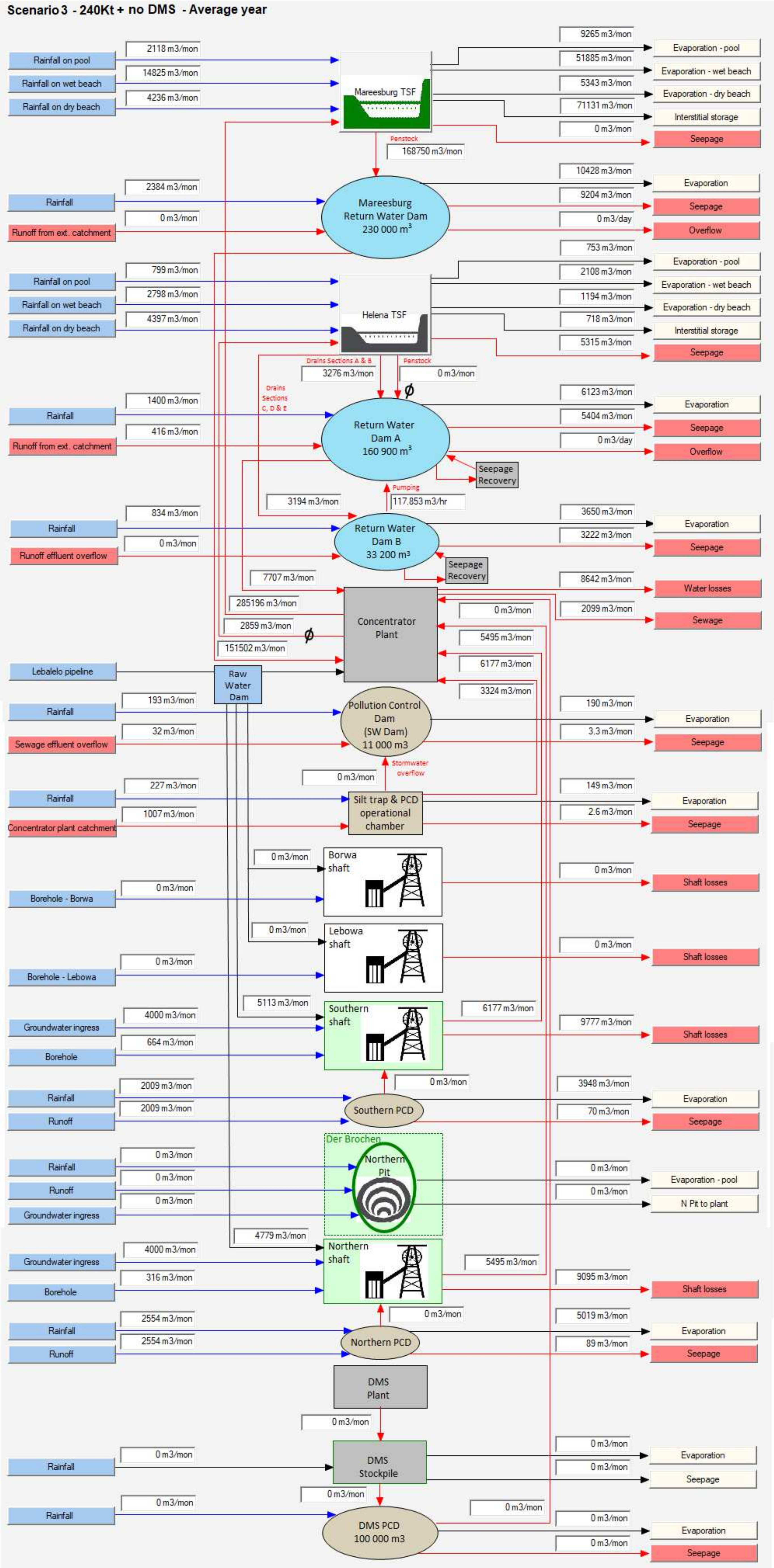

Figure 9-8: Der Brochen Integrated Water Balance – Scenario three (240 ktpm and no DMS) - average rainfall year

Table 9-5: Maximum minimum Average and Percentiles of monthly make-up water requirement for Scenario three

		October	November	December	January	February	March	April	May	June	July	August	September	Annual Average
Maximum		4631	4444	3951	4767	4233	5476	4057	3899	3640	3703	4015	4435	
Minimum		0	0	0	0	0	0	0	933	1672	1028	2366	377	
Average		2992	1352	1491	1728	1926	2071	2444	3171	3193	3279	3642	3624	2575
Percentile	**10%**	1722	0	0	0	440	170	1106	2165	2718	3003	3139	2509	
	30%	2583	67	485	501	1244	1035	1948	3018	3127	3370	3695	3567	
	50%	3068	1358	1505	1938	1792	2075	2577	3450	3358	3429	3768	3786	
	70%	3706	2103	• 2211	2562	2560	2881	3170	3597	3363	3431	3769	4104	
	90%	4160	3149	3024	3432	3580	3741	3643	3651	3611	3548	3888	4264	

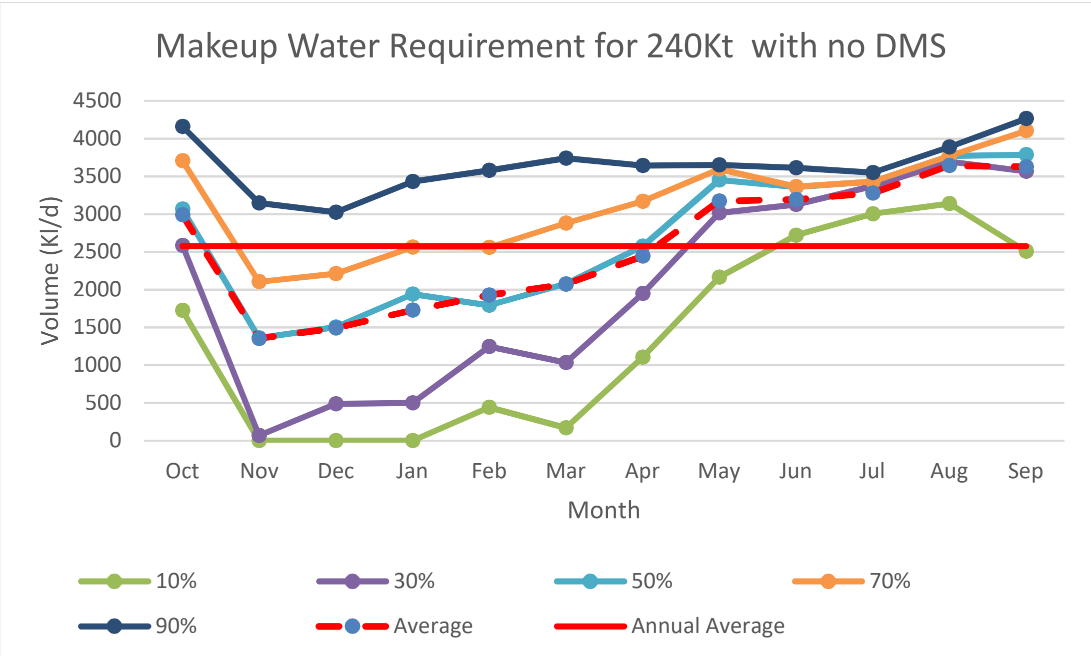

Figure 9-9: Average, annual average and percentiles of monthly make-up water requirement for Scenario three

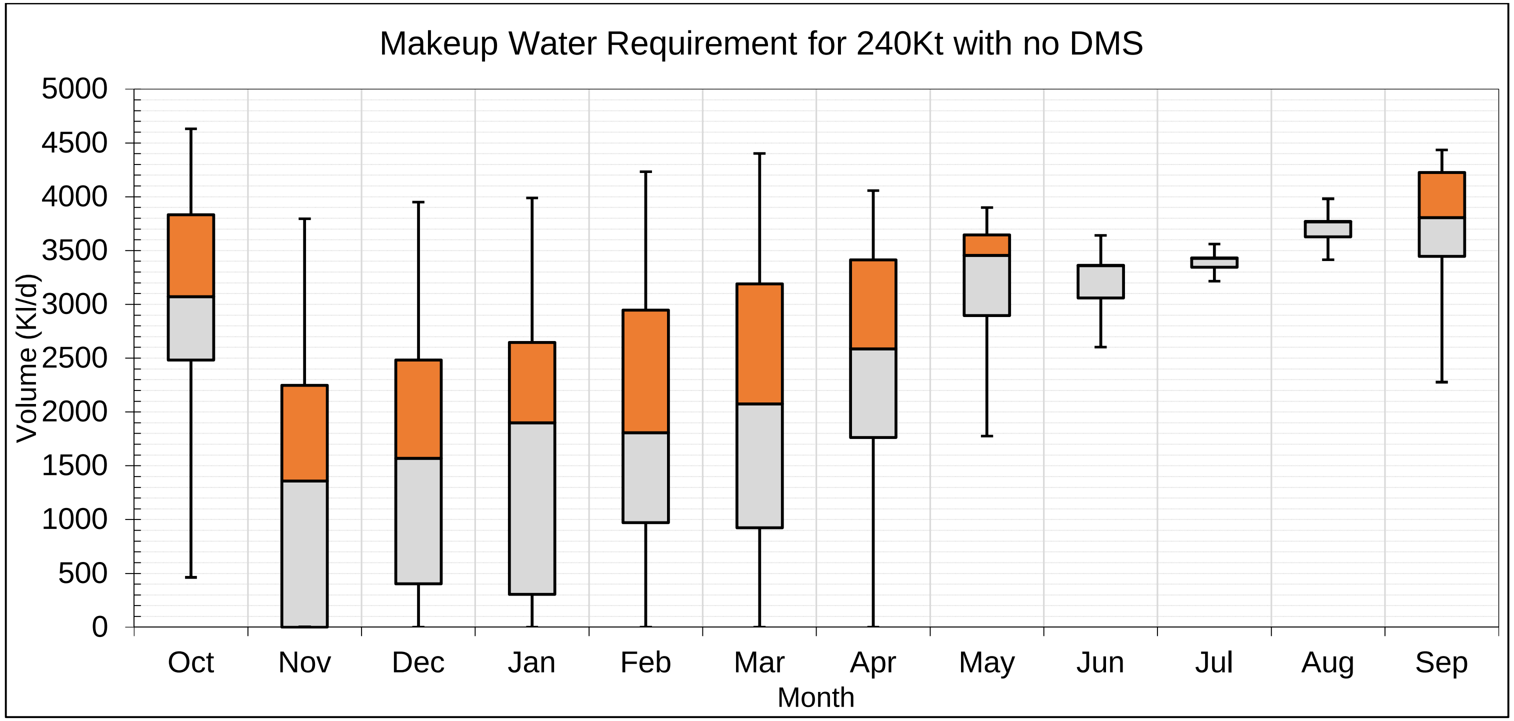

Figure 9-10: Box and whisker plots for Scenario three

9.6 Summary of results

A summary of the results for the various scenarios is shown in Table 9-6 below.

Table 9-6: Summary of water demand for the Der Brochen Project

Aspect		Scenario 1 240 ktpm + 80 ktpm for DMS (Lined)	Scenario 2 240 ktpm + 80 ktpm for DMS (unlined)	Scenario 3 240 ktpm + no DMS
Kilotonnes milled per month (ktpm)		240	240	240
DMS Throughput (thousand tpm milled)		80	80	0
Maximum Water demand (assuming no recycling)		10	10	9.5
1.46 SD	Average water demand per day	2.7	**2.8**	**2.6**
1.46 SD	Maximum water requirement during drought	6.8	**6.1**	**4.3**
Total Water Resources that could be made available (Ml/day):		**5.8**	**5.8**	**5.8**
Helena well-field		**0.4**	**0.4**	**0.4**
Richmond well field		**0.3**	**0.3**	**0.3**
Der Brochen Dam		**0.1**	**0.1**	**0.1**
Lebalelo / De Hoop Dam (additional water could be applied for to get back to 5 Ml/d		**5.0**	**5.0**	**5.0**

During times of extreme drought there will be a need for additional water to be obtained from either the de Hoop system or the wellfields.

10 Impact Assessment

The Impact Assessment Methodology used to assess the impacts of the proposed activities related to surface water management has been developed to comply with National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), Environmental Impact Assessment Regulations, 2014 (as amended by GN 326 in Government Gazette 40772 of 7 April 2017 and GN 706 in Government Gazette 41766 of 13 July 2018). Appendix 3, Section 2 of the Environmental Impact Assessment Regulations, 2014 as amended and published in Government Notice No. R. 326 in Gazette No. 40772 on 7 April 2017, states the following:

(2) The objective of the Environmental impact assessment process is to, through a consultative process-

(d) determine the-

(i) nature, significance, consequence, extent, duration and probability of the impacts occurring to inform identified preferred alternatives; and

(ii) the degree to which these impacts-

(aa) can be reversed;

(bb) may cause irreplaceable loss of resources, and

(cc) can be avoided, managed or mitigated

This impact assessment is divided into three stages:

- Issue identification – evaluation of issues arising from diverting, channelling or concentrating the flow of surface water resources and;
- Impact definition - positive and negative impacts associated with these issues (and any others not included) then need to be defined – the definition statement should include the activity (source of impact), aspect and receptor as well as whether the impact is direct, indirect or cumulative. Fatal flaws should also be identified at this stage; and
- Impact evaluation – this is not a purely objective and quantitative exercise. It has a subjective element, often using judgement and values as much as science-based criteria and standards. The

need therefore exists to clearly explain how impacts have been interpreted so that others can see the weight attached to different factors and can understand the rationale of the assessment.

10.1 Project activities with potential to impact surface water resources

Although it is recognised that existing legislation is in place that would not allow a project to be developed that would have a material detrimental impact on surface water resources, there are a number of potential impacts on water resources that can arise from mining activities related to both the volume and quality of water entering, or leaving, water resources which may include some of the following:

- Reduced availability of water to downstream water users due to changes in water quality;
- Damage to the aquatic ecosystem due to substances contained in releases from the mine;
- Increased erosion from areas of exposed soils;
- Linear crossings of the watercourses may cause scouring around the infrastructure in the river;
- Scouring effect on stream banks and bed due to releases from the mine (clean water diversions, storm water drains, road culverts etc);
- Increased risk of flooding due to changes in catchment hydrology;
- Reduced availability to downstream/down-gradient water users due to changes in water quantity or flow regime, specifically related to physical obstruction from mine infrastructure (watercourse crossing structures, portals, DMS stockpiles, PCD's) and containment of dirty runoff.

Impacts may be envisaged for the various phases of the development of the proposed activities during pre-construction, construction, operational, closure and rehabilitation phases. Specific activities identified for each of the major components are discussed in Table 10-1 for the pre-construction, construction, operational, decommissioning and closure phases.

The impacts from the planned North Pit are included in Table 10-1, only where cumulative impacts are considered. Individual impact from the North Pit were previously assessed and approved through the 2015 Consolidated EMProf Der Brochen Mine. The cumulative impact considers planned and proposed new activities, but excludes planned activities that are unlikely to go-ahead (i.e. South Open Pit and co-disposal dump).

Table 10-1: Activities identified proposed new infrastructure

Phase	Activities	Impact Summary	Significance Pre-Mitigation	Significance Post-Mitigation
Pre-Construction	Site clearing of all footprint areas associated with the proposed project infrastructure. (DMS Stockpile, PCD's and/or other water management infrastructure associated with the Southern Portal, vent shafts, ROM stockpile, DMS Plant, conveyors, haul roads and North Pit).	Increase in erosion from areas of exposed soils during site clearing and grubbing.	Moderate	Low
	Stockpiling of topsoil (stripping and stockpiling of topsoil for DMS stockpile, South Portal and North Pit)	As above	Moderate	Low
		Deterioation of surface water quality due to a localised increase in turbidity resulting from surface runoff from the topsoil stockpiles	Moderate	Low
	Use of existing gravel roads for pre-constuction activities.	Deterioation of surface water quality due to erosion, spillage and accidental discharges at road crossings is likely to be limited as there is seldom water in the water courses.	Low	Low
Construction	Construction of infrastructure (DMS plant, DMS Stockpile area and including terraces, berms and dams (MWSD and PCD's)) as well as staff	Reduction in water quality due to an increase in turbidity as a result of an increase in erosion due to cleared, compacted or hardstanding areas.	Moderate	Low

Phase	Activities	Impact Summary	Significance Pre-Mitigation	Significance Post-Mitigation
	accommodation and the explosive destruction bay, including the establishment of a contractor laydown area).	Provision of hardstanding areas and compacted areas will reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding. Increased runoff velocity	Low	Low
		Deterioration of surface water quality due to spillages and accidental discharges.	Low	Low
		Alteration in catchment hydrology causing a change in watercourse functuality and increased risk of flooding and scouring.	Moderate	Low
	Construction of linear infrastructure including • Gravel maintenance roads to the proposed ventilation shafts • Upgrading of existing gravel roads to tar roads to serve as main access roads	Deterioration of surface water quality due to spillages and accidental discharges at conveyor or road crossings	Moderate	Low
		Reduced availability of water to downstream uses due to obstruction of flow at crossings	Moderate	Low
Operational	Depostion of DMS material onto the DMS Stockpile Area	Deterioration of surface water quality due to surface water runoff of leachate from the DMS material.	Moderate	Low
		Impeding the flow in the rivers due to failure of the stockpile	Moderate	Low
	Operation / utilisation of stormwater management infrastructure at South Portal and North Pit, including the PCD's and MWD at the the shaft.	Reduced quality of water due to discharge from the PCD's and/or runoff of water from the mine during operation.	High	Moderate
		Reduced availability of water to downstream users due to containment of dirty water and alteration of catchment hydrology (volume).	Moderate	Moderate
		Erosion and scouring of water courses at diversion outlets due to stormwater runoff from the mine.	Moderate	Low
	Underground mining at South Portal (bord and pillar)	Impact to surface resources are limited to surface insfrastructure as streams are ephermeral (refer to reduction in baseflow in groundwater impact)	Low	Low
	Stockpiling of ore material at Mototolo Concentrator	Surface impacts are the same for all the facilities as these are all located within the existing Mototolo concentrator area.	Moderate	Low
	Operation of the Chrome Recovery Inter-stage Plant			
	Operation of the DMS Plant			
	Dangerous goods storage (including hydrocarbons/chemicals/explosives)	Spillages and accidental discharges from dangerous good storage areas and waste management facilities could locally affect the surface water resources.	Moderate	Low
	Waste Management			
	Linear structures including:	Deterioration of surface water quality due to erosion, spillages and	Moderate	Low

Phase	Activities	Impact Summary	Significance Pre-Mitigation	Significance Post-Mitigation
	5. Temporary hauling of ore from shafts to Mototolo Concentrator along the corridor associated with the Ore Conveyor System (whilst conveyor system is being constructed) 6. Operation of Conveyor Systems 7. Utilisation of tar access roads 8. Utilisation of gravel maintenance roads associated with the ventilation shafts	accidental discharges at conveyor or road crossings.		
		Reduced availability of water to downstream users due to obstruction of flow at crossings	Moderate	Low
	Utilisation of staff accommodation near the Der Brochen Dam	Provision of hardstanding areas and compacted areas will reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding	Low	Low
	Insufficient water to sustain mining activities	Limited water available to sustain mine	Moderate	Low
Closure/Rehabilitation	Demolish all surface infrastructure including the removal of all plant equipment, conveyor belt systems and staff accomodation	The impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction phase	Moderate	Low
	Rehabilitation of the DMS stockpiles and PCDs			
	Closure of the South Portal, underground workings and North Pit			
Post-closure	Monitoring and maintanence of DMS Stockpile and rehabilitated areas.	All rehabilitation activities should be monitored until vegetation is well estabiliahed and no further surface water quality impacts are deemed likely	Moderate	Low

10.2 Impact significance rating

The impact significance rating system is presented in Table 10-2.

Table 10-2: Method for rating the significance of impacts

	Duration	Probability
Occurrence	5 – Permanent	5- Definite / don't know
	4 – Long-term (ceases with the operational life)	4 – Highly probable
	3 – Medium term (5-15 years)	3 – Medium probability
	2 – Short term (0 – 5 years)	2 – Low probability
	1 - Immediate	1 – Improbable
		0 - None
Severity	Extent/Scale	Magnitude
	5 – International	10- Very high/uncertain
	4 – National	8 – High
	3 – Regional	6 – Moderate
	2 – Local	4 – Low
	1 – Site Only	2 - Minor
	0 - None	

10.3 Impacts during pre-construction

10.3.1 Site clearing and preparation of the footprint areas

An increase in erosion from cleared areas, topsoil stockpiles or any other area where there are exposed soils can occur during storm events (direct impact). Increased erosion can result in an increase in turbidity, suspended solids and sedimentation in the Groot-Dwars River and tributaries (indirect and cumulative impact). Some level of sedimentation is expected to occur in the Groot-Dwars River and/or Mareesburg Stream pre-development as runoff is naturally anticipated to pick up environmental debris as it crosses natural areas.

The increase in turbidity/suspended solids can result in a deterioation in the water quality such that water is no longer available for use by downstream users (indirect impact).

Increased turbidity is reversible and surface water should return to pre-impact turbidity levels once sediment levels entering the watercourse are reduced. Settled sediments should naturally move downstream during periods of high flow flowing storm events.

The impact assessment and ratings are provided in Table 10-3.

Significance is considered moderate pre-mitigation due to:

- the location of an eastern portion of the South Portal footprint within 100 m of the Groot-Dwars River;
- the proximity of the Leshaba and Moletsi community (around 480 m from the DMS stockpile) which use surface water from the Groot-Dwars downstream of the proposed DMS stockpile (Phase 1 and 2); and
- the proximity of the Phase 3 (after 2049) DMS Stockpile and PCD 2 to the Mareesburg Stream.

Activity	**Site clearing and preparation of the footprint areas associated with the mine infrastructure**
Project Phase	Pre-construction and construction
Impact Summary	Increased erosion from areas of exposed soils during site clearing and grubbing resulting in reduced availability of water to downstream users and sedimentation in the Groot-Dwars River and/or Mareesburg Stream
Potential Impact Rating	MODERATE, Refer Table 10.3
Management Measures	Clearing of vegetation should be limited to the minimum area safe for construction and operation. Flood protection berms should be constructed at the area where the Southern Portal and Phase 3 DMS Stockpile and PCD 2 footprints falls within 100 m of the river. Erosion control measures in the form of temporary erosion prevention berms should be implemented during pre-construction and construction. Clean water diversion bunds should be constructed upstream of the construction site prior to clearing areas for new infrastructure. PCD's should be constructed downstream of the working activities to minimise uncontrolled runoff from the site. Areas disturbed by construction activities should be rehabilitated immediately on completion of construction of each area. Areas disturbed by linear infrastructure should be rehabilitated progressively as construction progresses. Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact.
After Management Impact Rating	LOW, Refer Table 10.3

By minimising the area cleared for construction the potential for erosion will be reduced. Construction of appropriate stormwater controls in the form of clean water diversion bunds upstream of the construction site and PCD's downstream of the working activities will minimise the sediment loads leaving the construction area. Such sediments will be further reduced by temporary erosion prevention berms or similar measures within the path of the diverted clean water.

Rehabilitation of disturbed areas immediately after pre-construction will facilitate re-establishment of vegetation thus reducing the potential for erosion post-construction.

10.3.2 Stockpiling of Topsoil

Stripping of topsoil for DMS Stockpiles, South Portal and North Pit can result in an increase in erosion from cleared areas as discussed above. The Topsoil Stockpile is located with the 100 m zone of Regulation GN 704 and GN509 to the south and east of the Groot-Dwars River. The stockpile could become eroded during storm events and result in localised deterioration of water quality due to increased turbidity and suspended soilids in the Groot-Dwars River during storm events. The topsoil stockpile is located upstream of the DMS Stockpile and the potential impact to the downstream community is therefore lower than for the DMS Stockpile.

Activity	**Stripping and stockpiling of Topsoil**
Project phase	Pre-construction, Construction and Operation
Impact Summary	Increased erosion from areas of exposed soils during site clearing and grubbing as discussed above. Runoff of topsoil to the Groot-Dwars River resulting in an increase in turbidity in the river and reducing the volume available for rehabilitation on closure.
Potential Impact Rating	MODERATE, Refer Table 10.3
Management Measures	Increased turbidity is reversible and surface water should return to pre-impact turbidity levels once sediment levels entering the watercourse are reduced. Settled sediments should naturally move downstream during periods of high flow flowing storm events. Further management measures include: Clearing of vegetation should be limited to the minimum area safe for construction and operation. Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction. Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact. The topsoil stockpile should be vegetated and while vegetating, measures will be needed to contain erosion of the stockpile during rain events.
After Management Impact Rating	LOW, Refer Table 10.3

10.3.3 Use of existing gravel roads for pre-construction activities

In an unmanaged scenario; alteration or damming of water where roads cross ephermeral drainage lines could negatively affect downstream ecosystems, promote significant erosion of water course banks, prevent the flow of surface water to the Groot-Dwars River, and cause flooding at and above the point of alteration or obstruction.

Appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion. The specific conditions are included in the storm water management plan in Section 11.

Activity	**Use of existing gravel roads for pre-construction activities**
Project phase	Pre-construction
Impact Summary	In an unmanaged scenario; alteration or damming of water where roads cross ephermeral drainage lines could negatively affect downstream ecosystems, promote significant erosion of water course banks, prevent the flow of surface water to the Groot-Dwars River, and cause flooding at and above the point of alteration or obstruction
Potential Impact Rating	LOW, Refer Table 10.3
Management Measures	The impact limited as there is seldom water in the water courses but there is reliance on this resource for aquatic, floral and faunal diversity (refer SAS, 2019). These are existing gravel roads and as such, it is anticipated that this impact is likely to be minimal.

	Appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion.
After Management Impact Rating	LOW, Refer Table 10.3

10.4 Impacts during construction

10.4.1 Construction of infrastructure including terraces, berms and dams (MWSD and PCD's)

Increased potential for flooding and/or erosion due to establishment of hardstanding or compacted areas

Construction at the South Portal and DMS Stockpile will result in compacted areas and/or areas of hardstanding. These areas reduce infiltration and increase the potential for surface water runoff, damming of water and flooding. Increased runoff velocity and volume could also increase the potential for erosion as discussed under Section 10.3.1.

Damming and flooding may cause damage to property and infrastructure. This impact is considered of low significance as it can be managed through implementing appropriate stormwater controls and since the affected drainage lines are ephermeral..

Activity	**Establishment of the contractor laydown area.**	**Construction of DMS Plant, DMS Stockpile area and associated PCDs, South Portal, Ventilation shafts, staff accommodation and explosive destruction bay**
Project phase	Construction	
Impact Summary	Increased potential for damming and flooding and subsequent damage to property and infrastructure due to hardstanding or compacted areas	
Potential Impact Rating	LOW: Refer Table 10.3	
Management Measures	Stormwater measures should be appropriately designed to allow for free flow of water Areas should be appropriately graded to prevent ponding.	
After Management Impact Rating	LOW: Refer Table 10.3	

Deterioation of water quality

Spillages and accidental discharges could result in the contamination of surface water resources. Localised accidental spillages of hydrocarbons (diesel, oils etc.) from earthmoving and construction equipment, hazardous substances (ammonia nitrates for blasting) and other potentially polluting materials including human waste, could result in contaminated runoff leaving the site if spillages are not contained or inadequate emergency control measures are in place. This could result in indirect contamination of the surface water resources downgradient of the contractor laydown area.

The impact is potentially reversible through a combination of clean-up and assimilation in the watercourse. These potential impacts are considered to be of low significance as the contractor laydown area should be located outside the riparian zone considered to be the greater of the 1:100 year floodline or 100 m distance from the edge of the watercourse whichever is the greater. This impact can be mitigated and should there be an occurrence, the impact will be localised, of short duration and largely reversible.

Activity	**Establishment of the contractor laydown area.**	**Construction of DMS Plant, DMS Stockpile area and associated PCDs, South Portal, Ventilation shafts, staff accommodation and explosive destruction bay**
Project phase	Construction	
Impact Summary	Deterioration in surface water quality due to spillages and accidental discharges.	
Potential Impact Rating	LOW: Refer Table 10.3	LOW: Refer Table 10.3
Management Measures	The impact is potentially reversible through a combination of clean-up and assimilation in the	Clean water diversions should be constructed prior to clearing areas for new infrastructure. Hazardous substances and potentially polluting materials should be stored in appropriately bunded areas located

	watercourse. These potential impacts are considered to be of low significance as the contractor laydown area should be located outside the riparian zone considered to be the greater of the 1:100 year floodline or 100m distance from the edge of the watercourse whichever is the greater. This impact can be mitigated and should there be an occurrence, the impact will be localised, of short duration and largely reversible.	outside of the riparian zone. Bunds should be designed for a capacity of 110% of the stored material. Servicing and maintenance of vehicles and equipment should be done outside the riparian zone in appropriate facilities designed for this purpose. Contractors should be adequately trained in handling of hazardous substances and potentially polluting materials especially during transport in the vicinity of the riparian zone, e.g. over river crossings. Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages. Contaminated runoff should be contained and reused as necessary e.g. for dust suppression. Chemical toilets should be provided at construction sites. Management measures including appropriate design, prevention at source and general housekeeping can largely mitigate potential impacts associated with establishment of the contractor laydown area. The most important measures for managing this impact are appropriate stormwater and pollution control measures in compliance with Regulation 704 to facilitate effective clean and dirty water separation, namely clean water diversions, containment facilities for dirty runoff and bunding around potentially polluting materials. Appropriately located and equipped facilities for servicing of vehicles and equipment and provision of chemical toilets will further reduce the significance of this impact as will the appointment of adequately trained and aware contractors. In the event of spillage, implementation of an appropriate Emergency Action Plan as soon as practicable will enable any impact to be localised and appropriately mitigated.
After Management Impact Rating	LOW: Refer Table 10.3	

Alteration of catchment hydrology causing change in watercourse functionality and increased risk of flooding and scouring.

Changes to surface water hydrology could result due to placement of infrastructure within drainage lines and containment of dirty runoff at the portals, at the DMS Stockpile and ROM stockpile.

Surface drainage paths exist within the footprint area of the proposed infrastructure which capture water during rainfall events, but most of the time are dry. The hydrology of these water courses will have to change to allow the development of the portals and stockpiles, and clean water diversions will be required to route catchment water around these areas (as described in Section 8). Without adequate clean water diversions or suitable grading of areas there is an increased risk of flooding upstream (impedance of flow) which could result in damage to property and infrastructure. The impact will be localised but will remain throughout the activity.

Increased risk of flooding due to changes in catchment hydrology has the greatest significance for:

- the south eastern portion of the Southern Portal that is located adjacent to the 1:100 year floodline of the Groot-Dwars River; and
- eastern portion of the DMS stockpile (Phase 3) and PCD 2 which are located immediately adjacent to the 1:100 year floodline of the Mareesburg Stream.
- The staff accommodation is located within 100 m of the Der Brochen Dam, but outside the 1:100 year floodline.

Measures can be put in place to minimise the risk of flooding and reduce the significance of this impact.

The probability that local water courses will be diverted and will not carry the water falling directly in the footprint area and considered dirty water, is definite, and the overall significance of the impact is therefore rated as <u>moderate</u>. The impact will affect the flow regime and morphology of the watercourse and thus overall functionality of the local surface water courses. Watercourse functions are beyond the scope of this study and are described in the Biodiversity Specialist Report, (SAS 217170, 2019).

Diverted volumes will be concentrated at the clean water outlets and scouring effects on stream banks and bed may occur. Scouring may affect the integrity and stability of the watercourse and infrastructure within the watercourse. Scouring can be mitigated but the change to the surface water hydrology will be long term as the clean water diversions will continue to route the majority of catchment water into the local water courses thus overall significance remains as medium post mitigation.

Activity	**Construction of DMS Plant, DMS Stockpile area and associated PCDs, South Portal, Ventilation shafts, staff accommodation and explosive destruction bay**
Project phase	Construction
Impact Summary	Alteration of catchment hydrology causing change in watercourse functionality and increased risk of flooding and scouring.
Potential Impact Rating	MODERATE: Refer Table 10.3
Management Measures	Runoff from the catchment should be diverted away from the footprint by cut-off channels and diversion berms designed to handle the 1:50 year storm event. (refer to Section 8 for design) . Energy dissipaters should be constructed in areas of concentrated flows. Routine inspections and maintenance should be conducted to keep the diversions free of debris (silt build up, vegetation etc.) and areas suitably graded
After Management Impact Rating	LOW: Refer Table 10.3

Appropriately designed and constructed clean water diversion structures and outlets in compliance with Regulation 704 will return clean water runoff generated upgradient of the relevant infrastructure adjacent to the Groot Dwars River and Mareesburg Stream in manner as close to natural/pre-mining conditions as possible. Energy dissipaters should be constructed at points where there are concentrated discharges of water to the environment that could cause significant erosion and scouring within water channels to reduce the energy and speed of the water flow.

10.4.2 Construction of linear infrastructure: conveyors, gravel maintanence roads to the proposed ventilation shafts, and upgrading of existing gravel roads to tar.

Direct contamination of the Groot Dwars River or its tributaries at the conveyor crossings can occur due to:

- An increase in runoff velocity and volume as a result of soil compaction leading to an increased potential for erosion in disturbed areas with subsequent increase in turbidity, suspended solids and sedimentation in the Groot Dwars River and tributaries especially where crossings are close to or over the watercourse (as described under Section 10.3.1 and 10.3.3.); or
- Spillages and accidental discharges as described under Section 10.4.1;
- Reduced availability of water to downstream users due to obstruction of flow at crossings.

This impact is potentially reversible through a combination of clean-up and assimilation in the watercourse but is considered to be of <u>moderate</u> significance, particularly where the ore conveyor will cross the Groot-Dwars River since the conveyor will cross the riparian zone.

Activity	**Construction of gravel maintanence roads to the proposed ventilation shaft**	**Upgrade of existing gravel roads to tar roads to serve as main access roads**
Project phase	Construction	
Impact Summary	Deterioration of surface water quality due to erosion, spillages and accidental discharges at watercourse crossings.	
Potential Impact Rating	MODERATE: Refer Table 10.3	
Management Measures	The impact limited as there is seldom water in the water courses but there is reliance on this resource for aquatic, floral and faunal diversity (refer SAS, 2019) Construction should take place in the low flow period (dry season). Stormwater culverts at watercourse crossings should be designed and constructed to accommodate the 1:50 year storm event.	

	Areas disturbed by linear construction activities should be rehabilitated immediately on completion of construction of each area. Erosion protection and energy dissipaters should be constructed at the crossings as applicable Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages. Chemical toilets should be provided at construction sites. Rehabilitation should include ripping of compacted soils and revegetation of ripped and other disturbed areas. Weekly water monitoring is also required during construction and for three months post construction (pH, EC and turbidity). The specific conditions are included in the storm water management plan in Section 11.
After Management Impact Rating	LOW: Refer Table 10.3

In an unmanaged scenario; alteration or damming of water where roads cross ephermeral drainage lines could negatively affect downstream ecosystems, promote significant erosion of water course banks, prevent the flow of surface water to the Groot-Dwars River, and cause flooding at and above the point of alteration or obstruction. The impact is considered to be of moderate significance as the roads will cross the drainage lines. This can, however, be mitigated through appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion.

Erosion protection and energy dissipaters should be constructed at points where there are concentrated, high velocity flows of water to the environment that could cause significant erosion to slow the speed of water.

The standard WUL conditions require that construction takes place in the dry season and starts from upstream to downstream with concurrent rehabilitation taking place. Weekly water monitoring is also required during construction and for three months post construction. The specific conditions are included in the storm water management plan in Section 11.

Activity	**Construction of gravel maintanence roads to the proposed ventilation shafts**	**Upgrade of existing gravel roads to tar roads to serve as main access roads**
Project phase	Construction	
Impact Summary	In an unmanaged scenario; alteration or damming of water where roads cross ephermeral drainage lines could negatively affect downstream ecosystems, promote significant erosion of water course banks, prevent the flow of surface water to the Groot-Dwars River, and cause flooding at and above the point of alteration or obstruction.	
Potential Impact Rating	MODERATE, Refer Table 10.3	
Management Measures	The impact limited as there is seldom water in the water courses but there is reliance on this resource for aquatic, floral and faunal diversity (refer SAS, 2019). These are existing gravel roads and as such, it is anticipated that this impact is likely to be minimal. Appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion.	
After Management Impact Rating	LOW, Refer Table 10.3	

10.5 Impacts during operation

10.5.1 Deposition of DMS material onto the DMS Stockpile area

Deterioation of water quality

Rain falling on the stockpiled DMS material could, based on the preliminary geochemical characterisation undertaken by Delta H (Delta H, 2019, KP, 2019); leach trace concentrations of metals and salts to the environment. The water accumulating within the DMS stockpile footprint could potentially runoff into the surface water resources, resulting in a deterioration in water quality and a reduction in availability of water to the downstream users. The risk of leachate to the environment is assumed to be discussed in more detail in the groundwater report (Delta H, 2019).

KP has provided a preliminary design for the DMS Stockpile of a Class C or similar barrier system and drainage system at the downstream end of the stockpile, just before the starter wall, to intercept any water flowing down the liner as discussed in Section 8. The potential for contamination of the surface water due to releases of dirty water runoff is is considered to be of moderate significance due to the proximity to surface water resources.

Activity	**Deposition of the DMS material on the DMS Stockpile**
Project phase	Operational
Impact Summary	Reduced quality of water due to dirty water runoff from the DMS Stockpile
Potential Impact Rating	HIGH: Refer Table 10.3
Management Measures	Utilisation of an appropriate barrier system based on the risk for leachate as discussed in Section 8. During normal operations dirty water should be contained in PCDs designed to handle the 1:50 year event and enable settlement of solids in the contained water prior to reuse. Depending on the quality in the PCD's; spillages and accidental discharges of water from the PCDs can be mitigated by adequate source controls including appropriate design, routine inspections and maintenance and general housekeeping.
After Management Impact Rating	MODERATE: Refer Table 10.3

Impeding the flow in the rivers due to failure of the stockpile

The potential for the DMS stockpile to fail and result in a cause a run out of material was assessed by KP. The potential was assessed as moderate as the material could, due to its proximity, slide ino the Groot-Dwars and Mareesburg Stream (Refer KP Report DB-2018B-09, 2019) and potentially affect the Mareesburg TSF pipeline. KP recommendations to mitigate this risk are provided for reference as follows:

To mitigate this risk, the following actions can be implemented;

- Local slopes on benches could be flattened with earthmoving machinery;
- Increase the step width of the benches to provide a flatter overall slope;
- Provide monitoring / survey beacons on the stockpile to monitor movement of benches.

Activity	**Deposition of the DMS material on the DMS Stockpile**
Project phase	Operational
Impact Summary	Blockages, flooding and loss to operation following failure of the stockpile
Potential Impact Rating	MODERATE: Refer Table 10.3
Management Measures	Appropriate measures including an inspections and maintenance schedule is required to ensure mitigate the risk. KP 2019 further recommend that: • Local slopes on benches could be flattened with earthmoving machinery; • Increase the step width of the benches to provide a flatter overall slope, • Provide monitoring / survey beacons on the stockpile to monitor movement of benches.
After Management Impact Rating	LOW: Refer Table 10.3

10.5.2 Utilisation of stormwater management infrastructure at South Portal and PCD's at DMS Stockpile

The need to capture and contain dirty water generated in the operations (mainly at the DMS Stockpile and South Portal PCDs) will increase the volume of contaminated water that needs to be managed on the mine.

Deterioation of water quality due to surface runoff from the plant areas and discharges from the PCD's

Release of dirty water can occur if the containment facilities are not appropriately managed or during periods of extended high rainfall. Overflow from the dirty water containment facilities can result in the formation of channels and the formation of drainage lines resulting in the water reaching the Groot-Dwars River and/or the Mareesburg Stream (DMS Stockpile Phase 3 only). Such overflows and runoff can have a detrimental impact on surface water quality and result in a loss of availability of drinking water to the downstream community (as discussed in Section 10.3.1.).

Increased risk is associated with:

- The south-eastern portion of South Portal located adjacent to the 1:100 floodline of the Groot-Dwars River;
- The DMS Stockpile (Phase 1 and 2) is located adjacent to the Groot-Dwars River 480 m (closest point) from the Leshaba and Moletsi Community who utilise surface water for domestic use;
- Eastern portion of the DMS stockpile (Phase 3) and PCD_2 is located immediately adjacent to the 1:100 floodline of the Mareesburg Stream.

Activity	**Utilisation of storm water management infrastructure at South Portal, and PCD's at DMS stockpile**
Project phase	Operational
Impact Summary	Reduced quality of water due to discharge from the PCD's.
Potential Impact Rating	HIGH: Refer Table 10.3
Management Measures	Appropriately placed clean water diversions, designed to handle the the 1:50 year event or more conservative AAP requirements should be constructed to divert water away from mining infrastructure and return it to the natural environment. Energy dissipaters should be constructed at points where there are concentrated discharges of water to the environment that could cause significant erosion and scouring within water channels to slow the speed of water and (for example in the storm water diversions around the DMS Stockpiles and Portal). During normal operations dirty water should be contained in PCDs designed to handle the 1:50 year event and enable settlement of solids in the contained water prior to reuse. Manage the overall water on site to fully utilise the storage available on site, for example, do not discharge from the PCDs if there are other dams available for storage..
After Management Impact Rating	MODERATE: Refer Table 10.3

All clean and dirty water separation measures should be appropriately located, designed, operated and managed in compliance with Regulation 704.

Energy dissipaters should be constructed at points where there are concentrated discharges of water to the environment that could cause significant erosion and within water channels to slow the speed of water and (for example in the storm water diversions around the DMS Stockpile and South Portal).

During normal operations dirty water should be contained in PCDs designed to handle the 1:50 year event and enable settlement of solids in the contained water prior to reuse. Water containment facilities should be designed, constructed, operated and maintained to have a minimum freeboard of 0.8 m above full supply level and all other water systems related thereto shall be operated in such a manner that it is at all times capable of handling the 1:50 year flood-event on top of its mean operating level. The quality of the contained water should be monitored on a regular basis and reuse as process water make-up optimised through development of a reuse and reclamation plan.

Routine inspections and maintenance should be conducted to maintain integrity of infrastructure and keep the diversions and silt traps free of debris (silt build up, vegetation etc.) to maintain the 1:50 year capacity.

Reduced availability of water to surrounding water users

The need to capture and contain dirty water generated in the operations (mainly at the DMS Stockpile and South Portal PCDs) may reduced availability of water to surrounding water users. The rainfall that falls within this area will be removed from the catchment and may reduce the quantity of water available to downstream users. The probability that the impact will be contained to the site, and will occur for the duration of the project is definite. Therefore this impact is rated as having a moderate significance. However, loss of MAR due to dirty water containment is considered of LOW significance to the B41G catchment (refer to Section 6.4) but will remain locally at Moderate.

Loss will be minimised through sizing of dirty areas to the minimum required and by the clean water diversion around potentially dirty areas.

Physical obstruction from mine infrastructure (watercourse crossing structures, portal, DMS stockpile, PCD's) may also contribute to reduced availability downstream. Clean water diversions and management of crossings to maintain capacity for the 1:50 year event also reduce potential impacts on quantity downstream to LOW significance.

Activity	**Mine**
Project phase	Operational
Impact Summary	Reducted water available to downstream users.
Potential Impact Rating	MODERATE: Refer Table 10.3
Management Measures	Maintain clean water diversions and crossings to ensure the structures are continuously capable of handling the the 1:50 year event or more conservative AAP requirements. Maintain all water management structures so that only dirty water is contained and clean water is diverted to the natural environment.
After Management Impact Rating	MODERATE: Refer Table 10.3 (Regionally LOW)

Erosion and scouring of water courses at diversion outlets due to stormwater runoff from the mine

Alteration of catchment hydrology causing change in watercourse functionality and increased risk of flooding and scouring. Surface drainage paths exist within the footprint area of the proposed infrastructure which capture water during rainfall events, but most of the time are dry. The hydrology of these water courses will have to change to allow the development of the portals and stockpiles, and clean water diversions will be required to route catchment water around these areas (as described in Section 8). This alteration of catchment hydrology can cause a change in watercourse functionality which, without adequate clean water diversions or suitable grading of areas, could result in an increased risk of flooding upstream (impedance of flow) which could result in damage to property and infrastructure. The impact will be localised but will remain throughout the activity.

Activity	**Mine**
Project phase	Operational
Impact Summary	Erosion and scouring of water courses at diversion outlets due to stormwater runoff from the mine can result due to alteration of the catchment
Potential Impact Rating	MODERATE: Refer Table 10.3
Management Measures	Runoff from the catchment should be diverted away from the footprint by cut-off channels and diversion berms designed to handle the 1:50 year storm event. (refer to Section 8 for design) . Energy dissipaters should be constructed in areas of concentrated flows. Routine inspections and maintenance should be conducted to keep the diversions free of debris (silt build up, vegetation etc.) and areas suitably graded
After Management Impact Rating	MODERATE: Refer Table 10.3 (Regionally LOW)

10.5.3 Underground mechanised mining at South Portal

The underground mining at the South Portal will enter via a boxcut. These areas are located to the west of the Groot-Dwars River within the deignated infrastructure areas as described in Section 8. The rainfall that falls within this area will be removed from the catchment and may reduce the quantity of water available to downstream users. The probability that the impact will be contained to the site, and will occur for the duration of the project is definite. Therefore this impact is rated as having a moderate significance. This impact is mitigated by the same measures as indicated in Section 10.5.2.

10.5.4 Stockpiling of ore material at Mototolo Concentrator (ROM), Operation of Chrome Recovery Inter-stage Plant and DMS Plant

The stockpiling of ore material at Mototolo Concentrator (ROM), Operation of Chrome Recovery Inter-stage Plant and DMS Plantrainfall water within the North and South Portal area all occur within the already affected Mototolo Concentrator area where there are already existing measures for the containment of dirty water runoff. The ROM is located down-stream of the stormwater diversion from Helena TSF and the structures will therefore need to divert this and the stormwater around the ROM.

Management and monitoring of the PCD and the improvements noted for the operational areas around the Mototolo Concentrator (refer to Redco, 2018) should be implemented but this forms part of the current site management and as such is excluded from this study.

Activity	**Stockpiling of ore material at Mototolo Concentrator (ROM), Operation of Chrome Recovery Inter-stage Plant and DMS Plant**
Project phase	Operational
Impact Summary	Reduced quantiy of water due to containment of dirty water runoff and deteriorationin water quality due to spillages from dirty water areas.
Potential Impact Rating	LOW: Refer Table 10.3
Management Measures	New activities are located within the Mototolo Concentrator Plant and additional impacts are therefore not antipated. Management and monitoring of the PCD and the improvements noted for the operational areas around the Mototolo Concentrator (refer to Redco, 2018) should be implemented but this forms part of the current site management and as such is excluded from this study.
After Management Impact Rating	LOW: Refer Table 10.3

10.5.5 Dangerous good storage and waste management

Spillages and accidental discharges from dangerous good storage areas and waste management facilities could locally affect the surface water resources.

These are, however, assumed to be located within the South Portal area, and as such can be contained within the MSD and/or PCD's. The significance is therefore as discussed in Section 10.5.2.

Wash water from the Trackless Mobile Machinery (TMM) workshop will drain to a silt trap with an oil separator. Water from the oil separator will drain into the settling ponds, from where the water will flow into the mine service water dam for transfer to the mine service water tank for reuse underground or on surface as wash water. Any excess water will flow via the spillway to the PCD for transfer to the concentrator for reuse in the process water circuit.

Spillages and accidental discharges can be mitigated by adequate source controls including appropriate design, routine inspections and maintenance and general housekeeping. In the event of spillage, implementation of an appropriate Emergency Action Plan as soon as practicable will enable any impact to be appropriately addressed.

Activity	**Dangerous good storage and waste management**
Project phase	Operational
Impact Summary	Reduced quantiy of water due to spillages
Potential Impact Rating	MODERATE: Refer Table 10.3

Management Measures	Contain spillages in silt and/or oil traps which are then contained within the MSD and/.or PCD's. Carry out management as described for the DMS Stockpile and Portal PCD's. Spillages and accidental discharges can be mitigated by adequate source controls including appropriate design, routine inspections and maintenance and general housekeeping. In the event of spillage, implementation of an appropriate Emergency Action Plan as soon as practicable will enable any impact to be appropriately addressed.
After Management Impact Rating	LOW: Refer Table 10.3

10.5.6 Utilisation and operation of linear structures including the temporary haulage of ore, operation of the conveyor systems, utilisation of tar and gravel roads

Changes to the hydrology at the gravel and tar road crossings will continue from the construction phase, as for construction the main impacts are:

- Reduced availability of water to downstream users due to obstruction of flow at crossings; and
- Deterioration of surface water quality due to erosion, spillages and accidental discharges at conveyor or road crossings.

Along the haul road/conveyor route, culverts will accommodate storm flows in the drainage lines crossed. These drainage lines are typically dry under normal weather conditions but during rain events will contribute flow to the Groot Dwars River.

Physical obstruction from mine infrastructure (watercourse crossing structures, portal, DMS stockpile, PCD's) may also contribute to reduced availability downstream. Clean water diversions and management of crossings to maintain capacity for the 1:50 year event also reduce potential impacts on quantity downstream to LOW significance.

Appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion. The specific conditions are included in the storm water management plan in Section 11.

Activity	**Use of existing gravel roads for pre-construction activities**
Project phase	Operation
Impact Summary	Reduced availability of water to downstream users due to obstruction of flow at crossings and Deterioration of surface water quality due to erosion, spillages and accidental discharges at conveyor or road crossings.
Potential Impact Rating	MODERATE, Refer Table 10.3
Management Measures	The impact limited as there is seldom water in the water courses but there is reliance on this resource for aquatic, floral and faunal diversity (refer SAS, 2019). Appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion. Along the haul road/conveyor route, culverts will accommodate storm flows in the drainage lines crossed. Contractors should be made aware of the WUL conditions that apply during transfer of ore and/or materials and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages.
After Management Impact Rating	LOW, Refer Table 10.3

10.5.7 Staff accommodation at Debrochen Dam

Staff accommodation is proposed over a small area located adjacent to Der Brochen Dam. The potential impact is likely to be as for 10.4.1.

Activity	**Staff accomodation**
Project phase	Operation

Impact Summary	Provision of hardstanding areas and compacted areas could reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding. Increased runoff velocity
Potential Impact Rating	LOW, Refer Table 10.3
Management Measures	Areas should be appropriately graded to prevent ponding.
After Management Impact Rating	LOW, Refer Table 10.3

10.5.8 Insufficient water to sustain mining activities

The mine has limited water available under the current water authorisations to sustain the mine without water conservation and storage of excess water.

Activity	**Mine**
Project phase	Operational
Impact Summary	Limited water available to sustain mine.
Potential Impact Rating	HIGH: Refer Table 10.3
Management Measures	Buffer storage and water conservation are critical to sustain the mine.
After Management Impact Rating	MODERATE: Refer Table 10.3

The following should be noted from the water balance Report:

- Generally, the make-up water is consistent during the winter period, but variable during the wet season and it is recommended that the wellfield development must form part of the feasibility study; and
- In order not to spill from the system, a buffer facility (RWD A and RWD B), were included as additional buffer storage into the model. This excess water was then used as make-up when appropriate.

10.6 Impacts during closure/rehabilitation

10.6.1 Removal of all plant equipment including conveyor belt systems and staff accomodation

The impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction and pre-construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction and pre-construction phase.

10.6.2 Rehabilitation of the DMS Stockpile and PCDs

The impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction and pre-construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction phase. There will be concurrent rehabilitation of disturbed and/or contaminated areas so there is no residual contamination from the stockpiles (e.g. oil spills and silt load from eroded areas) remaining at closure.

During the closure and decommissioning phase, the PCDs and associated infrastructure should be removed and the footprint areas rehabilitated.

The DMS Stockpile will remain in-situ and should be vegetated to manage on-going dust generation and erosion. All rehabilitation activities should be monitored until vegetation is well established and no further surface water quality impacts are deemed likely.

10.6.3 Rehabilitation of the DMS Stockpile and PCDs

As above, the impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction phase.

10.7 Post-closure

The main activity identified during the post-closure phase that has the potential to impact on surface water resources is dispersion of the contaminated groundwater plume which is discussed in the groundwater specialist report.

During the post-closure phase, all infrastructure will have been removed or vegetated (DMS stockpile), therefore the surface water quality should not be further impacted by any of the post-closure activities.

Table 10-3: Method for rating the significance of impacts

Nature of the impact		Significance of potential impact BEFORE mitigation							Mitigation Measures	Significance of potential impact AFTER mitigation							degree of mitigation (%)
		Probability	Duration	Extent	Magnitude	Loss of Resources	Significance			Probability	Duration	Extent	Magnitude	Loss of Resources	Significance		
Pre-Construction Phase																	
Site clearing of all footprint areas associated with the proposed project infrastructure																	
***Reduction in water quality due to an increase in turbidity as a result of an increase in erosion from cleared areas, topsoil stockpiles or any other area where there are exposed soils can occur during storm events**. Increased erosion can result in an increase in turbidity, suspended solids and sedimentation in the Groot-Dwars River and tributaries (indirect and cumulative impact). Some level of sedimentation is expected to occur in the Groot-Dwars River and/or Mareesburg Stream pre-development as runoff is naturally anticipated to pick up environmental debris as it crosses natural areas. The increase in turbidity/suspended solids can result in a deterioation in the water quality such that water is no longer available for use by downstream users (indirect impact). It is noted that: 1) The south-eastern portion of South Portal located adjacent to the 1:100 floodline of the Groot-Dwars River, 2) The DMS Stockpile (Phase 1 and 2) is located adjacent to the Groot-Dwars River 480 m (closest point) from the Leshaba and Moletsi Community who utilise surface water for domestic use. 2) Eastern portion of the DMS stockpile (Phase 3) and PCD_2 is located immediately adjacent to the 1:100 floodline of the Mareesburg Stream.*	-	4	2	1	8	1	**44**	**Moderate**	*Increased turbidity is reversible and surface water should return to pre-impact turbidity levels once sediment levels entering the watercourse are reduced. Settled sediments should naturally move downstream during periods of high flow flowing storm events. Further management measures include: 1_Clearing of vegetation should be limited to the minimum area safe for construction and operation. 2_Flood protection berms should be constructed at the area where the Southern Portal and DMS Stockpile 3_Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction. 4_Clean water diversion bunds should be constructed upstream of the construction site prior to clearing areas for new infrastructure. 5_PCD's should be constructed downstream of the working activities to minimise uncontrolled runoff from the site. 6_Areas disturbed by construction activities should be rehabilitated immediately on completion of construction of each area. 7_Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact.*	3	2	1	6	1	**27**	**Low**	38.6
Stockpiling of Topsoil																	
Stripping of topsoil for DMS Stockpiles and portals can result in an increase in erosion from cleared areas as discussed above. The Topsoil Stockpile is located with the 100 m zone of Regulation GN 704 and GN509 to the south and east of the Groot-Dwars River (more than 1 km upstream of the Leshaba and Moletsi Community who utilise surface water for domestic use). The stockpile could become eroded during storm events and result in localised deterioration of water quality due to increased turbidity and suspended soilids in the Groot-Dwars River during storm events.	-	4	3	1	6	1	**40**	**Moderate**	*Increased turbidity is reversible and surface water should return to pre-impact turbidity levels once sediment levels entering the watercourse are reduced. Settled sediments should naturally move downstream during periods of high flow flowing storm events. Further management measures include: Clearing of vegetation should be limited to the minimum area safe for construction and operation. Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction. Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact. The topsoil stockpile should be vegetated and while vegetating, measures will be needed to contain erosion of the stockpile during rain events.*	3	3	1	4	1	**24**	**Low**	40.0
Use of existing gravel roads for pre-construction activities																	
In an unmanaged scenario; alteration or damming of water where roads cross ephermeral drainage lines could negatively affect downstream ecosystems, promote significant erosion of water course banks, prevent the flow of surface water to the Groot-Dwars River, and cause flooding at and above the point of alteration or obstruction.	-	2	2	1	4	1	**14**	**Low**	*The impact limited as there is seldom water in the water courses but there is reliance on this resource for aquatic, floral and faunal diversity (refer SAS, 2019). These are existing gravel roads and as such, it is anticipated that this impact is likely to be minimal Appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion.*	2	2	1	2	1	**10**	**Low**	28.6
Construction Phase																	
Construction of infrastructure (DMS Plant, DMS Stockpile area and associated PCDs, conveyor belt systems, South Portal, Ventilation shafts, staff accommodation and explosive destruction bay)																	
Reduction in water quality due to an increase in turbidity as a result of an increase in erosion due to cleared, compacted or hardstanding areas.	-	4	2	1	8	1	**44**	**Moderate**	*Increased turbidity is reversible and surface water should return to pre-impact turbidity levels once sediment levels entering the watercourse are reduced. Settled sediments should naturally move downstream during periods of high flow flowing storm events. Further management measures include: 1_Clearing of vegetation should be limited to the minimum area safe for construction and operation. 2_Flood protection berms should be constructed at the area where the Southern Portal and DMS Stockpile 3_Erosion control measures in the form of temporary erosion prevention berms should be implemented during construction. 4_Clean water diversion bunds should be constructed upstream of the construction site prior to clearing areas for new infrastructure. 5_PCD's should be constructed downstream of the working activities to minimise uncontrolled runoff from the site. 6_Areas disturbed by construction activities should be rehabilitated immediately on completion of construction of each area. 7_Activities should be limited to months of low rainfall (dry season) to reduce probability of potential impact.*	3	2	1	6	1	**27**	**Low**	38.6
Provision of hardstanding areas and compacted areas will reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding. Increased runoff velocity	-	3	2	1	2	1	**15**	**Low**	*Stormwater measures should be appropriately designed to allow for free flow of water Areas should be appropriately graded to prevent ponding.*	2	2	1	2	1	**10**	**Low**	33.3
Deterioration in surface water quality due to spillages and accidental discharges. Spillages and accidental discharges could result in the contamination of surface water resources. Localised accidental spillages of hydrocarbons (diesel, oils etc.) from earthmoving and construction equipment, hazardous substances (ammonia nitrates for blasting) and other potentially polluting materials including human waste, could result in contaminated runoff leaving the site if spillages are not contained or inadequate emergency control measures are in place. This could result in indirect contamination of the surface water resources.	-	2	2	1	2	1	**10**	**Low**	*Clean water diversions should be constructed prior to clearing areas for new infrastructure. Hazardous substances and potentially polluting materials should be stored in appropriately bunded areas located outside of the riparian zone. Bunds should be designed for a capacity of 110% of the stored material. Servicing and maintenance of vehicles and equipment should be done outside the riparian zone in appropriate facilities designed for this purpose. Contractors should be adequately trained in handling of hazardous substances and potentially polluting materials especially during transport in the vicinity of the riparian zone, e.g. over river crossings. Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages. Contaminated runoff should be contained and reused as necessary e.g. for dust suppression. Chemical toilets should be provided at construction sites.*	1	2	1	2	1	**5**	**Low**	50.0

Nature of the impact	Significance of potential impact BEFORE mitigation								Mitigation Measures	Significance of potential impact AFTER mitigation							degree of mitigation (%)
		Probability	Duration	Extent	Magnitude	Loss of Resources (%)	Significance			Probability	Duration	Extent	Magnitude	Loss of Resources	Significance		
Construction Phase																	
Alteration of catchment hydrology causing change in watercourse functionality and increased risk of flooding and scouring. *Surface drainage paths exist within the footprint area of the proposed infrastructure which capture water during rainfall events, but most of the time are dry. The hydrology of these water courses will have to change to allow the development of the portals and stockpiles, and clean water diversions will be required to route catchment water around these areas (as described in Section 8). This alteration of catchment hydrology can cause a change in watercourse functionality which, without adequate clean water diversions or suitable grading of areas, could result in an increased risk of flooding upstream (impedance of flow) which could result in damage to property and infrastructure. The impact will be localised but will remain throughout the activity.*	-	3	4	2	6	2	36	Moderate	*The impact limited as there is seldom water in the water courses but there is reliance on this resource for aquatic, floral and faunal diversity (refer SAS, 2019).* *These are existing gravel roads and as such, it is anticipated that this impact is likely to be minimal* ***Appropriately designed and constructed crossing structures and stormwater outlets in compliance with Regulation 704 will reduce the potential for erosion. Ongoing maintanence and monitoring is required. The specific conditions are included in the storm water management plan in Section 11***	2	4	2	6	2	24	Low	33.3
Establishment of contractor laydown area																	
Provision of hardstanding areas will reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding as discussed above	-	3	2	1	2	1	15	Low	*Stormwater measures should be appropriately designed to allow for free flow of water* *Areas should be appropriately graded to prevent ponding.*	2	2	1	2	1	10	Low	33.3
Spillages and accidental discharges could result in the contamination of surface water resources. Localised accidental spillages of hydrocarbons (diesel, oils etc.) from earthmoving and construction equipment, hazardous substances (ammonia nitrates for blasting) and other potentially polluting materials including human waste, could result in contaminated runoff leaving the site if spillages are not contained or inadequate emergency control measures are in place. This could result in indirect contamination of the surface water resources downgradient of the contractor laydown area.	-	3	2	1	2	1	15	Low	*The impact is potentially reversible through a combination of clean-up and assimilation in the watercourse. These potential impacts are considered to be of low significance as the contractor laydown area should be located outside the riparian zone considered to be the greater of the 1:100 year floodline or 100m distance from the edge of the watercourse whichever is the greater. This impact can be mitigated and should there be an occurrence, the impact will be localised, of short duration and largely reversible.*	2	2	1	2	1	10	Low	33.3
Construction of gravel maintenance roads to the proposed ventilation shafts																	
Deterioration of surface water quality due to erosion, spillages and accidental discharges at conveyor or road crossings.	-	3	4	1	6	1	33	Moderate	*Construction should take place in the low flow period (dry season).* *Areas disturbed by linear construction activities should be rehabilitated immediately on completion of construction of each area.* *Erosion protection and energy dissipaters should be constructed at the crossings as applicable* *Contractors should be made aware of the WUL conditions that apply during construction and made liable for environmental damages caused by spillages.* *Emergency action plans should be drawn up to deal with spillages.* *Chemical toilets should be provided at construction sites* *Rehabilitation should include ripping of compacted soils and revegetation of ripped and other disturbed areas.*	2	4	1	6	1	22	Low	33.3
Reduced availability of water to downstream users due to obstruction of flow at crossings	-	4	4	1	6	1	44	Moderate	*Stormwater culverts at watercourse crossings should be designed and constructed to accommodate the 1:50 year storm event.* *Erosion protection and energy dissipaters should be constructed at the crossings as applicable*	3	4	1	4	1	27	Low	38.6
Upgrading of existing gravel roads to tar roads to serve as main access roads																	
As above for gravel maintanence roads	-	3	4	1	6	1	33	Moderate	*As above for linear structures.*	2	4	1	6	1	22	Low	33.3
Operational Phase																	
Deposition of DMS material onto the DMS Stockpile Area																	
Deterioation of surface water quality due to surface water runoff of leachate from the DMS material.*Rain falling on the stockpiled DMS material could, based on the preliminary geochemical characterisation undertaken by Delta H (Delta H, 2019, KP, 2019) ; leach trace concentrations of metals and salts to the environment. The water accumulating within the DMS stockpile footprint could potentially runoff into the surface water resources, resulting in a deterioration in water quality and a reduction in availability of water to the downstream users. The risk of leachate to the environment is assumed to be discussed in more detail in the groundwater report (Delta H, 2019).*	-	4	4	2	8	1	56	Moderate	*Utilisation of an appropriate barrier system based on the risk for leachate as discussed in Section 8.* *During normal operations dirty water should be contained in PCDs designed to handle the 1:50 year event and enable settlement of solids in the contained water prior to reuse.* *Depending on the quality in the PCD's; spillages and accidental discharges of water from the PCDs can be mitigated by adequate source controls including appropriate design, routine inspections and maintenance and general housekeeping.*	3	4	2	6	1	36	Moderate	35.7
Reduced availability of water to downstream users due to containment of dirty water and alteration of catchment hydrology (volume). The rainfall that falls within this area will be removed from the catchment and may reduce the quantity of water available to downstream users.	-	5	4	1	6	1	55	Moderate	*The probability that the impact will be contained to the site, and will occur for the duration of the project is definite. Therefore this impact is rated as having a moderate significance. However, loss of MAR due to dirty water containment is considered of LOW significance to the B41G catchment (refer to Section 6.4) but will remain locally at Moderate.* *Maintain all water management structures so that only dirty water is contained and clean water is diverted to the natural environment.* *Maintain clean water diversions and crossings to ensure the structures are continuously capable of handling the the 1:50 year event or more conservative AAP requirements.*	5	4	1	4	1	45	Moderate	18.2
Erosion and scouring of water courses at diversion outlets due to stormwater runoff from the mine.	-	5	4	1	6	1	55	Moderate	*Runoff from the catchment should be diverted away from the footprint by cut-off channels and diversion berms designed to handle the 1:50 year storm event. (refer to Section 8 for design) .* *Energy dissipaters should be constructed in areas of concentrated flows.* *Routine inspections and maintenance should be conducted to keep the diversions free of debris (silt build up, vegetation etc.) and areas suitably graded*	4	4	1	4	1	36	Moderate	34.5
Underground mechanised mining at South Portal																	
Reduced availability of water to downstream users due to containment of dirty water and alteration of catchment hydrology (volume). The rainfall that falls within this area will be removed from the catchment and may reduce the quantity of water available to downstream users.	-	5	4	1	4	1	45	Moderate	*The probability that the impact will be contained to the site, and will occur for the duration of the project is definite. Therefore this impact is rated as having a moderate significance. However, loss of MAR due to dirty water containment is considered of LOW significance to the B41G catchment (refer to Section 6.4) but will remain locally at Moderate.* *Maintain all water management structures so that only dirty water is contained and clean water is diverted to the natural environment.* *Maintain clean water diversions and crossings to ensure the structures are continuously capable of handling the the 1:50 year event or more conservative AAP requirements.*	5	4	1	2	1	35	Moderate	22.2

Nature of the impact		Significance of potential impact BEFORE mitigation: Probability	Duration	Extent	Magnitude	Loss of Resources	Significance		Mitigation Measures	Significance of potential impact AFTER mitigation: Probability	Duration	Extent	Magnitude	Loss of Resources	Significance		degree of mitigation (%)
Operational Phase																	
Stockpiling of ore material at Mototolo Concentrator																	
New activities are located within the Mototolo Concentrator Plant and additional impacts are therefore not antipated.	-	2	4	1	6	1	22	Low	*Management and monitoring of the PCD and the improvements noted for the operational areas around the Mototolo Concentrator (refer to Redco, 2018) should be implemented but this forms part of the current site management and as such is excluded from this study. The ROM is located down-stream of the stormwater diversion from Helena TSF and the structures will therefore need to divert this and the stormwater around the ROM*	2	4	1	6	1	22	Low	0.0
Operation of the Chrome Recovery Inter-Stage Plant																	
New activities are located within the Mototolo Concentrator Plant and additional impacts are therefore not antipated.	-	2	4	1	6	1	22	Low	*Management and monitoring of the PCD and the improvements noted for the operational areas around the Mototolo Concentrator (refer to Redco, 2018) should be implemented but this forms part of the current site management and as such is excluded from this study.*	2	4	1	6	1	22	Low	0.0
Operation of the DMS Plant																	
New activities are located within the Mototolo Concentrator Plant and additional impacts are therefore not antipated.	-	2	4	1	6	1	22	Low	*Management and monitoring of the PCD and the improvements noted for the operational areas around the Mototolo Concentrator (refer to Redco, 2018) should be implemented but this forms part of the current site management and as such is excluded from this study.*	2	4	1	6	1	22	Low	0.0
Dangerous Goods storage (including hydrocarbons/chemicals/explosives)																	
Spillages and accidental discharges from dangerous good storage areas and waste management facilities could locally affect the surface water resources.	-	4	2	1	8	1	44	Moderate	*Contain spillages in silt and/or oil traps which are then contained within the MSD and/.or PCD's. Carry out management as described for the DMS Stockpile and Portal areas PCD's. Spillages and accidental discharges can be mitigated by adequate source controls including appropriate design, routine inspections and maintenance and general housekeeping. In the event of spillage, implementation of an appropriate Emergency Action Plan as soon as practicable will enable any impact to be appropriately addressed.*	3	2	1	6	1	27	Low	38.6
Waste Management																	
Spillages and accidental discharges from dangerous good storage areas and waste management facilities could locally affect the surface water resources.	-	4	2	1	8	1	44	Moderate	*Contain spillages in silt and/or oil traps which are then contained within the MSD and/.or PCD's. Carry out management as described for the DMS Stockpile and Portal PCD's. Spillages and accidental discharges can be mitigated by adequate source controls including appropriate design, routine inspections and maintenance and general housekeeping. In the event of spillage, implementation of an appropriate Emergency Action Plan as soon as practicable will enable any impact to be appropriately addressed.*	3	2	1	6	1	27	Low	38.6
Temporary hauling of ore from South Portal to Mototolo Concentrator along the corridor associated with the Ore Conveyor System (whilst conveyor system is being constructed)																	
Deterioration of surface water quality due to erosion, spillages and accidental discharges at conveyor or road crossings.	-	3	4	1	6	1	33	Moderate	*Erosion protection and energy dissipaters should be maintained at the crossings as applicable Contractors should be made aware of the WUL conditions that apply during transfer of ore and/or materials and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages.*	2	4	1	6	1	22	Low	33.3
Reduced availability of water to downstream users due to obstruction of flow at crossings	-	4	4	1	6	1	44	Moderate	*Stormwater culverts at watercourse crossings should be designed and constructed to accommodate the 1:50 year storm event. Erosion protection and energy dissipaters should be constructed at the crossings as applicable*	3	4	1	4	1	27	Low	38.6
Operation of Conveyor Systems																	
As above for the hauling of ore	-	3	4	1	6	1	33	Moderate	*Erosion protection and energy dissipaters should be maintained at the crossings as applicable Contractors should be made aware of the WUL conditions that apply during transfer of ore and/or materials and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages.Stormwater culverts at watercourse crossings should be designed and constructed to accommodate the 1:50 year storm event.*	2	4	1	6	1	22	Low	33.3
Utilisation of tar access roads																	
As above for the hauling of ore	-	3	4	1	6	1	33	Moderate	*Erosion protection and energy dissipaters should be maintained at the crossings as applicable Contractors should be made aware of the WUL conditions that apply during transfer of ore and/or materials and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages.Stormwater culverts at watercourse crossings should be designed and constructed to accommodate the 1:50 year storm event.*	2	4	1	6	1	22	Low	33.3
Utilisation of gravel maintenance roads associated with the ventilation shafts																	
As above for the hauling of ore	-	3	4	1	6	1	33	Moderate	*Erosion protection and energy dissipaters should be maintained at the crossings as applicable Contractors should be made aware of the WUL conditions that apply during transfer of ore and/or materials and made liable for environmental damages caused by spillages. Emergency action plans should be drawn up to deal with spillages.Stormwater culverts at watercourse crossings should be designed and constructed to accommodate the 1:50 year storm event.*	2	4	1	6	1	22	Low	33.3
Utilisation of the Staff Accommodation near the Der Brochen Dam																	
Provision of hardstanding areas and compacted areas will reduce infiltration and increase the volume and velocity of stormwater runoff with subsequent potential for damming of water and flooding. Increased runoff velocity	-	2	2	1	2	1	10	Low	*Areas should be appropriately graded to prevent ponding.*	2	2	1	2	1	10	Low	0.0
Insufficient water to sustain mining activities																	
Limited water available to sustain mine	-	5	4	2	8	3	70	High	*Buffer storage and water conservation are critical to sustain the mine.*	4	4	2	8	4	56	Moderate	20.0

Nature of the impact		Significance of potential impact BEFORE mitigation: Probability	Duration	Extent	Magnitude	Loss of Resources (%)	Significance		Mitigation Measures	Significance of potential impact AFTER mitigation: Probability	Duration	Extent	Magnitude	Loss of Resources	Significance		degree of mitigation (%)
Decommissioning and Rehabilitation Phase																	
Pre-Decommissioning planning (* for Social component only)																	
Not applicable																	
Removal of all plant equipment including conveyor belt systems and staff accommodation																	
The impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction phase.	+	3	4	1	6	1	33	Moderate	*As above for construction phase.*	2	4	1	6	1	22	Low	33.3
Rehabilitation of the DMS Stockpile and PCD																	
The impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction phase.	+	3	4	1	6	1	33	Moderate	*As above for construction phase. The DMS Stockpile will remain in-situ and should be revegetated to manage on-going dust generation and erosion. All rehabilitation activities should be monitored until vegetation is well established and no further surface water quality impacts are deemed likely.*	2	4	1	6	1	22	Low	33.3
Closure of the South Portal and underground workings																	
The impacts on closure/rehabilitation are likely to be similar to the water quality and erosion impacts discussed in the construction phase. No additional impacts are envisaged as this activity should be restricted to the already disturbed areas. These impacts have therefore been addressed in the construction phase.	+	3	4	1	6	1	33	Moderate	*As above for construction phase. The DMS Stockpile will remain in-situ and should be revegetated to manage on-going dust generation and erosion. All rehabilitation activities should be monitored until vegetation is well established and no further surface water quality impacts are deemed likely.*	2	4	1	6	1	22	Low	33.3
Post Closure																	
The main activity identified during the post-closure phase that has the potential to impact on surface water resources is dispersion of the contaminated groundwater plume which is discussed in the groundwater specialist report.	+	2	2	1	2	1	10	Low	*During the post-closure phase, all infrastructures will have been removed, therefore the surface water quality should not be further impacted by any of the post-closure activitiespact*	1	2	1	2	1	5	Low	50.0

11 Surface Water Management Plan

The proposed Surface Water Management Plan has been prepared to ensure that effective water resource mitigation measures are implemented and maintained during all phases of the project. Specific impacts and risks associated with the proposed water-related activities that need to be managed include:

- Siltation of watercourses largely during the construction phase due to vegetation removal, soil instability, erosion and disturbance of topsoil;
- Pollution of water resources due to accidental spillages and releases of dirty water;
- Stormwater runoff and changes to catchment hydrology;
- Water supply to the mine.

Day to day management and supervision of the implementation of the Surface Water Management Plan should primarily be the responsibility of the Der Brochen Land Manager and appointed Environmental Control Officer(s), as applicable, hereafter referred to as the appointed environmental persons.

11.1 General requirements

The appointed environmental persons should:

- Make all contractors and employees involved in any way with the construction and operation of the proposed infrastructure aware of the existing WUL conditions, specifically Appendix IV of the WUL for clean water diversions and crossings, and Appendix V for dirty water containment. Ensure the WUL conditions are implemented accordingly as these standard conditions are likely to also be applied by DWA to the proposed new infrastructure;
- Maintain all records of implementation of the applicable WUL conditions for auditing purposes;
- Familiarise themselves with all engineering drawings covering soil and water management measures associated with the proposed infrastructure construction;
- Demarcate the 1:100 year floodline and 100 m boundary, whichever is the greater, in the Southern Portal and DMS Stockpile area to ensure that development of the Southern Portal and/or DMS Stockpile (including the PCD) does not encroach into the riparian zone except in the area where flood protection berms are in place;
- Regularly meet with all relevant supervisors, personnel, contractors, monitoring personnel (i.e. during toolbox meetings) to ensure the communication and implementation of this surface water management plan;
- Ensure activities within the riparian zone are scheduled for the dry season as far as possible;
- Maintain a regular programme of monitoring to obtain water pH, electrical conductivity (EC) and turbidity monitoring and observational data including photographs pre-construction (refer to Appendix C), during construction and post construction/rehabilitation;
- Implement any remedial measures required as a result of site inspection and monitoring findings;
- Ensure that all hazardous chemicals, fuels and materials are stored appropriately on site and an MSDS for each material is readily available for review in an emergency. Bunds should have a capacity of 110% of the stored material;
- Ensure servicing and maintenance of vehicles and equipment is done outside the riparian zone in appropriate facilities designed for this purpose;
- Deploy an oil and fuel spill containment boom at a suitable downgradient position if applicable;
- Ensure spill kits and other mitigation equipment are available for rapid deployment;
- Ensure construction areas are rehabilitated in a timely and progressive manner;
- Report directly and regularly to the project management on current soil and water management status; and
- Ensure this plan is regularly reviewed and amended where site conditions dictate new or revised strategies of management.

11.2 Construction phase

The management measures include a range of measures recommended by relevant Guidelines that should be implemented where reasonable and feasible. Best practices for erosion controls are provided in Table 11-1

Table 11-1: Summary of best practices for erosion controls

Issues	Mitigation measures
Soil stability	Compact to minimum standard
Channel soil erosion	Protect with appropriate controls, for example, Armorflex
Daylight shoots (high velocities)	Implement energy dissipaters
Culverts and diversion discharge points	Implement energy dissipaters and protect with appropriate controls, for example concrete aprons, weaved mesh gabion and rock mattress structures.
Embankment erosion	Vegetate with grass or alternative controls as appropriate

The requirements of Appendix IV of the 2011 WUL, which were applicable to the construction of the currently authorised weirs, also apply to the proposed crossings and diversions. The recommended measures in this section are aligned with the WUL requirements but do not replace the WUL requirements, which are as follows:

- Condition 1.5 - Construction activities must not take place within the 1:100 year flood-line or within a horizontal distance of 100 meters from any watercourse, estuary, borehole or well, whichever is the greatest, unless authorised by this licence (as part of the activities described in the Report(s) (referred to in condition 1.2) submitted to the Department);
- Condition 1.12 and 7.2 - Construction activities at or close to river crossings, streams or wetlands must be scheduled to take place during the dry seasons when flows are lowest;
- Condition 1.11 & 4.4 - Construction activities shall start up-stream and proceed into a down-stream direction, so that the recovery processes can start immediately, without further disturbance from upstream construction works;
- Condition 1.15 - The construction camp shall not be located within the 1:100 year flood line or within 100 m of any watercourse whatever the greatest;
- Condition 3.1 - The in-stream water quality must be analysed on weekly basis during the construction of the activities of the river diversion, at the monitoring points for both upstream and downstream of the activities for the river diversion for the following variables: pH, Electrical conductivity (ms/m), suspended solids (mg/l), and total dissolved solids (mg/l). Monitoring shalt continue on monthly basis for three months after the cessation of the activities;
- Condition 6.1 - All disturbed areas must be re-vegetated with an indigenous seed mix in consultation with an indigenous plant expert, ensuring that during rehabilitation only indigenous shrubs, trees and grasses are used in restoring the biodiversity; and
- Condition 7.4.2 - Where appropriate, large individual indigenous riparian trees shall be avoided during construction and shall be clearly marked on site.

11.2.1 Cut to fill earthworks operations

Cutting and filling operations will be designed and engineered to ensure cutting profiles will provide long term stability. The following will also need consideration during “Cut and Fill” operations:

- Actual locations and appropriate measures will be assessed by the engineering consultant after detailed investigation and opening of the access road cuttings where required taking into account any soil test results;
- Where cut and fill batters are not required to be supported by engineered structures, graded batters for temporary and permanent cuts should be formed at normally accepted angles;
- During and following construction, all soil and rock batters should be inspected by geotechnical consultants to confirm their stability and recommend stabilisation measures if necessary;
- Excavated soils should be suitably stockpiled and separated into discrete material types; and
- Stockpiles should be appropriately bunded and, where possible, progressively rehabilitated to minimise any run-off or windblown dust.

It should be the responsibility of the appointed person(s) to ensure that contractors follow all engineering design and best practice in regard to managing erosion and sediment control from cutting and filling operations and to promptly raise any issues of concern at site meetings.

The principal objective underlying the design and construction of diversions should be to:

- Ensure stability of the diversion and associated embankments;
- Produce negligible post construction settlement; and
- Minimize the potential for piping, undercutting or slumping.

11.2.2 Soil stability

- Embankment stability should be managed by adopting fill batter slopes with a maximum grade of 2H:1V, where geotechnical information is not available for the soil type, along with adequate compaction of the fill materials. Fill embankments should also be keyed into sloping ground by benching;
- Potential instability in embankment fill foundation should be addressed by removing any unsuitable materials, as identified by the above soil testing and any uncontrolled fill encountered prior to filling, along with proof rolling;
- Methods of excavation, transport, depositing and spreading of the fill materials should be selected to ensure that the placed materials are uniformly mixed.

It should be the responsibility of the appointed person(s) to ensure that contractors follow all engineering design and best practice in regard to diversion and embankment construction and stabilisation and to promptly raise any issues of concern at site meetings.

11.2.3 General erosion and sediment control measures

All work will be carried out to avoid erosion and sedimentation of the site and surrounding areas. General erosion and sediment control measures employed by site contractors will include:

- Provision of training to staff to ensure awareness of erosion and sediment control issues and specific control measures to be used;
- Ensure erosion and sediment control planning and implementation will apply to all areas that may be disturbed;
- Ensure clearing of vegetation is limited to the minimum area safe for construction and operation especially in areas where soils are unstable and erodible (i.e. slopes and gradients);
- Control surface water drainage from outside construction areas by diverting surface run-off through constructing earth berms or similar diversion channels around the perimeter of any excavations to prevent surface water entering these areas;
- Construct graded contour drains and diversion channels to control the flow of storm run-off and divert flows away from exposed areas of the construction sites;
- Construct PCD's to contain storm run-off generated in exposed areas of the construction sites and/or sediment filters or fences downslope of disturbed areas;
- Keep areas of excavation to a minimum, including the time that surfaces are left exposed;
- Separate and stockpile different soils and earth layers from cutting operations to minimise the opportunity for mixing of soil types;
- Locate material stockpiles away from roadways or stormwater drains;
- Minimise the size of stockpiles and bund or cover stockpiles at the end of each day;
- Construct erosion and sediment controls around stockpiles and immediately down slope of any excavation areas to minimize siltation and sedimentation;
- Provide water cart or water sprays (as required) to soil and spoil stockpiles to keep them moist to minimise dust and loss through wind erosion;
- Minimise non-construction traffic in construction zones and use dedicated parking areas; and
- Progressive re-vegetation of all disturbed areas once construction works are completed to prevent extended exposure to erosion.

Erosion and sedimentation control measu3res will be implemented in accordance with the above mentioned requirements and as per the “Blue Book” (Landcom, 2004).

11.2.4 General erosion and sediment control maintenance and inspection

The following key management strategies are proposed:

- The erosion and sediment control structures (i.e. drainage lines and earth embankments) and bunds associated with the construction of the project will be inspected on a weekly basis, as well as after every significant storm and rainfall event (i.e. >10 mm in a 24 hour period) to check that they are operating satisfactorily and to perform any maintenance work and repairs that may be required. Regular maintenance will include:
  - Sediment removal from silt traps if any or paddocks, fences and filters, as applicable, to maintain functionality;
  - Debris removal from channels and culverts;
  - Repair of areas which have eroded or become unstable following periods of high flow;
  - Repair of infrastructure damaged due to normal wear and tear, incidents or during high flow periods (bunds, drains, energy dissipaters, erosion protection measures etc.);
- Identification of drainage channels and effective management of surface water during construction and operational phases of work;
- Disturbed areas will be progressively re-vegetated and stabilised to minimise erosion and scour;
- Reducing the amount and velocity of any water flows over the construction site;
- Minimising the length and duration of exposed excavations. Where trenches and soil stockpiles are exposed for more than one week then silt fences will be deployed immediately adjacent to the disturbed areas on the down-slope side; and
- Maintain vegetation adjacent to any disturbed areas and direct runoff to flow through vegetated areas prior to any flow to waterways.

11.3 Operational phase

11.3.1 Linear infrastructure: access roads, conveyors, pipelines and powerlines

The appointed person(s) shall ensure that following is carried out during the operational phase of the DMS Stockpile and South Portal:

- Progressively re-vegetate and rehabilitate disturbed areas once mining is completed;
- Maintain and clean all drainage structures along the access road and pipeline.

11.3.2 Stockpiles

The appointed person(s) shall ensure that the following is carried out during the operational phase of the DMS Stockpile:

- Where trenches and soil stockpiles are exposed for more than one week then silt fences will be deployed immediately adjacent to the disturbed areas on the down-slope side;
- Ensure stockpiles are covered or wetted down to prevent dust emissions during periods of warm weather and high winds.

To counter the effects of erosion, naturally occurring grassland species will be planted on the slopes and tops of the DMS Stockpile. The vegetation will provide soil holding capacity and reduce runoff velocity. Note was made that the Mototolo closure team is planning to utilise self-sustaining plants, but the slopes of the stockpiles are too steep for successful vegetation of the slopes. The vegetation requirements will need to be understood during the next study phase, to ensure the stockpile design is in line with rehabilitation requirements.

Vegetation establishment will be in line with the Biodiversity Action Plan (BAP) that the Der Brochen Project is expected to develop, to manage its impacts on biodiversity;

• *Closure water quality compliance criteria will be governed by the Water Use Licence;*

• *Buildings that are not retained for post-closure use, sold or used by another party will require demolition*

11.6 Rehabilitation action plan

11.6.1 PCDs

11.3.3 DMS and Portal pollution control dams

The appointed person(s) shall ensure that following is carried out during the operational phase :

- Ensure operation, inspection and maintenance of the DMS Stockpile is according to the design;
- This will include operation to ensure that the DMS side slopes do not represent a stability risk;
- Ensure operation inspection and maintenance of the PCDs is according to the design specifications (also refer to Section 8);

11.3.4 Report General erosion and sediment control maintenance and inspection

The key management strategies proposed for the construction phase under Section 11.2.4 will apply during the operational phase.

11.3.5 General dirty water containment maintenance and inspection

The following key management strategies are proposed:

- The dirty water containment and drainage structures and bunds associated with the operational phase of the project will be inspected on a weekly basis, as well as after every significant storm and rainfall event (i.e. >10 mm in a 24 hour period) to check that they are operating satisfactorily and to perform any maintenance work and repairs that may be required;
- Regular maintenance will include:
  - Sediment and debris removal from silt traps and drains;
  - Repair of areas which have eroded or become unstable following periods of high flow (DMS Stockpile side slopes);
  - Repair of infrastructure damaged due to normal wear and tear, incidents or during high flow periods (bunds, drains, dam walls etc.).

11.4 Monitoring and Reporting

11.4.1 Water quality

Routine water quality monitoring is proposed up and down stream of construction activities. Baseline data can be sourced from data gained from previous water quality, hydrological, aquatic ecological and hydrogeological investigations as available.

The field water quality monitoring should include pH, EC and turbidity data collection. In addition, weekly water quality samples should be collected for laboratory analysis of pH, EC, total dissolved solids and suspended solids as a minimum as per condition 3.1 of Appendix IV of the WUL. Weekly sampling should continue for three months after construction as per the WUL.

Thereafter monthly monitoring should be implemented. The existing routine monitoring points are sufficient to monitor upstream of the Mareesburg TSF in the Mareesburg Stream (M3 and M1) and in the Groot-Dwars River immediately downstream of the Mareesburg confluence (G_Drs 3) although consideration should be given to moving G_Drs 3 about 300 m downstream on completion of Phase 2 of the DMS Stockpile as this will better represent the area of impact..

11.4.2 Rainfall monitoring

During the construction phase a weather station should be installed on site to be a permanent fixture that will continue to operate during the operational phase. As a minimum the parameters measured should include temperature, humidity, rainfall, wind speed and wind direction. Meteorological data will be used in the interpretation of other monitoring results.

11.4.3 Reporting requirements

Reporting requirements are proposed as follows:

- It is the responsibility of the appointed person(s) to ensure that extensive records are kept of all inspections of water management control structures;

- These records are to include photographs, observations made and any remedial actions required as part of the monitoring, inspection and maintenance regime;
- Water quality monitoring results are also to be recorded in a format that allows a clear and concise review and comparison with baseline and historical data for the project. In the event that an exceedence figure is recorded then the contingency plan will be enacted to attempt to manage the factors contributing to the water quality impact;
- Environmental performance will be reported in accordance with the WUL and included in the Annual Water Report to DWA; and
- Any incidents that cause water or environmental pollution or have the potential to water or environmental pollution will be reported to DWA as soon as possible (within 24 hours) as per the relevant WUL condition.

11.5 Non-compliance procedures

In the event that regular inspections and ongoing water monitoring show that there has been a significant release of excessively turbid or saline water to the natural watercourse connected to the mine activities then appropriate management and mitigation measures may be required. The appointed person(s) shall be responsible for the implementation of all contingency plans and strategies to deal with incidents that may occur including the following:

- Excessively turbid water downstream of construction areas; or
- Spills resulting in increased salinity water from the PCD's or DMS Stockpile area or operational area into the river; or
- Spills of oil, fuel or otherwise contaminated water from the site roadways, conveyors or construction or operational areas.

11.6 Contingency and response plans

The proper planning for contingencies and responses to environmental issues/ incidents is important and will be the responsibility of the appointed person(s).

- A well-defined methodology (mechanism) for the timely detection of any exceedences and overflows during heavy rainfall events;
- A well-defined methodology (mechanism) for handling accidental releases of hazardous or potentially polluting substances to the environment.

12 Conclusions and Recommendations

The key findings and recommendations following assessment of the site floodlines, water quality and water balance are as follows:

- The proposed infrastructure is located outside of the 1:100 year floodline but the South Portal and Phase 3 of the DMS Stockpile will be in close proximity to the floodline. Flood protection berms should be constructed at the South Portal and Phase 3 of the DMS Stockpile to minimise the potential for flooding;
- Groot-Dwars River water quality in the vicinity of the Der Brochen project area is generally well within the applicable standards and limits with the few exceptions to the WUL considered to be due to the natural geology and not related to the existing operations. To protect the surface water quality in the project area it is recommended that the proposed measures in this report be implemented including ongoing monitoring at the existing WUL compliance monitoring points;
- Water balances for the mine have been developed and demonstrate that the mine has limited water available under the current water authorisations to sustain the mine without water conservation and storage of excess water..

Based on the site assessment clean and dirty water separation measures in compliance with Regulation 704 have been developed and include the following:

- Additional dirty water storage has been sized in compliance with Regulation 704. It is recommended that the PCDs be provided with a formal engineered liner system appropriate to the containment of impacted waters for reuse purposes;

- Design criteria for the proposed water course crossings and proposed clean water diversions include appropriate erosion controls and energy dissipation to minimise the potential for erosion and subsequent sediment loads in the Groot-Dwars River; and
- Further design considerations for clean and dirty water separation will need to be informed by recommendations from the detailed survey and geotechnical, biodiversity and other specialist studies as appropriate.

The identified potential surface water related environmental impacts associated with the proposed activities range from medium–high to very low significance in the absence of appropriate mitigation measures. The identified impacts can be largely mitigated reducing the significance to low-medium to very low. The proposed mitigation measures have been incorporated into a surface water management plan for the project area. The plan includes applicable best practices and requirements related to inspection, maintenance, monitoring and management of incidents. This plan should be further developed as more detailed project information becomes available.

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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