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## **Xivono Weltevreden Coal Mining Project near Belfast, Mpumalanga**

### **Surface Water Impact Assessment**

**Prepared for:**

Xivono Mining (Pty) Ltd

**Project Number:**

MBU5710

November 2019



This document has been prepared by Digby Wells Environmental.

<b>Report Type:</b>	Surface Water Impact Assessment
<b>Project Name:</b>	Xivono Weltevreden Coal Mining Project near Belfast, Mpumalanga
<b>Project Code:</b>	MBU5710

<b>Name</b>	<b>Responsibility</b>	<b>Signature</b>	<b>Date</b>
Daniel Fundisi	Report writer		November 2019
Mashudu Rafundisani	First review		November 2019
Andre Van Coller	OpsCo review		November 2019

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## EXECUTIVE SUMMARY

Digby Wells Environmental (Pty) Ltd (hereafter Digby Wells) was appointed by Xivono Mining (Pty) Ltd (hereafter Xivono) to undertake a hydrological assessment study as part of the requirements for an Environmental Authorisation (EA), Integrated Water Use Licence Application (IWULA) and a Mining Right Application (MRA) for the proposed Weltevreden Mining Project in order to comply with the following legislation:

- The Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA);
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The NEMA Regulations, 2017 (Government Notice Regulations GNR 982 as amended by GN R 326);
- The National Water Act, 1998 (Act No. 26 of 1998) (NWA); and
- The National Environmental Management: Waste Act, 2008 (Act No. 56 of 2008) (NEM: WA).

The Project site is characterised by a temperate climate with dry winters and warm summers. The Mean Annual Precipitation (MAP) and Mean Annual Evaporation (MAE) for the Project site were determined to be 742 mm and 1414 mm, respectively. The region clearly experiences higher evaporation than precipitation, giving rise to distinctly dry winters and wet summers. The Mean Annual Runoff (MAR) depth was calculated to be 80.91 mm, and this accounts for approximately 7.4% of the MAP for the area.

Baseline water quality was assessed and benchmarked against the Department of Water and Sanitation (DWS) standard limits for domestic use, aquatic ecosystems, livestock watering and irrigation as these were identified as dominant water uses in the area. Electrical Conductivity (EC), Total Dissolved Solids (TDS), major cations and P are below the DWS standard limits. All assessed trace elements including Aluminium (Al), Cadmium (Cd), Copper (Cu), Manganese (Mn), Selenium (Se), Zinc (Zn) exceed the DWS standard limits.

Modelled floodlines indicate that the proposed mine infrastructure is outside the 1:100-year floodline except for part of the western OC2 Pit which slightly encroaches by 130m into the headwaters of a non-perennial tributary of the Klein-Komatirivier. Reducing the size of the OC2 Pit will remove it from the 1:100-year exclusion zone.

The study also involved assessment of storm water management on the Project site. The stormwater management plan addressed separation of clean and dirty water on site by a network of lined dirty water channels, clean water perimeter berms and containment facilities such as pollution control dams.

The water balance for the mine indicated total water inflows (rainfall, groundwater ingress and abstraction from boreholes) and outflows (evaporation and losses) to be 257 452 m<sup>3</sup>/annum

and 224 564 m<sup>3</sup>/annum, respectively. The water that is circulating within the mine system was determined to be 32 888 m<sup>3</sup>/annum.

Impacts on surface water resources arising from proposed mining activities were identified for the construction, operation and decommissioning phases of the proposed Weltevreden Mine. The identified impacts include the following:

- Reduction of base flow arising from disturbed wetlands;
- Sedimentation and siltation of nearby watercourses;
- Increase of paved surfaces and subsequent increase in runoff and potential flooding;
- Surface water contamination leading to deterioration of water quality.
- Reduction of catchment runoff yield due to containment and interception of runoff and rainfall by open storage facilities; and
- Contamination of surface water resources by acid mine drainage.

Mitigation/management measures to prevent, and/or minimise the identified potential surface water impacts were described. It is recommended that the developed stormwater management plan, the monitoring programme for surface water quality, water use flows and volumes be implemented to ensure the reduction or outright prevention of the identified potential impacts. Should the mitigation and management measures be implemented, this project is unlikely to pose significant concerns to water resources within and around the project area. Determined mitigation/management measures include the following:

- That the mine should avoid placement of infrastructure or making excavations within the 100-year floodlines or 100 m buffer from watercourses, whichever is greater;
- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;
- Dirty water from workshops and washbays must be channelled to a pollution control facility through oil separator to prevent possible contamination of the natural environment;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas;
- Dirt or gravel roads must be well compacted to avoid erosion of the soil into nearby streams;
- Dust suppression on haul roads and cleared areas must be undertaken regularly;
- Runoff from dirty areas should be directed to stormwater management infrastructure (drains and PCDs) and should not be allowed to flow into the natural environment, unless DWS discharge authorisation and compliance with relevant discharge standards as stipulated in the NWA is obtained;

- Water quality monitoring programme should be implemented to monitor water resources within and in proximity to the Project site to detect any contamination arising from operational activities;

The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites

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Appendix A: Specialist CV

## 1 Introduction

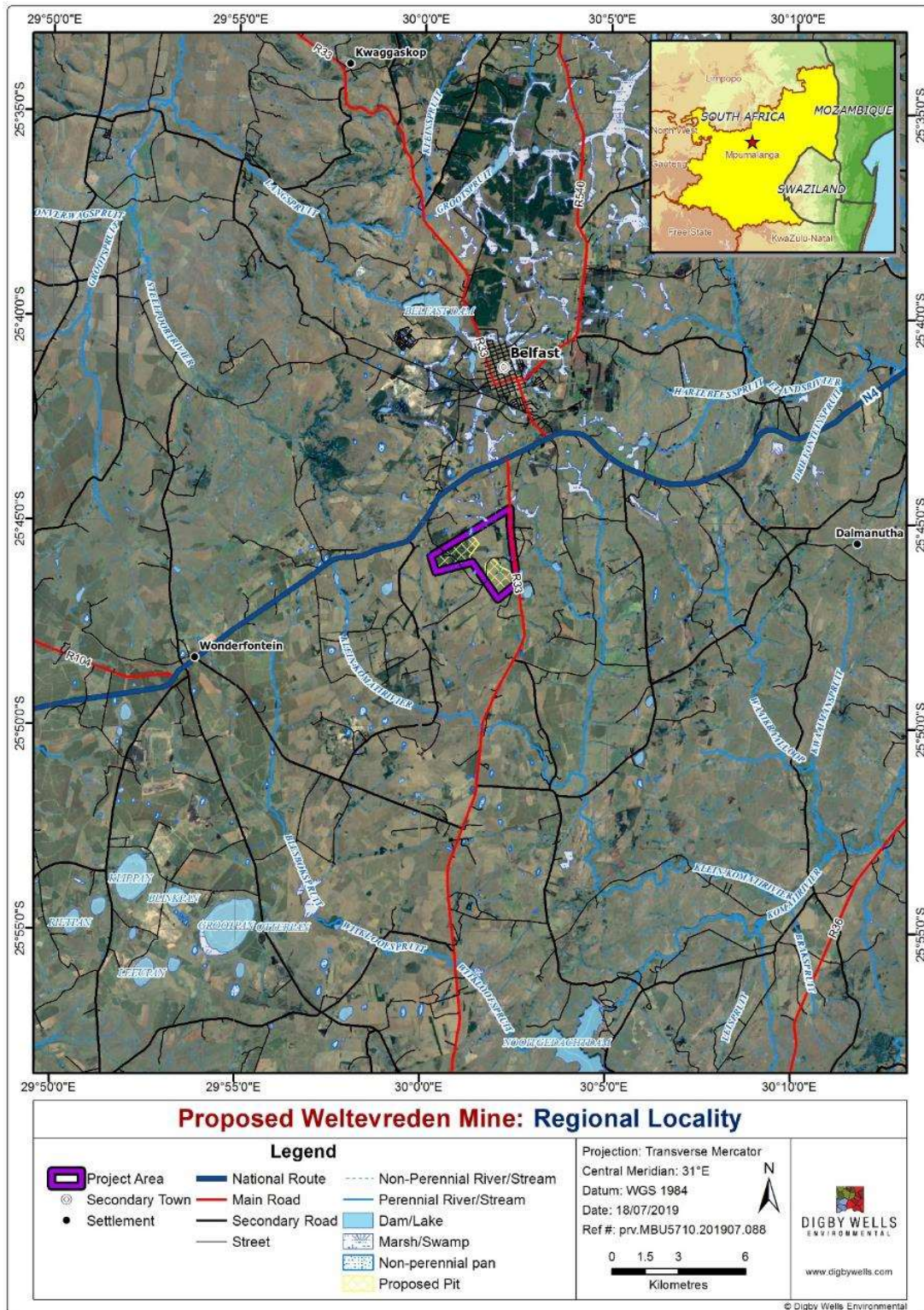
Digby Wells Environmental (Pty) Ltd (hereafter Digby Wells) was appointed by Xivono Mining (Pty) Ltd (hereafter Xivono) to undertake a hydrological assessment study as part of the requirements for an Environmental Authorisation (EA), Integrated Water Use Licence Application (IWULA) and a Mining Right Application (MRA) for the proposed Weltevreden Mining Project in order to comply with the following legislation:

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- The National Environmental Management: Waste Act, 2008 (Act No. 56 of 2008) (NEM: WA).

## 2 Site Locality and Project Background

### 2.1 Locality

The Applicant, Xivono, has an existing Prospecting Right (Number 2006/023906/07) for the proposed Weltevreden Mining Project approximately 8 km south of Belfast in Mpumalanga, South Africa. The Project site is in the Emakhazeni Local Municipality which falls within the Nkangala District Municipality. The Project site locality is presented in Figure 2.1.



**Figure 2.1: Locality of the Project Site**

## 2.2 Project Background

The Prospecting Right included Portion 381, the Remaining Extent (RE), RE of Portion 3, Portion 9, Portion 10, RE of Portion 11, Portion 21, Portion 23 and Portion 24 of the Farm Weltevreden 381 JS. The Prospecting Right is divided into an east and west section by the R33 which runs in a north-south direction through the site. The proposed mining activities will only take place on the western half of the Prospecting Right Area which covers a surface area of approximately 800 hectares. The eastern portion will not be mined nor accommodate any mining-related infrastructure. Xivono proposes to mine two pits, OC1 (162 ha footprint) and OC2 (200 ha footprint) through open pit mining. Xivono plans to utilise containers for the mine offices and workshop infrastructure which will occupy a footprint of approximately 0.03 ha (300m<sup>2</sup>). Other surface infrastructure proposed for the site includes a pollution control dam, crushing and screening plant (no washing to take place on site), Run of Mine (ROM) pad, overburden dump, stockpiles, pipelines and lined trenches. The surface infrastructure is expected to have a footprint of approximately 1 ha. The proposed project activities are summarised in Table 2-1.

**Table 2-1: Proposed project activities**

Project Phase	Project Activity
Construction Phase	Site/vegetation clearance
	Access and haul road construction
	Infrastructure construction
	Linear infrastructure - Power line and water pipelines
	Diesel storage and explosives magazine
	Topsoil stockpiling
<ul style="list-style-type: none"> <li>Operational Phase</li> </ul>	Open pit establishment
	Removal of rock (blasting)
	Stockpiling (rock dumps, soils, ROM, discard dump) establishment and operation
	Diesel storage and explosives magazine
	Operation of the underground workings
	Operating crushing and screening plant



Project Phase	Project Activity
	Operating sewage treatment plant
	Water use and storage on-site – during the operation water will be required for various domestic and industrial uses. A pollution control dam will be constructed that capture water from the mining area which will be stored and used accordingly
	Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste
	Maintenance activities – through the operations maintenance will need to be undertaken to ensure that all infrastructure in operating optimally and does not pose a threat to human or environmental health. Maintenance will include haul roads, pipelines, crushing and screening plant, machinery, water and stormwater management infrastructure, stockpile areas
Decommissioning Phase	Demolition and removal of infrastructure – once mining activities have been concluded infrastructure will be demolished in preparation of the final land rehabilitation.
	Rehabilitation – rehabilitation mainly consists of spreading of the preserved subsoil and topsoil, profiling of the land and re-vegetation
	Post-closure monitoring and rehabilitation

### 3 Details of the Specialist

The following specialists were involved in this hydrological assessment study. Their responsibilities and summary of qualifications are provided below. A detailed curriculum vitae of the report writer is provided in Appendix A.

Responsibility	Report Writer
Full Name of Specialist	Daniel Fundisi
Highest Qualification	MSc Hydrology
Years of experience in specialist field	8
Registration(s):	Pr.Sci.Nat.; Reg. No.: 400034/17
Responsibility	Technical Review

<b>Full Name of Specialist</b>	Mashudu Rafundisani
<b>Highest Qualification</b>	BSc Honours
<b>Years of experience in specialist field</b>	7
<b>Responsibility</b>	<b>Final Review</b>
<b>Full Name of Specialist</b>	Andre van Coller
<b>Highest Qualification</b>	MSc Geohydrology
<b>Years of experience in specialist field</b>	10

### 3.1 Declaration of Specialist

I, Daniel Fundisi, as the appointed specialist, hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent, other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity;
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all of the requirements and that failure to comply with any the requirements may result in disqualification;
- have disclosed/will disclose, to the applicant, the Department and interested and affected parties, all material information that have or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.



#### Signature of the specialist

Daniel Fundisi

#### Full Name and Surname of the specialist

Digby Wells Environmental

#### Name of company

November 2019

#### Date

## 4 Methodology

The study was undertaken following relevant Best Practice methodologies, guidelines and legislative frameworks governing national, regional and local settings. As such, the hydrology of the Inkomati-Usuthu Water Management Area (WMA 3), quaternary catchment X11D, and the Project site, was assessed as described in the following sections.

### 4.1 Baseline Hydrology

Rainfall, evaporation and runoff data obtained from the results database of the Water Resources of South Africa 2012 study (WRC, 2015) was analysed to determine the Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE) and the Mean Annual Runoff (MAR). These analyses were useful to provide insight into the general rainfall-runoff and evaporation dynamics which informed the surface water impact assessment for the Project site.

### 4.2 Peak Flows

Catchment delineation was undertaken in Global Mapper using Advanced Land Observing Satellite (ALOS) World 3D – 30m (AW3D30) global digital surface model (DSM) data (JAXA, 2015). This dataset is stored in a raster GeoTIFF format referenced to the Hartebeesthoek 94 Datum (WGS84 ellipsoid). The ALOS data showed a higher resolution than a Digital Elevation Model (DEM) generated from 5 m contours (National Geospatial Institute, 2013) of the area.

Widely used and recommended methods including the Rational Method Alternative 3 (RM3), Standard Design Flood (SDF) and the Midgley & Pitman (MIPI) (SANRAL, 2013) were used to calculate the 1:50-year and 1:100-year peak flows for delineated sub-catchments at the Project site. Design rainfall depths were determined using the Design Rainfall Programme for South Africa and the modified Hershfield equation as input to the RM3 and SDF methods, respectively.

### 4.3 Land Cover and Soils

Land cover and soil data are necessary for peak flow calculations since they determine potential for infiltration and overland flow. The South African Atlas of Climatology and Agro-hydrology (Schulze, 2008) was used to classify general land cover. Soil information was obtained from databases of the Agricultural Research Council Institute for Soil, Climate and Water (ARC-ISCW).

### 4.4 Floodlines

Hydraulic modelling was conducted in HEC-RAS 5.07 which allows pre-processing within the in-built RAS Mapper module. A digital terrain model (DTM) was generated from the ALOS DSM for the area to make the topographic data compatible with RAS Mapper. The pre-

processing involved generation of the channel geometry, including the river network, banks, flow paths and cross sections.

The HEC-RAS model simulates total energy of water by applying basic principles of mass, continuity and momentum as well as roughness factors between all cross sections (US Army Corps of Engineers, 1995). A height is calculated at each cross-section, which represents the level to which water will rise at that section, given the calculated initial peak flows for the 1:50-year and 1:100-year events on all river sections.

Analyses are performed by modelling flows at the sub-catchment outlet of stream or channel sections first, moving upstream. Manning's Roughness Coefficients ( $n$ ) for the channels were set at 0.025, and those for river banks were determined to be 0.035 representing natural channels with weeds, reeds and brush on the banks (Chow, 1959).

#### 4.5 Storm Water Management Plan

The conceptual Storm Water Management Plan (SWMP) was developed with adherence to guidelines of the Government Notice 704 (GN704) of the National Water Act, 36 of 1998 (NWA). Clean and dirty water catchments were delineated based on the functions of proposed infrastructure on site. Stormwater drains, berms and pollution Control Dam (PCD) were determined and sized using the Personal Computer Storm Water Management Model (PCSWMM). PCSWMM is a dynamic rainfall-runoff simulation model used for single event or continuous simulation of runoff rate and quantity (James et al., 2010). Site elevation details were obtained from a Digital Elevation Model (DEM) generated using 1m contours for the site.

The simulated stormflow, incident rainfall and depth for a defined outfall represented the storage capacity of the outfall/containment structure when the model is optimised to ensure zero flooding or surcharge. The drains were sized not to spill, on average, when a 1:50-year flood event occurs, in compliance to the Best Practice guidelines of the GN 704 as stipulated by the Department of Water and Sanitation (DWS).

The model uses the catchment area, average slope, catchment permeability and the design rainfall depth to simulate storm flows which are channelled to containment structures or discharged through low-point outlets. The influence of paved areas such as rooftops, roads and concrete slabs was incorporated in PCSWMM by specifying the proportionate percentages of impervious areas within the demarcated sub-catchments.

#### 4.6 Water Quality

Chemistry results of water samples collected at the upstream and downstream of the nearby natural water bodies and analysed at a South African National Standards (SANAS) accredited laboratory was assessed and interpreted to provide baseline conditions prior to commencement of mining activities. The DWS water quality guidelines for domestic use, livestock watering, irrigation and aquatic ecosystems were used as benchmarks against the laboratory results. These guidelines were selected based on dominant water uses in the area.



## 4.7 Water Balance

The Water Balance was undertaken in accordance with the DWS Best Practice Guidelines (BPG) G2: Water and Salt Balances (DWA, 2006). The static water balance compilation utilised results of the hydrological assessment to provide hydrological inputs as rainfall, runoff and evaporation into water balance calculations. Other water volumes were either obtained from Xivono or assumed based on best practice standards for similar mining developments.

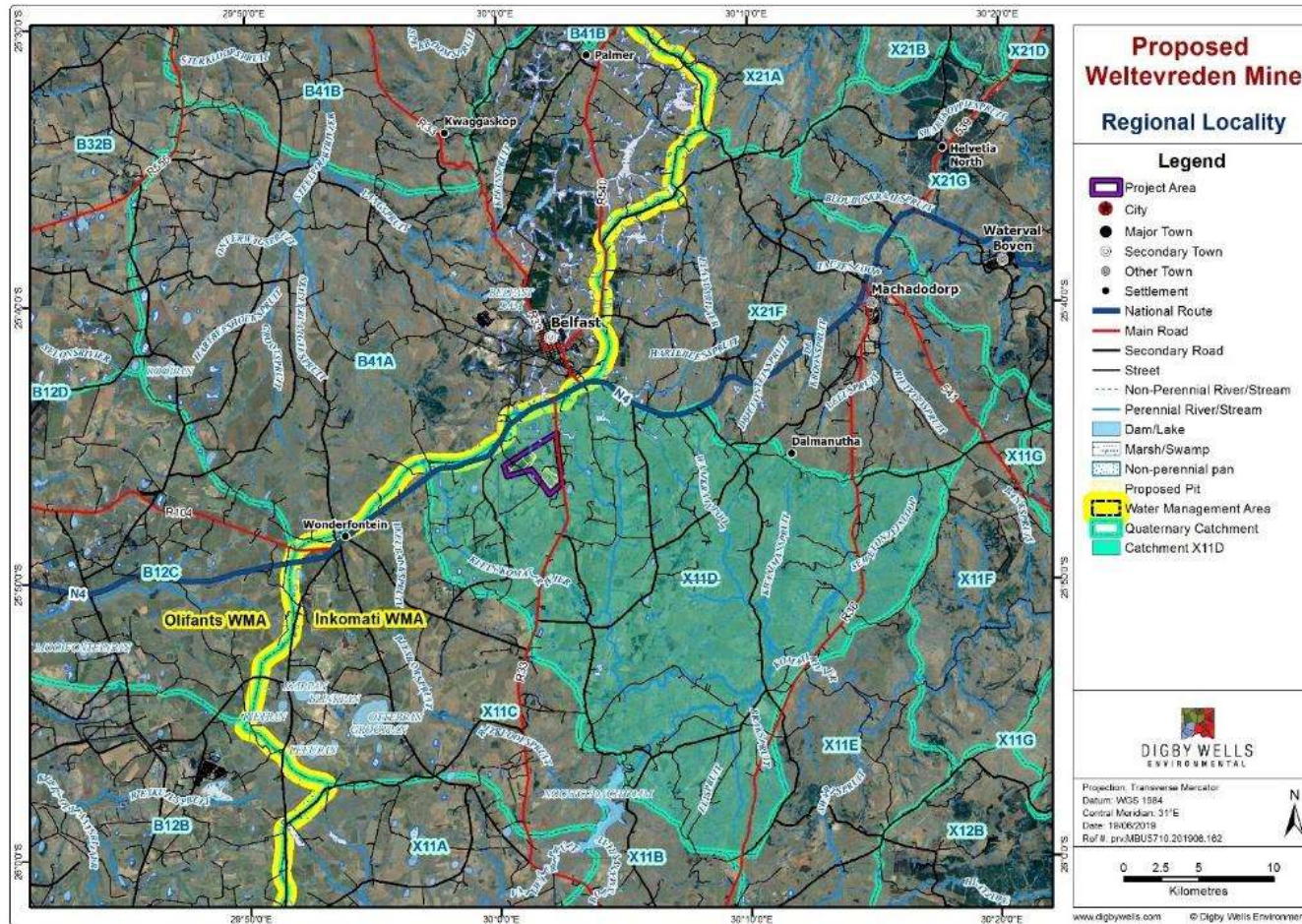
## 4.8 Surface Water Impact Assessment

Potential surface water impacts (quality and quantity) that may result from the proposed mining activities, based on the established baseline conditions, were identified. The detailed impact assessment methodology is appended in Appendix B.

## 5 Baseline Environment

South Africa is divided into nine Water Management Areas (WMA) (Revised National Water Resource Strategy, 2012), managed by their own water boards. Each of the WMAs is made up of quaternary catchments which relate to the drainage regions of South Africa, ranging from A to X (excluding O). These drainage regions are subdivided into four known divisions based on size. For example, the letter A represents the primary drainage catchment; A2 for example will represent the secondary catchment; A21 represents the tertiary catchment and A21D would represent the quaternary catchment which is the lowest subdivision in the Water Resources of South Africa, 2012 manual. Each of the quaternary catchments has associated hydrological parameters.

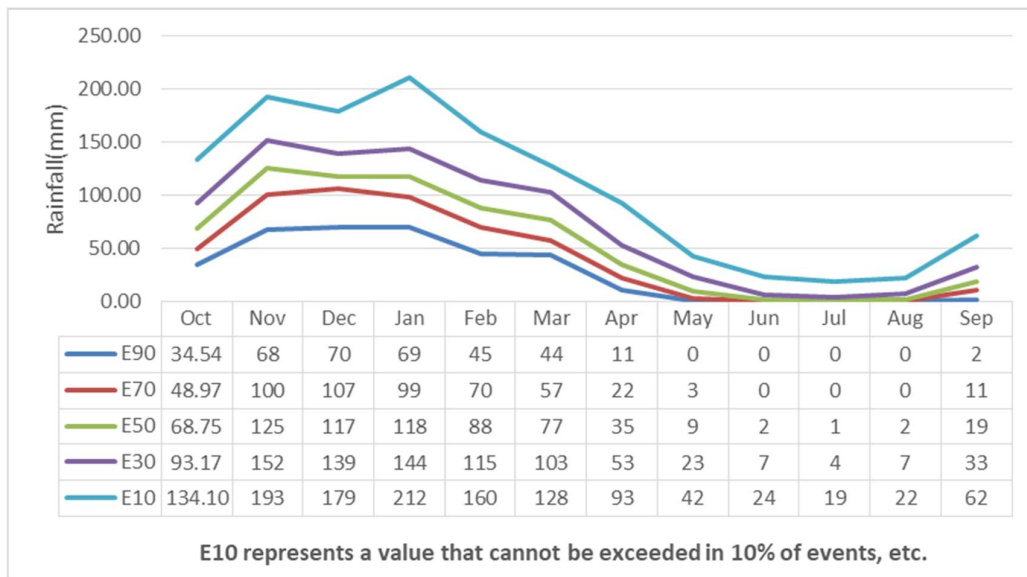
The Project site is situated within the Inkomati-Usuthu Water Management Area (WMA 3) and in quaternary catchment X11D as revised in the 2012 water management area boundary descriptions (RAS Government Gazette No. 35517, 2012). The farm Weltevreden is located on a watershed. The Klein-Komati River and its tributaries drain the area in a southerly direction joining up with the Komati River further downstream before flowing eastwards towards the Indian Ocean. The Langspruit flows to the north while the Steelpoort River flows in the northwest direction from the Project site (see Figure 5.1).



**Figure 5.1: Hydrological setting of the Project Site**

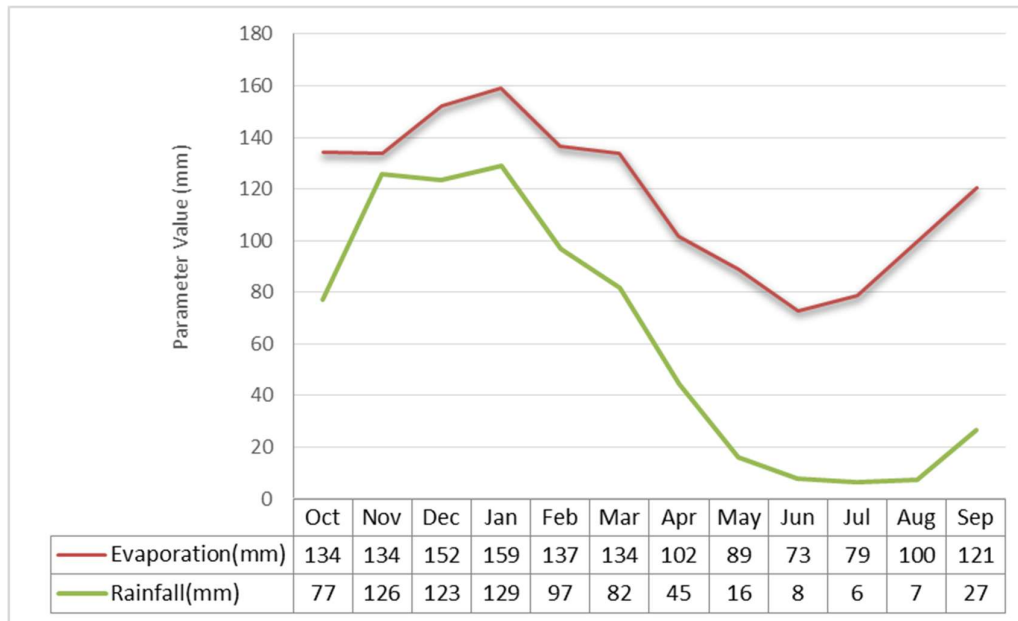
## 5.1 Climate and Runoff Evaluation

The Project site is characterised by warm and temperate climate with dry winters and warm summers. The precipitation of the driest month in winter is less than one-tenth of the wettest month precipitation in summer (Cannon, 2011). The Mean Annual Precipitation (MAP) of the region is 742.06 mm which is likely to be distributed as indicated in Figure 5.2. The normal rainfall (E70: 70% of the events) for the wettest month will likely not exceed 99 mm, while extreme rainfall (E10: 10% of the events) will likely not exceed 212 mm. This implies that the region experiences moderate to high rainfall.



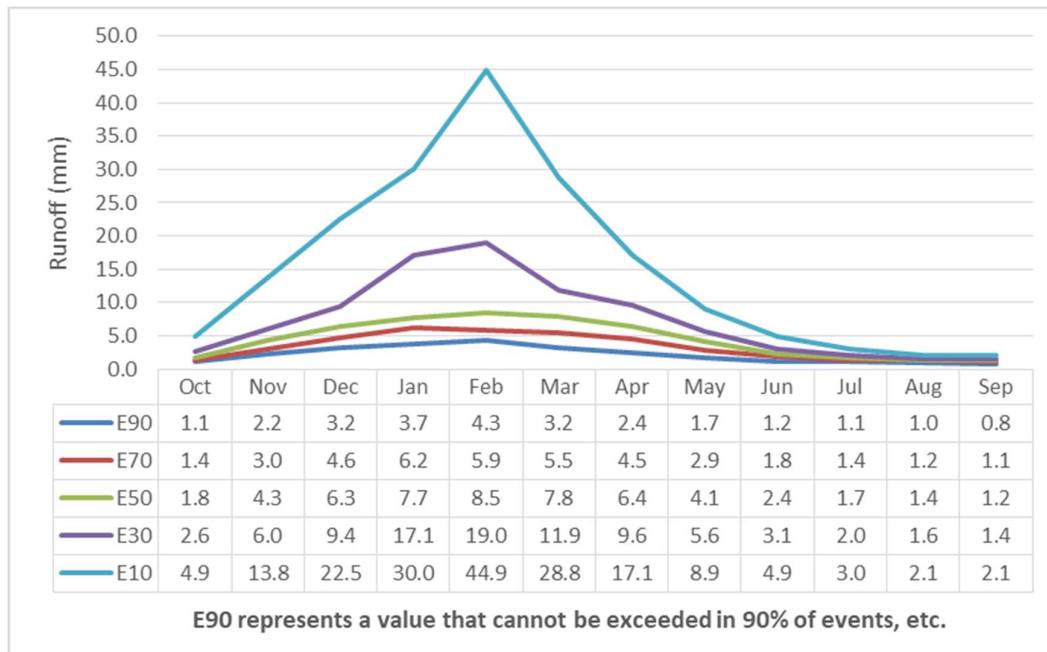
**Figure 5.2: Monthly Rainfall distribution for quaternary X11D**

The Mean Annual Evaporation (MAE) for the X11D quaternary catchment is 1413.5 mm (WRC, 2015). The region clearly experiences higher evaporation than precipitation, giving rise to dry winters and wet summers with a negative natural water balance. The monthly distribution of potential evaporation and rainfall can be seen in Figure 5.3.



**Figure 5.3: Monthly evaporation and rainfall for quaternary X11D**

The Mean Annual Runoff (MAR) depth for the area was calculated to be 80.91 mm. This runoff accounts for approximately 7.4% of the MAP for the area. Normal runoff (E70: 70% of events) and high flood flows (E10: 10% of events) during the wettest month of December will likely not exceed 3.2 mm and 22.5 mm, respectively. The MAR is likely to be distributed as indicated in Figure 5.4.

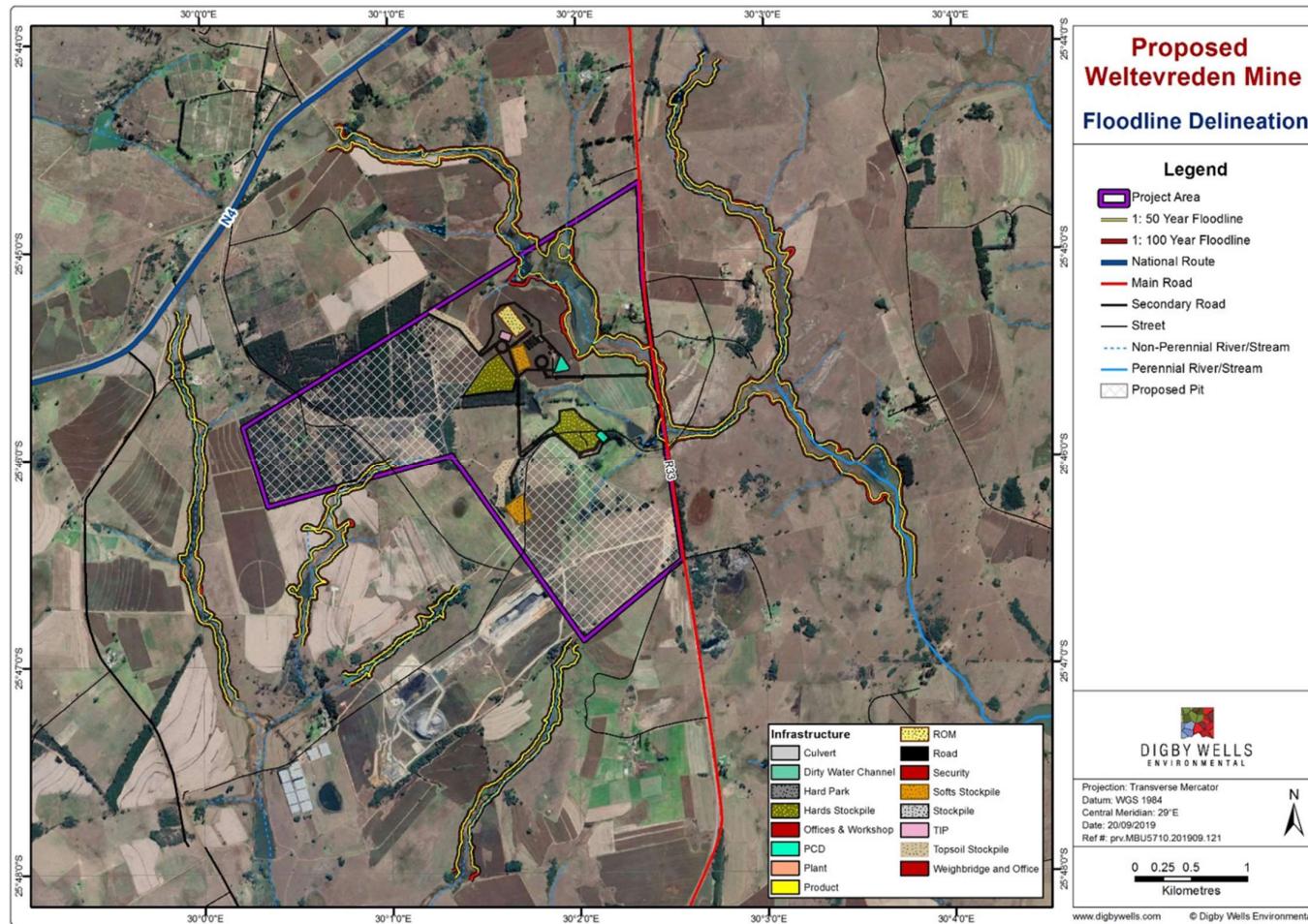


**Figure 5.4: Monthly runoff distribution for quaternary X11D**

## 6 Floodlines

Floodlines modelling was carried out for rivers traversing or in the vicinity of the Project site. The 1:50-year and 1:100-year return period events were considered for hydraulic modelling as per the requirements of the National Water Act, 36 of 1998 (NWA). Results of flood extents at the Project site are indicated in Figure 6.1. The currently proposed mine infrastructure is outside the 1:100-year floodline except for part of the western pit (OC2) which slightly encroaches by 130m into the headwaters of a non-perennial tributary of the Klein-Komatirivier. The size of the OC2 Pit should be reduced by approximately 130m on the southern fringe for it to be outside the 1:100-year floodline. Placement of any additional infrastructure should be guided by the modelled flood extents to protect water resources in the area and to prevent destruction of property and human lives due to the proposed mining development.





**Figure 6.1: 1:50-year and 1:100-year floodlines at the Project Site**

## 7 Stormwater Management Plan

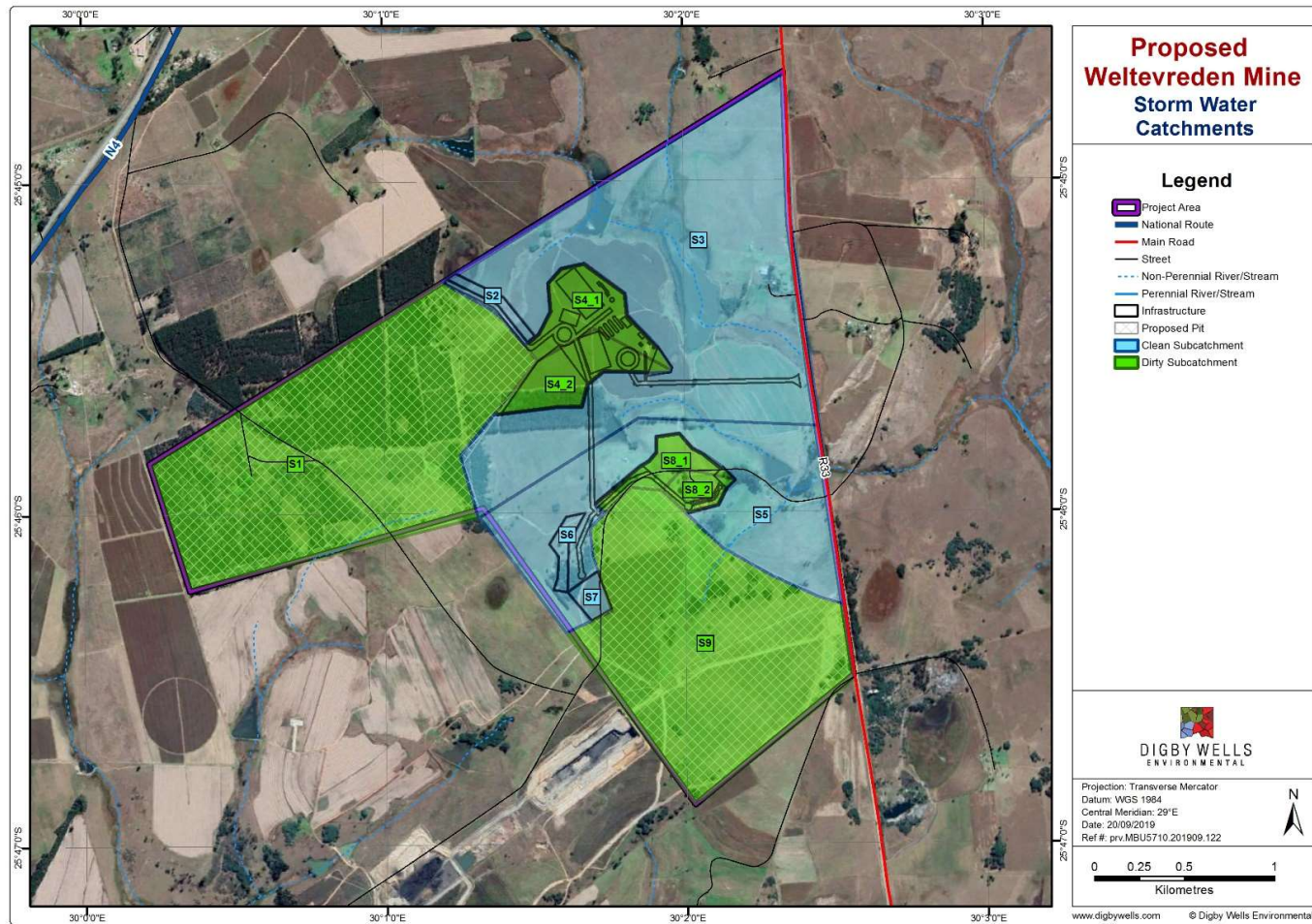
Key issues that were considered for management of stormwater entail the separation of clean and dirty water, minimizing runoff, avoiding erosion of exposed ground surfaces, avoiding sedimentation of drainage systems and minimizing exposure of pollutants and polluted areas to stormwater runoff (DWAF, 2000; IFC, 2007).

- Clean water should, as far as possible, be kept separate from dirty water. Water from clean catchments should be diverted away from dirty water areas and should be allowed to pass through to downstream users;
- Dirty water must be contained and captured on site. All dirty water must be captured and transported in lined channels (capable of containing 1:50-year design floods) to prevent the seepage of contaminated water into groundwater resources. Dirty water runoff must be stored in a PCD, where reasonable precautions are taken to prevent leaks or seepage.
- Reducing dirty water areas - special attention should be paid to early rehabilitation of mining and other dirty water areas to reduce the dirty water footprint area to an absolute minimum. This will reduce the total volumes of dirty water and simplify the final measures to be taken at mine closure. Part of any SWMP will include processes that identify and implement opportunities to reduce the dirty water footprint areas.
- Monitoring the quality and quantity of mine effluent streams discharged to the environment, including stormwater drainage should be conducted to minimise pollution of clean water resources;
- Reducing exposure of sediment-generating materials to wind or water (e.g. proper placement of soil and rock piles and implementing dust suppression processes);
- Reducing or preventing off-site sediment transport by use of settling ponds and silt fences.
- Stormwater drains, ditches, and stream channels should be protected against erosion through a combination of adequate dimensions, slope limitation techniques, and/or use of riprap and lining.
- Preventing the pollution of water resources - exposure between water and potential pollutants should be reduced to a minimum. Special precautions may be required to prevent the transport of pollutants in water. Oil traps should be specified below workshops, fuel depots and vehicle wash-bays to prevent the flow of hydrocarbons into PCDs.

### 7.1 Delineated Clean and Dirty Water Catchments

Delineation of clean and dirty sub-catchments was based on the proposed function of various areas at the Project site. The delineated clean and dirty water catchments are presented in Figure 7.1.





**Figure 7.1: Delineated clean and dirty water managements**



## 7.2 Stormwater Modelling

Manning's roughness coefficient (n) used in the model for the impervious and pervious areas were 0.013 (float finish, concrete) and 0.04 (grassland vegetation), respectively (McCuen, 1996).

The soils of the Project site are generally classified as clay loam. The PCSWMM model used within this study requires these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The clay loam group resulted in a Suction Head of 208.8 mm, a Hydraulic Conductivity of 2 mm/hr and an Initial Deficit of 0.146 being used in the modelling. Simulated peak flows and runoff volumes for delineated storm water catchments are summarised in Table 7 1 for the 1:50-year recurrence interval, 24-hour flood event

**Table 7-1: Simulated peak flows and runoff volumes for stormwater catchments**

Name	Description	Classification	Area (ha)	Slope (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)	Runoff Volume (ML)	Peak Runoff (m <sup>3</sup> /s)
S1	Mine Pit 1	Dirty	199.1762	0.9	208.8	2	0.146	194.99	36.5
S2	Topsoil Stockpile	Clean	3.018071	0.9	208.8	2	0.146	2.85	0.84
S3	Clean Area around ROM etc.	Clean	237.5692	0.9	208.8	2	0.146	234.83	47.86
S4_1	Workshops; ROM Stockpile; Product Stockpile; Hards & Softs Stockpiles	Dirty	20.39491	0.8	208.8	2	0.146	23.62	8.36
S4_2		Dirty	19.34623	0.8	208.8	2	0.146	22.4	7.74
S5	Clean Area around Mine Pit 2	Clean	121.3742	0.9	208.8	2	0.146	118.91	22.4
S6	Topsoil	Clean	3.306888	0.9	208.8	2	0.146	3.14	1
S7	Softs Stockpile	Clean	3.633053	0.9	208.8	2	0.146	3.47	1.25
S8_1	Hards Stockpile	Dirty	10.09952	0.8	208.8	2	0.146	10.67	3.48
S8_2		Dirty	6.1955	0.8	208.8	2	0.146	6.6	2.64
S9	Mine Pit 2	Dirty	166.358	0.8	208.8	2	0.146	167.36	40.92

### **7.3 Proposed Stormwater Management Strategy**

A conceptual SWMP has been developed for the Project site. The purpose of a SWMP is to prevent the pollution of water resources in and around the mining area, or areas where mining-related activity occurs. It also prevents flooding and provides a safe working environment during extreme rainfall-runoff events. The proposed conceptual layout of clean and dirty stormwater infrastructure can be seen in Figure 7.2.

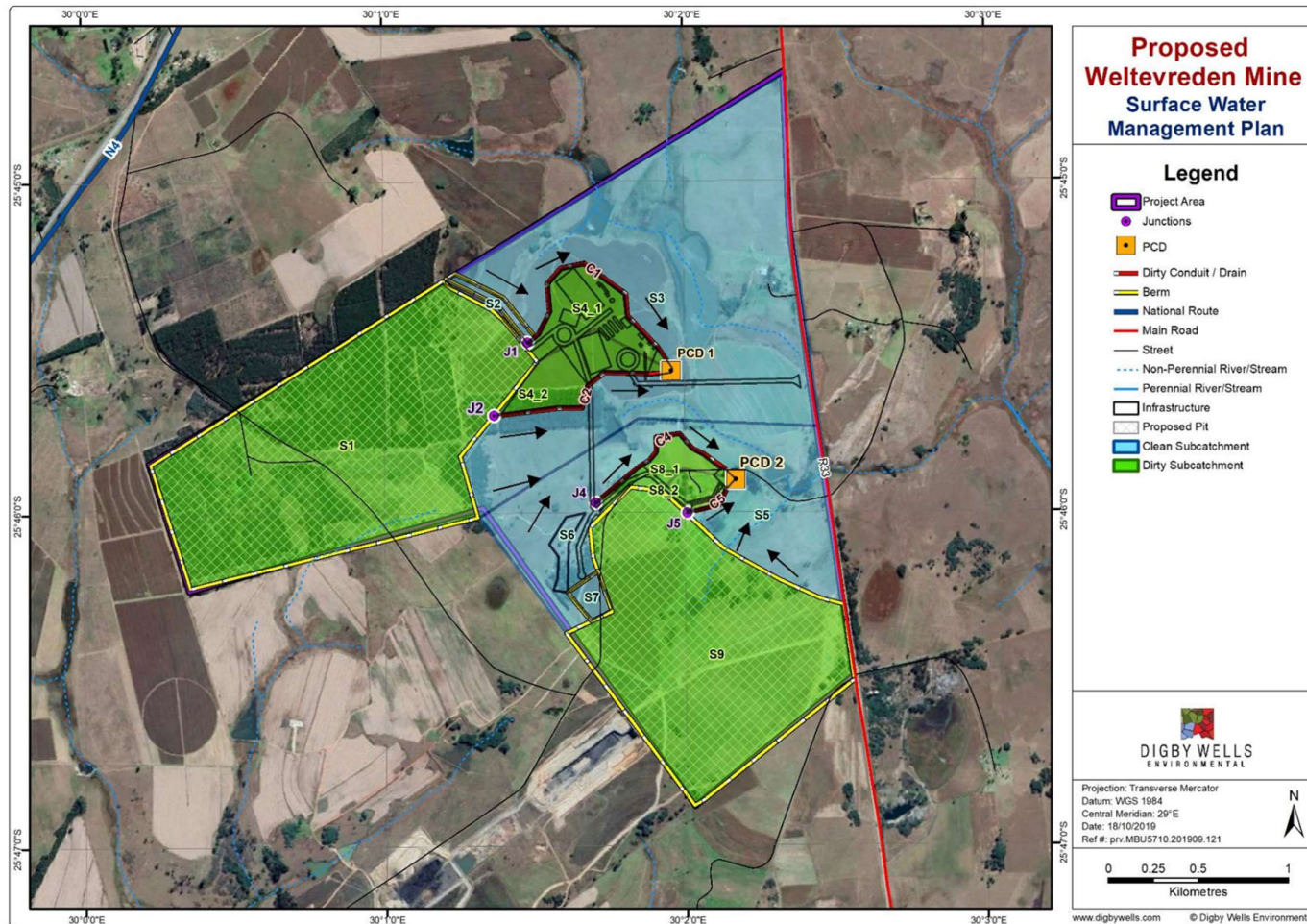


Figure 7.2: Weltevreden conceptual stormwater management plan

### 7.3.1 Stormwater Channels

The dimensions and characteristics of proposed stormwater channels are presented in Table 7-2. All stormwater channels have been sized to prevent potential flooding resulting from the 1:50-year, 24-hour rainfall events. The Manning's roughness coefficient assumed for the proposed High-Density Polyethylene (HDPE) lined channels was 0.013. Owing to relatively steeper slopes the results show that the channels convey erosive flows indicated by velocities greater than 3m/s (see Table 7-2) (Hicks and Mason, 1991). Since the channels are lined to prevent pollution of groundwater resources, no erosion will occur due to the lining.

**Table 7-2: Proposed stormwater channel characteristics**

Name	Cross-Section	Depth (m)	Width (m)	Left Slope	Right Slope	Slope (m/m)	Max.  Flow  (m³/s)	Max.  Velocity  (m/s)
C1	TRAPEZOIDAL	1	1	2	2	0.012	8.238	6.56
C2	TRAPEZOIDAL	1	1	2	2	0.025	7.774	7.77
C4	TRAPEZOIDAL	1	1	2	2	0.006	3.328	5.08
C5	TRAPEZOIDAL	1	1	2	2	0.001	2.641	3.43

### 7.3.2 Conceptual sizes of pollution control dams

Stormflows or runoff from areas where the ROM Stockpile, Offices and Workshops, Hards Stockpile 1 and Product Stockpile will be conveyed through dirty water channels into PCD1 (Figure 7.2). Runoff from the area where the Hards Stockpile 2 is located will be conveyed to PCD2 as indicated in Figure 7.2.

The proposed PCDs have been sized to contain the 1:50-year flood flows and this conceptual design agrees with GN 704 guidelines (DWAf, 2000). The sizing was undertaken using PCSWMM which is commonly used in many sewer and storm water studies throughout the world to design and size drainage system components for flood control and water quality protection (Rosman, 2010). The simulated required storage capacities of the PCDs to accommodate the runoff are presented in Table 7-3. Please note that a freeboard allowance of 0.8 m should be considered in the final design of each of the PCDs, direct rainfall into the PCD must also be considered when determining the freeboard.

Any excess water from PCDs can be pumped for authorised uses on the mine site, such as dust suppression.

**Table 7-3: Conceptual storage capacities of pollution control dams**

Storage Structure	Max. Volume (m³)
PCD1	31022
PCD2	12803

## 8 Water Quality

### 8.1 Sampling Points

Assessment and interpretation of surface water quality was undertaken for six points on the Klein-Komati River and its tributaries upstream and downstream of the Project site. The sampling points are indicated in Table 8-1 and Figure 8.1. The baseline water quality was benchmarked against the DWS water quality guidelines for domestic use, aquatic ecosystems, livestock watering and irrigation (DWA, 1996). The guidelines were selected based on water uses identified in the Project site and surrounds.

Surface water quality monitoring should be conducted at the current baseline monitoring sites (**Error! Reference source not found.**) and in all surface water circuits that shall be established including stormwater detention and retention structures such as pollution control dams.

**Table 8-1: Location and description of surface water monitoring points**

Monitoring Point	Description	Coordinates	
		Latitude	Longitude
SW1	Downstream of Western Pit (OC2)	-25.777513	30.009216
SW2	Upstream of Western Pit (OC2)	-25.761663	30.003781
SW3	Downstream of Eastern Pit (OC1)	-25.787959	30.076553
SW4	Adjacent Mine site	-25.774543	30.080537
SW5	Upstream of Mine site	-25.727477	30.066199
SW6	Upstream of Western Pit (OC2)	-25.737885	30.042653
SW7	Upstream of both Western and Eastern Pits	-25.742731	30.025773
SW8	South of Eastern Pit adjacent to an existing Msobo Coal Mine	-25.792616	30.026443



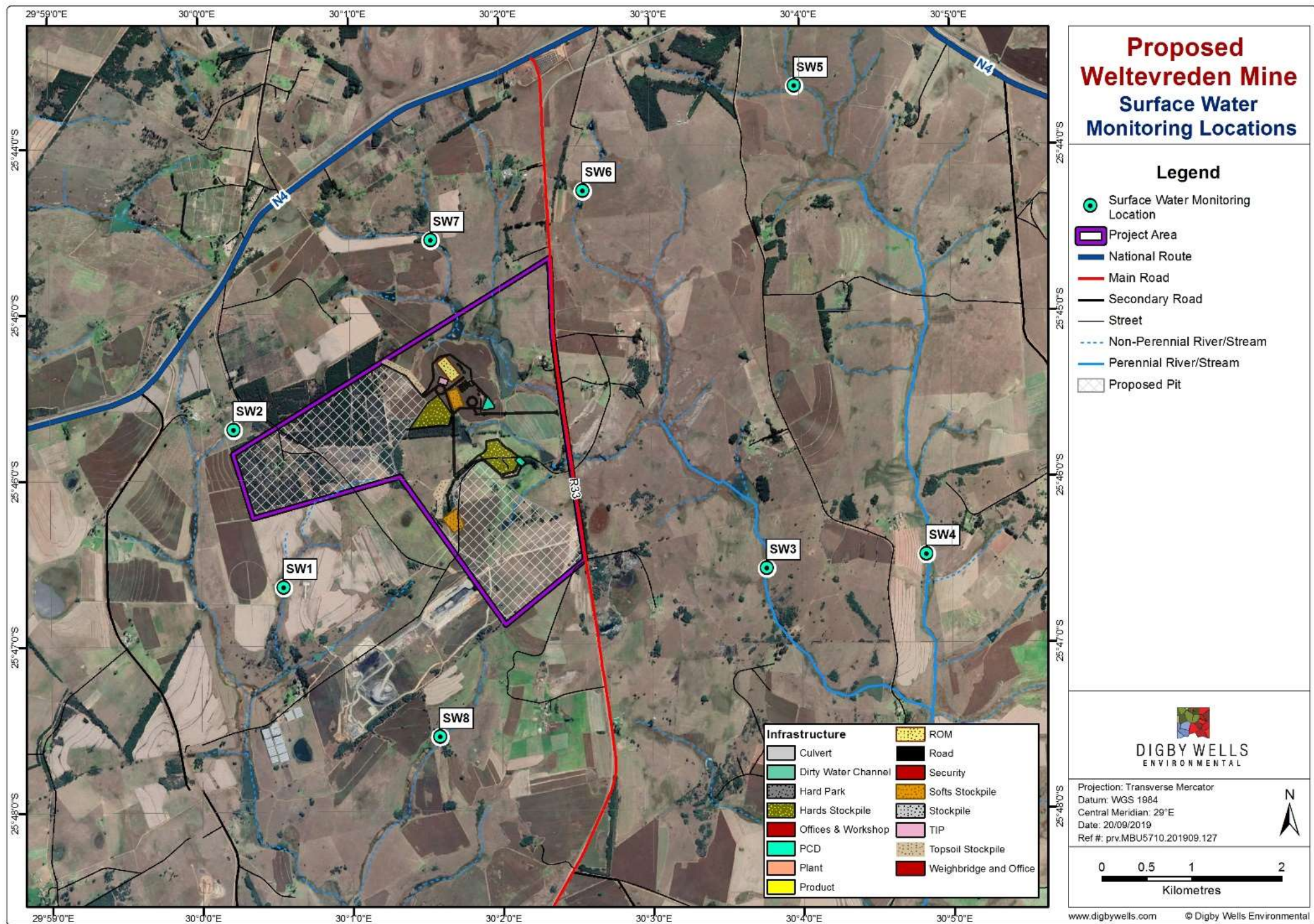


Figure 8.1: Surface water sampling localities at the Project Site

## 8.2 Results Interpretation

The water quality results represent baseline conditions prior to commencement of the proposed mining activities which should thus provide a necessary benchmark for any future water quality changes.

Electrical Conductivity (EC) and Total Dissolved Solids (TDS) are within the DWS water quality guidelines as indicated in Table 8-2. All major cations (K, Na, Ca and Mg) are also within the DWS guidelines.

Anions which include Sulphate ( $\text{SO}_4$ ), Chlorine (Cl), Fluoride (F), Nitrate ( $\text{NO}_3$ ) and Phosphate ( $\text{PO}_4$ ) were within the DWS water quality guidelines as indicated in Table 8-2.

Trace elements which include Aluminium (Al), Cadmium (Cd), Copper (Cu), Manganese (Mn), Selenium (Se), Zinc (Zn) exceeded the DWS water quality guidelines for livestock watering, domestic use, irrigation and for aquatic ecosystems (Table 8-2).



**Table 8-2: Surface water quality for streams within and around the Project Site**

Parameter	SW1	SW2	SW5	SW6	SW7	SW8	DWA TV Domestic Use	DWA TV Aquatic Ecosystem	DWA TV Livestock Watering	DWA TV Irrigation
	(mg/L, unless otherwise stated)									
pH, at 25°C (pH meter units)	6.7	5.5	6.8	5.8	7.1	7.1	6 - 9	NS	NS	6.5 - 8.4
Electrical Conductivity, (mS/m)	8.9	4.6	7.4	2.9	48.7	11.4	<70	NS	NS	NS or <40
Total Dissolved solids (TDS)	56	50	56	14	338	78	<450	NS	<1000	NS
Aluminium	< 0.100	< 0.100	< 0.100	0.294	< 0.100	< 0.100	<0.15	<0.01	<5	<5
Ammonia	3.6	0.8	0.2	0.2	4.3	0.1	NS	NS	NS	NS
Arsenic	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	≤200	0.01	≤1	0.1
Barium	0.058	0.047	0.045	0.021	0.12	0.029	NS	NS	NS	NS
Beryllium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	NS	0.10
Bismuth	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	NS	NS
Boron	< 0.010	< 0.010	0.011	< 0.010	0.022	< 0.010	NS	NS	<5	<0.5
Cadmium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	<0.005	<0.00015	<0.01	<0.01
Calcium	2	2	5	1	43	5	<32	NS	<1000	NS
Cerium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	<5	NS
Caesium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	<5	NS
Chloride	17	6	6	5	45	16	<100	NS	<1500	<100
Chromium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	<0.05	0.007	<1	<0.1
Cobalt	< 0.010	0.019	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	<1	<0.05
Copper	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	<1	<0.0003	<0.5	<0.2
Fluoride	0.2	0.2	0.2	0.2	0.3	0.2	<1	<0.75	<2	<2
Iron	0.679	2.65	0.591	0.626	20	0.642	<0.1	NS	<10	<5
Lead	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	<0.01	<0.0002	<0.1	<0.2
Lithium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	NS	NS
Magnesium	2	1	3	1	17	5	<30	NS	<500	NS
Manganese	< 0.025	0.232	0.049	0.031	1.05	< 0.025	<0.05	<0.18	<10	<0.02
Mercury	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	<1	0.04	<1	NS
Molybdenum	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	0.04	0.01	0.01
Nickel	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	<1	<0.2
Nitrate	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	≤6	NS	<200	100
Total Phosphate, as P	0.2	0.4	<0.2	<0.2	9	0.2	NS	NS	NS	NS
Potassium	4.5	2.1	2.7	1.4	19.2	2.9	<50	NS	NS	NS
Selenium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	<0.02	<0.002	<0.05	<0.02
Silicon	2.4	0.3	4.0	2.6	1.9	5.1	NS	NS	NS	NS
Silver	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	NS	NS
Sodium	8	2	3	2	12	7	<100	NS	<2000	<70
Strontium	0.027	0.022	0.027	< 0.010	0.124	0.038	NS	NS	NS	NS
Sulphate	6	6	<2	<2	<2	<2	<200	NS	<1000	NS
Suspended Solids at 105°	20	167	12.7	3.3	2 993	107	NS	NS	NS	<50
Tin	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	NS	NS	NS	NS
Titanium	< 0.010	< 0.010	< 0.010	< 0.010	0.054	< 0.010	NS	NS	NS	NS
Uranium (in Bq)	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.070 - 0.284	NS	NS	0.01
Vanadium	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	<0.1	NS	<1	<0.1
Zinc	0.047	0.061	0.039	0.046	0.038	0.038	<3	<0.002	<20	<1

**KEY:**

Exceeds least stringent standard or only available standard

Exceeds most stringent standard

No Standard



## 9 Water Balance

### 9.1 Calculations and Assumptions

#### 9.1.1 Rainfall, Runoff and Potential Evaporation Volumes

Monthly rainfall and evaporation data used in the proposed Weltevreden Mine water balance is indicated in Table 9-1. A monthly rainfall time series record of 89 years from 1920 to 2009 was used (WRC, 2015). Calculated rainfall and potential evaporation volumes for open storage facilities are presented in Table 9-2. Areas of the open storage facilities were obtained from the proposed Weltevreden Mine infrastructure layout plan provided by Xivono.

**Table 9-1: Average monthly rainfall for Quaternary X11D based on 89 years of historical data (WRC, 2015)**

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation (mm)	134	134	152	159	137	134	102	89	73	79	100	121
Rainfall (mm)	77	126	123	129	97	82	45	16	8	6	7	27

**Table 9-2: Open mine facility areas and associated annual rainfall-runoff and evaporation volumes**

Name of Facility	Area (m <sup>2</sup> )	Rainfall Volume	Runoff Volume	Evaporation Volume
	(m <sup>2</sup> )	(m <sup>3</sup> )		
ROM Stockpile	33983	25217	1866	48035
Hards Stockpile 1	94674	70254	5199	133822
Hards Stockpile 2	94166	69877	5171	133104
PCD1	11659	8652	640	16480
PCD2	7005	5198	385	9901
TIP Area	7000	5194	384	9894
OC1 (Pit sump)	30776	22837	1690	43501
OC2 (Pit sump)	39051	28978	2144	55198

### 9.1.2 Assumptions and Constants

Assumptions were made to determine certain water use volumes on the Weltevreden Mine. These assumptions are presented in Table 9-3.

**Table 9-3: Assumptions and constants made to complete the Weltevreden Mine water balance**

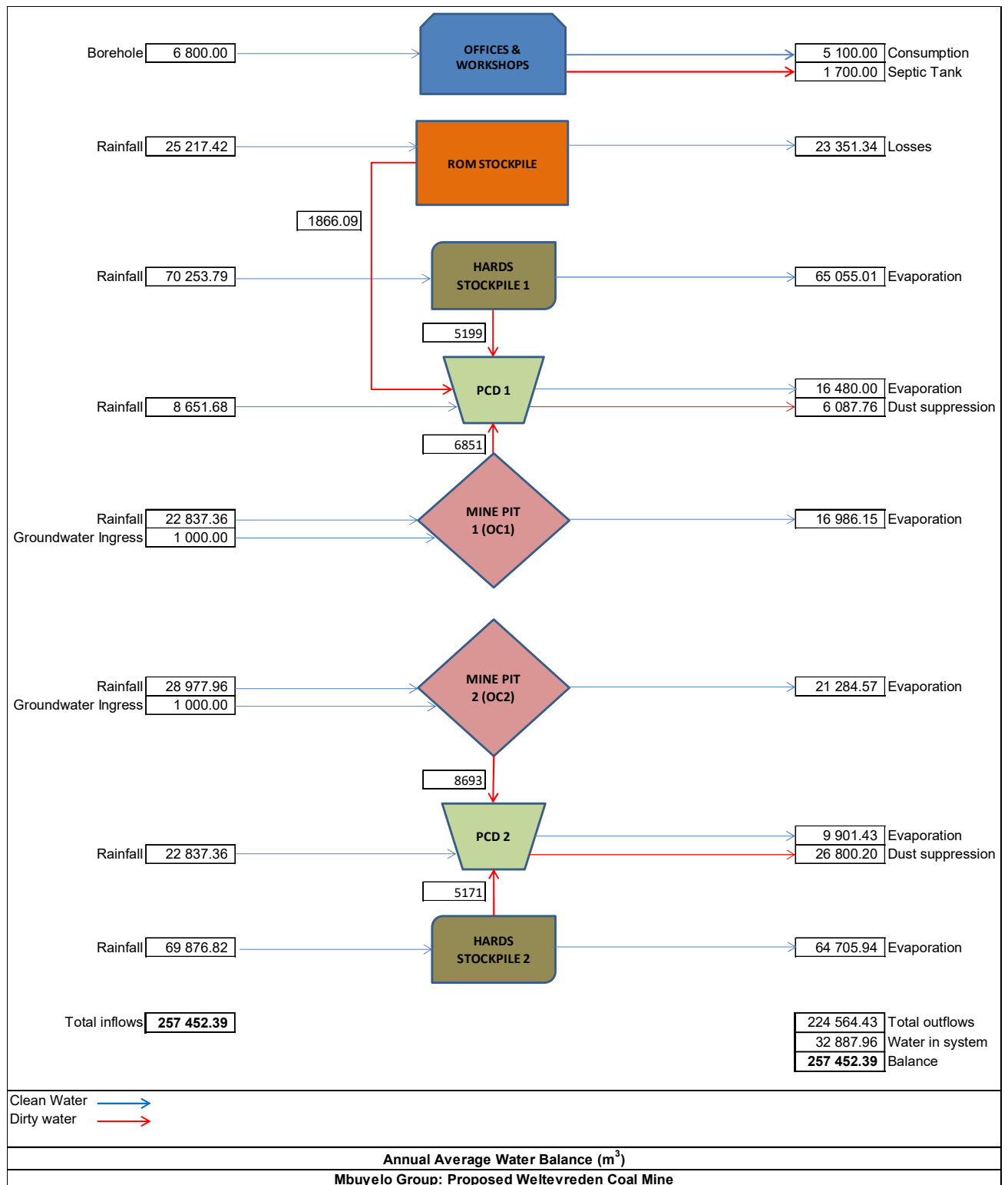
Water Use Assumption	Volume	Unit
Potable water consumption (offices & workshops) was calculated based on a daily per capita consumption volume of 0.05m <sup>3</sup> (1800m <sup>3</sup> for 100 people) plus a constant washing volume of 5000m <sup>3</sup> per annum	6800	m <sup>3</sup>
Groundwater ingress assumed to be 1000 m <sup>3</sup> /annum per pit (This will be updated with a groundwater model result)	1000	m <sup>3</sup>
Groundwater pumped from pit sumps to PCDs assumed to be 30% of rainfall into each pit:		
OC1 Pit sump	6851	m <sup>3</sup>
OC2 Pit sump	8693	m <sup>3</sup>
25% of borehole water to workshop goes to septic tank as wastewater	1700	m <sup>3</sup>

## 9.2 Water Process Flow and Water Balance

The Weltevreden annual average water balance with the water process flow diagram (PFD) is indicated in Figure 9.1, while the DWS format version of the water balance is presented in Table 9-4.

The water supply for the mine comes from groundwater boreholes. The annual average water balance indicates that 6 800 m<sup>3</sup>/annum of borehole potable water will be used in the mine offices and workshops. Water that drains from the ROM and Hards Stockpile areas and that which is pumped from mine pits during dewatering will be used for dust suppression. The total dust suppression volume for the mine is indicated to be 32 888 m<sup>3</sup>/annum.

Total water inflows (rainfall, groundwater ingress and abstraction from boreholes) and outflows (evaporation and losses) at the mine are indicated to be 257 452 m<sup>3</sup>/annum and 224 564 m<sup>3</sup>/annum, respectively. The water that is circulating within the mine system is indicated to be 32 888 m<sup>3</sup>/annum.



**Figure 9.1: Process flow and annual average water balance for Weltevreden Mine**

**Table 9-4: DWS format annual average water balance for Weltevreden Mine**

Weltevreden Mine Annual Average Water Balance					
Facility Name	Water In	Quantity	Water Out	Quantity	Balance
	Water Circuit/stream	(m <sup>3</sup> /annum)	Water Circuit/stream	(m <sup>3</sup> /annum)	
Offices and Workshops	Borehole abstraction	6 800	Consumption	5100.00	
			Septic Tank	1700.00	
		<b>6 800</b>		<b>6 800</b>	<b>-</b>
ROM Stockpile	Rainfall	25 217	Evaporation	30736.84	
	Moisture in product	7 386	Drainage to PCD1	1866	
		<b>32 603</b>		<b>32 603</b>	<b>-</b>
Hards Stockpile 1	Rainfall	70 254	Evaporation	65055.01	
			Drainage to PCD1	5198.78	
		<b>70 254</b>		<b>70 254</b>	<b>-</b>
PCD 1	Rainfall	8652			
	From ROM Stockpile	1866	Evaporation	16480	
	From Hards Stockpile 1	5199	Dust suppression	6088	
	From Mine Pit 1 (OC1)	6851			
		<b>22568</b>		<b>22568</b>	<b>-</b>
Mine Pit 1 (OC1)			Evaporation	16986	
	Rainfall	22837	To PCD 1	6851.21	
	Groundwater Ingress	1000			
		<b>23 837</b>		<b>23 837</b>	<b>-</b>
Mine Pit 2 (OC2)			Evaporation	21285	
	Rainfall	28978	To PCD 2	8693	
	Groundwater Ingress	1000			
		<b>29 978</b>		<b>29 978</b>	<b>-</b>
PCD2	Rainfall	22 837	Evaporation	9901.43	
	From Hards Stockpile 2	5 171	Dust suppression	26800.20	
	From Mine Pit 2 (OC2)	8 693			
		<b>36 702</b>		<b>36 702</b>	<b>-</b>
Hards Stockpile 2	Rainfall	69 877	Evaporation	64705.94	
			Drainage to PCD 2	5171	
		<b>69 877</b>		<b>69 877</b>	<b>-</b>

## 10 Surface Water Impact Assessment

Surface water impacts were assessed for the three phases of the Project site which are construction, operation and decommissioning phases.

### 10.1 Construction Phase

Activities during the construction phase that may have potential impacts (Table 10-1) on the surface water resources are described and the appropriate management/mitigation measures are provided below.

**Table 10-1: Interactions and Impacts of Activity**

Interaction	Impact
Excavations on the Project site to prepare or install mine infrastructure including mine pits and pollution control dams disturb headwater wetlands that contribute base flow to adjacent streams/rivers	Reduction of base flow arising from disturbed wetlands
Site preparation including vegetation clearance and excavations. Stockpiling of overburden and discard;	Sedimentation and siltation of nearby watercourses;
Construction and installation of infrastructural facilities including administration offices, ablutions, storerooms, workshops, pollution control dams, roads, pipelines, power lines and conveyors.	Increase of paved surfaces and subsequent increase in runoff and potential flooding
Handling of hydrocarbons and other chemicals; Loading, hauling and transportation of product coal.	Surface water contamination leading to deterioration of water quality

**10.1.1.1 Reduction of base flow arising from disturbed wetlands**

Excavations on the Project site to prepare or install mine infrastructure including mine pits and pollution control dams disturb headwater wetlands that contribute base flow to adjacent streams/rivers (Digby Wells, 2019). The excavations will affect groundwater/surface water interactions by intercepting vadose zone flow paths that lead fluxes to adjacent streams/rivers.

**10.1.1.2 Impact Description: Sedimentation and siltation of nearby watercourses**

Clearing or removal of vegetation leaves the soils prone to erosion during rainfall events, and as a result runoff from these areas will be high in suspended solids increasing turbidity in the natural water resources. Stockpiled topsoil and discard may be eroded and thereby introducing sediments into nearby streams and rivers.

**10.1.1.3 Impact Description: Increase of impermeable surfaces and subsequent increase in runoff and potential flooding**

Construction of infrastructure such as administration offices, ablutions, storerooms, workshops and roads will increase the total area of paved surfaces. The process of installing pipelines, power lines and conveyor belts will likely cause soil compaction along these servitudes due to movement of vehicles and machinery. Increased impermeable areas or compacted soils will reduce infiltration, subsequently increasing runoff leading to potential flooding in nearby watercourses.

#### **10.1.1.4 Impact Description: Surface water contamination leading to deterioration of water quality**

Handling of general and hazardous waste including spillages of hydrocarbons such as oils, fuels and grease potentially contaminate nearby water resources when washed off into rivers, streams and pans.

#### **10.1.1.5 Management/Mitigation Measures**

- Avoid placement of infrastructure or making excavations within the 100-year floodlines or 100 m buffer from watercourses, whichever is greater;
- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised so as to minimise creation of new ones;
- Hydrocarbon and hazardous waste storage facilities must be placed on hard park and bunded areas. Dirty water from workshops and washbays must be channelled to a pollution control facility through oil separator to prevent possible contamination of the natural environment;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited vendors;
- Implement a storm water management plan (SWMP) to attenuate the high runoff velocities and dissipate flood flows that result from increased impervious areas;
- Dirt or gravel roads must be well compacted to avoid erosion of the soil into nearby streams; and
- Dust suppression on haul roads and cleared areas must be regularly undertaken.

**Table 10-2: Impact Significance Rating for Construction Phase**

Dimension	Rating	Motivation	Significance
Impact: Reduction of base flow arising from disturbed wetlands			
Duration	7	The impact will remain long after the life of the Project	108- Moderate (negative)
Intensity	7	High significant impact on the environment resulting in irreparable damage to aquatic ecosystems	
Spatial scale	4	Impact has the potential to affect a wider area beyond the mining right area	
Probability	6	Almost certain that the impact will occur.	
Post-mitigation			
This impact does not have any mitigation measures. The only way to avoid impacting on base flow is to avoid excavations or placement of infrastructure on the wetland areas on the Project site.			





Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses			
Duration	5	The impact will likely occur during the construction and decommissioning phases	78- Moderate (negative)
Intensity	4	Serious medium-term environmental effects	
Spatial scale	4	Impact has the potential to affect a wider area beyond the mining right area	
Probability	6	Almost certain that the impact will occur.	
Post-mitigation			
Duration	2	The impact will only likely occur in the short term given implementation of recommended mitigation measures	18- Negligible (negative)
Intensity	2	Minor effects on biological or physical environment are expected if silt traps and soil stabilisation procedures are followed	
Spatial scale	2	With proper management, the impact will be localised to disturbed mine areas	
Probability	3	There is a possibility that the impact will occur	

Dimension	Rating	Motivation	Significance
Impact: Increase of impermeable surfaces, subsequently increasing runoff and potential flooding			
Duration	5	This is a long-term impact which will occur for the life of the project	60- Minor (negative)
Intensity	4	Increased runoff velocities on impermeable areas will cause sedimentation and possible siltation of nearby watercourses	
Spatial scale	3	The impacts will be localised to the immediate surroundings of the mine site.	
Probability	5	The impact will likely occur	
Post-mitigation			
Duration	5	Impact will occur for the duration of the project	27-Negligible (negative)
Intensity	2	Implementation of recommended storm water management measures will cause the impact to be low on the receiving environment	

Dimension	Rating	Motivation	Significance
Spatial scale	2	With proper management, the impact will be localised to operational areas within the mine's footprint.	
Probability	3	There is a possibility that the impact will occur	

Dimension	Rating	Motivation	Significance
Impact: Surface water contamination leading to deterioration of water quality			
Duration	5	The impact will likely occur for the life of the project	60- Minor (negative)
Intensity	4	This will moderately impact the water quality and the ecosystem functionality for downstream users.	
Spatial scale	3	The impacts will be localised extending across the site and to nearby settlements.	
Probability	5	The impact will likely occur	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	18-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact will have low intensity	
Spatial scale	2	With proper management, the impact will be localised to sites where incidents occur	
Probability	2	The possibility of the impact occurring is very low as a result of implementation of adequate mitigation measures	

## 10.2 Operational Phase

Activities during the operational phase that may have potential impacts on surface water resources are summarised in Table 10-3 and further described together with recommended management/mitigation measures in the following subsections.

**Table 10-3: Interactions and Impact Activity**

Interaction	Impact
Runoff from the dirty water areas or catchments	Surface water contamination and deterioration of water quality
Hydrocarbons and chemicals spillages and leakages from equipment, moving haulage trucks and machinery.	Surface water contamination by hydrocarbon waste and deterioration of water quality
Containment of dirty runoff and interception of rainfall in the PCDs	Reduction of catchment runoff yield

### **10.2.1.1 Impact Description: Surface water contamination by runoff from dirty water areas**

Water contamination may occur as a result of runoff from contaminated surfaces within the mine into nearby watercourses. The dirty water areas include Stock Yards, PCD Area, Workshop Area, Crusher Area, Washing Bay Area and the Opencast Pit Area. The runoff generated from these areas will likely be contaminated and thus will have a detrimental effect on water quality thereby affecting aquatic ecosystems and downstream water users.

### **10.2.1.2 Surface water Contamination from hydrocarbon and chemical spillages and leakages**

The operational machinery, transportation and storage at the mine site are potential sources of hydrocarbon and chemical spills and leakages. When not properly managed, hydrocarbon and chemical spills and leakages will contaminate surface water resources within and in proximity to the Project site.

### **10.2.1.3 Impact Description: Reduction of catchment runoff yield**

Containing runoff and interception of rainfall in open storage facilities will capture water that was supposed to report to the nearby streams. This will lead to reduced runoff yield within the catchment and subsequently reduce streamflow downstream.

### **10.2.1.4 Management/Mitigation Measures**

The following mitigation measures are recommended:

- Runoff from dirty areas should be directed to stormwater management infrastructure (drains and PCDs) and should not be allowed to flow into the natural environment, unless DWS discharge authorisation and compliance with relevant discharge

standards as stipulated in the National Water Act, 1998 (Act No. 36 of 1998) (NWA) is obtained;

- Keep or confine dirty catchments to footprint areas to limit the spatial extent of the impact;
- Recycle dirty water in order to limit the amount of new water intake or use of reticulated water in mine operations;
- Excess dirty water which cannot be recycled can be treated to acceptable discharge standards before being discharged to the environment;
- Water quality monitoring program should be implemented to monitor water resources within and in proximity to the Project site to detect any contamination arising from operational activities;
- The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites;
- Wash bay and workshop discharged water should flow through oil separators to the PCD.
- The hydrocarbon and chemical storage areas and facilities must be located on hard-standing area (paved or concrete surface that is impermeable), roofed and bunded in accordance with SANS1200 specifications. This will prevent mobilisation of leaked hazardous substances;
- Training of mine personnel and contractors in proper hydrocarbon and chemical waste handling procedures is recommended;

**Table 10-4: Impact Significance Rating for Operational Phase**

Dimension	Rating	Motivation	Significance
Impact: Surface water contamination by runoff from dirty water areas			
Duration	6	The impact will remain for some time after the life of the mining project.	105-Moderate (negative)
Intensity	5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate	
Spatial scale	4	The impacts will likely extend to watercourses in the whole municipal area affecting downstream water users	
Probability	7	The impact will definitely occur based on coal mining history and explainable scientific reasons	
Post-mitigation			

Dimension	Rating	Motivation	Significance
Duration	5	The impact is expected to occur for the whole life of the coal mining project	18-Negligible (negative)
Intensity	2	Proper and continued implementation of storm water management plan and water quality monitoring will lower the intensity of the contaminated runoff impact on proximal water resources.	
Spatial scale	2	Limited spatial extent if mitigation measures are adequately implemented.	
Probability	2	The possibility of the impact occurring is very low if mitigation measures are adequately implemented.	

Dimension	Rating	Motivation	Significance
Impact: Surface water Contamination from hydrocarbon and chemical spillages and leakages			
Duration	5	The impact will likely occur for the whole life of the project	72- Minor (negative)
Intensity	4	Moderate impacts to water quality and ecosystem functionality are expected	
Spatial scale	3	The impact may extend across the site and to nearby settlements if contaminants are washed into proximal watercourses	
Probability	6	It is most likely that the impact will occur	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	18-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact intensity will be low	
Spatial scale	2	With proper management, the impact will be localised to incident sites, where contaminants will quickly be cleaned up.	



Probability	2	The possibility of the impact occurring is very low if mitigation measures re adequately implemented	
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Dimension	Rating	Motivation	Significance
Impact: Reduction of catchment runoff yield			
Duration	5	The impact will occur for the duration of the project	91 - Moderate (negative)
Intensity	4	Impact will be felt across the site to downstream reaches	
Spatial scale	4	Moderate to medium intensity since the proposed Project site is significantly smaller compared to the entire contributing catchment into the Klein-Komatirivier (<5% of total catchment)	
Probability	7	The impact will definitely occur if no measures are put in place	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	70 - Minor (negative)
Intensity	3	With management measures of dirty water recycling and re-use and possible treatment for discharge purposes, the impact intensity will be low	
Spatial scale	2	With proper management, the impact will be localised to incident sites, where contaminants will quickly be cleaned up.	
Probability	7	The impact will occur	

### 10.3 Decommissioning Phase

Activities during the decommissioning and closure phase that pose potential impacts on surface water resources are summarised in and further described together with recommended management/mitigation measures in the following subsections.

**Table 10-5: Interactions and Impact Activity**

Interaction	Impact
Demolition of mine infrastructure (PCDs, workshops, haul roads, crusher etc.) Disturbance of soils and erosion by overland flow	Sedimentation and siltation of nearby watercourses and deterioration of water quality
Decant of Acid Mine Drainage (AMD)	Contamination of surface water resources by acid mine drainage
Rehabilitation of disturbed sites close to pre-mining conditions	Restoration of pre-mining streamflow regime in nearby watercourses

**10.3.1.1 Impact Description: Sedimentation and siltation of nearby watercourses and deterioration of water quality**

During the decommissioning phase demolition of infrastructure, will cause disturbance and subsequent erosion of soils into nearby watercourses. This will result in higher rates of sedimentation and siltation in nearby streams, pans and dams thereby reducing their flow/storage capacities and their ability to sustain aquatic ecosystems. The quantity and quality of water for downstream water users will thus be compromised.

**10.3.1.2 Impact Description: Contamination of surface water resources by acid mine drainage**

AMD causes acidification and metal contamination of surface water bodies when mine materials containing metal sulphides, such as iron pyrites, are exposed to oxidizing conditions. Heavy-metal contaminated and acidified groundwater discharges into streams at points where the water table is close to the surface. The oxidation of iron sulphide causes the precipitation of sulphuric acid which lowers in-stream water pH. Acidic water environments are detrimental to most aquatic life species, and they affect irrigation and livestock watering functions for downstream water users. The potential for AMD was confirmed for the Project site through geochemical assessment and groundwater contamination modelling (Digby Wells, 2019).

**10.3.1.3 Impact Description: Restoration of pre-mining streamflow regime in nearby watercourses**

In accordance with the Government Notice 704 (GN 704) of the NWA, the mine is required to separate clean and dirty water to prevent contamination of the clean water resources. Dirty water is required to be contained on site for re-use in mine processes or it is allowed to evaporate. In pre-mining period, this is the runoff which could have been reporting to natural streams, so containment of dirty water runoff in the mine reduces the amount of runoff reporting to downstream segments of the Project site. A decrease in the catchment yield may have an impact on downstream water users as they may not have sufficient water for their needs, while also decreasing the required natural ecological flows.

A positive impact thus occurs as water freely flows to downstream water users due to restoration of higher streamflow regime close to pre-mining conditions.

#### **10.3.1.4 Management/Mitigation Measures**

The following mitigation measures are recommended:

- Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas;
- Movement of demolition machinery and vehicles should be restricted to designated access roads to minimise the extent of soil disturbance;
- Options to deal with AMD include the following:
  - Treating AMD decant to acceptable water quality levels prior to discharge into the natural stream; and
  - Neutralisation of AMD effluent with calcium carbonate or lime at identified decant points to obtain water with acceptable quality.
- Backfilled, top-soiled areas should be re-profiled and revegetated to allow free drainage that is close to pre-mining conditions.

**Table 10-6: Impact Significance Rating for Decommissioning and Closure Phase**

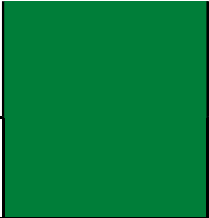
Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses and deterioration of water quality			
Duration	2	The impact will short term during the decommissioning phase.	63-Minor (negative)
Intensity	4	Serious medium-term environmental effects	
Spatial scale	3	The impacts might extend across the site and to nearby settlements	
Probability	7	Without appropriate mitigation, it is probable that this impact will occur	
Post-mitigation			
Duration	2	The impact will likely only occur during the decommissioning phase	12-Negligible (negative)
Intensity	2	Should the impact occur, it will have minor medium-term impacts due to implementation of mitigation measures	
Spatial scale	2	The impacts will be localised to sites where demolition will be undertaken and contained by silt traps on site	

Dimension	Rating	Motivation	Significance
Probability	2	The possibility of the impact occurring is very low due to implementation of adequate mitigation measures.	

Dimension	Rating	Motivation	Significance
Impact: Water Contamination from Acid Mine Drainage into surface water resources			
Duration	7	The impact will remain for some time after the life of the project.	108-Moderate (negative)
Intensity	7	High significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem.	
Spatial scale	4	The impact has the potential to affect the whole municipal area.	
Probability	6	It is highly probable that the impact will occur.	
Post-mitigation			
Duration	7	The impact will remain for some time after the life of the project.	44-Minor (negative)
Intensity	2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants.	
Spatial scale	2	Limited to the site and its immediate surroundings.	
Probability	4	It is probable the impact will occur.	

Dimension	Rating	Motivation	Significance
<b>Impact: Restoration of pre-mining streamflow regime in nearby watercourses</b>			
Duration	7	The impact will remain long after the life of the Project.	112-Major (positive)
Intensity	4	The impact leads to significant increase in the quality of the receiving environment.	



Spatial scale	5	The impact may extend across the Project site and to nearby settlements	
Probability	7	It is definite that this positive impact will occur (there is no mitigation for this impact)	

### 10.3.2 Cumulative Impacts

The Project site is located upstream of the Inkomati-Usuthu catchment (quaternary X11D). The area is water scarce and farmers rely heavily on seasonal rain (Northern Coal (Pty) Ltd Report; 2009). Coal mining is currently being undertaken by Msobo Coal (Pty) Ltd within the catchment which has two operations situated approximately 2 km and 6 km from the proposed Project site. All coal mining and associated infrastructure will require water which will pose a threat to the quantity and quality of water resources in the area.

The opencast mining methods have the potential to reduce catchment yields if not properly managed. Coal mining, processing and dust suppression, are generally water intensive activities hence they impact on water quantity within catchments. Furthermore, contaminated (acidic/high sulphate) decant water from opencast areas often finds its way to surface streams, reducing the quality of water in these streams. Against this background the cumulative effect may be highly significant.

## 11 Summary of Mitigation and Management

A summary of impact mitigation and management measures including the relevant legislation whose standards and guidelines should be achieved is presented in Table 11-1.

**Table 11-1: Summary of Mitigation and Management Measures**

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation	Standard to be Achieved/Objective
<ul style="list-style-type: none"> <li>Site clearing;</li> <li>Mine Pit excavations;</li> <li>Access and haul road construction;</li> <li>Construction of Infrastructure;</li> <li>Handling of hydrocarbons and other chemicals.</li> </ul>	<ul style="list-style-type: none"> <li>Reduction of base flow arising from disturbed wetlands</li> <li>Sedimentation and siltation of nearby watercourses</li> <li>Increase of paved surfaces and subsequent increase in runoff and potential flooding</li> <li>Surface water contamination leading to deterioration of water quality</li> </ul>	Surface water quality and quantity	Construction	<ul style="list-style-type: none"> <li>Avoid placement of infrastructure or making excavations within the 100-year floodlines or 100 m buffer from watercourses, whichever is greater;</li> <li>Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;</li> <li>Hydrocarbon and hazardous waste storage facilities must be placed on hard park and bunded areas. Dirty water from workshops and washbays must be channelled to a pollution control facility through oil separator to prevent possible contamination of the natural environment;</li> <li>Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited vendors;</li> <li>Dirt or gravel roads must be well compacted to avoid erosion of the soil into nearby streams; and</li> <li>Dust suppression on haul roads and cleared areas must be regularly undertaken.</li> </ul>	<ul style="list-style-type: none"> <li>South African National Water Act, Act.36 of 1998 (NWA)</li> <li>South African National Environmental Management Act, 107 of 1998 (NEMA)</li> <li>The National Environmental Management: Waste Act, 2008 (Act No. 56 of 2008) (NEM: WA)</li> </ul>
<ul style="list-style-type: none"> <li>Runoff from the dirty water areas or catchments;</li> <li>Handling of hydrocarbons and other chemicals</li> <li>Containment of dirty runoff and interception of rainfall in the PCDs</li> </ul>	<ul style="list-style-type: none"> <li>Surface water contamination and deterioration of water quality;</li> <li>Surface water contamination by hydrocarbon waste and deterioration of water quality; and</li> <li>Reduction of catchment runoff yield</li> </ul>	Surface water quality and quantity	Operation	<ul style="list-style-type: none"> <li>Runoff from dirty areas should be directed to stormwater management infrastructure (drains and PCDs);</li> <li>Water quality monitoring program should be implemented to monitor quality and quantity of water resources;</li> <li>General and other forms of waste must be collected into clearly marked skip bins and then disposed of by approved contractors at accredited disposal sites;</li> <li>Wash bay and workshop discharged water should flow through oil separators to the PCD.</li> <li>Hydrocarbon and chemical storage areas and facilities must be located on paved hard-standing areas, roofed and bunded;</li> <li>Mine personnel and contractors should be trained in proper hydrocarbon and chemical waste handling procedures;</li> <li>All the runoff captured in the PCDs should be re-used in the mine processes where possible;</li> </ul>	<ul style="list-style-type: none"> <li>South African National Water Act, Act.36 of 1998 (NWA)</li> <li>South African National Environmental Management Act, 107 of 1998 (NEMA)</li> <li>The National Environmental Management: Waste Act, 2008 (Act No. 56 of 2008) (NEM: WA)</li> </ul>

Activities	Potential Impacts	Aspects Affected	Phase	Mitigation	Standard to be Achieved/Objective
<ul style="list-style-type: none"> <li>Demolition and removal of infrastructure;</li> <li>Decant of Acid Mine Drainage; and</li> <li>Rehabilitation of project area</li> </ul>	<ul style="list-style-type: none"> <li>Sedimentation and siltation of nearby watercourses and deterioration of water quality;</li> <li>Contamination of surface water resources by acid mine drainage; and</li> <li>Restoration of pre-mining streamflow regime in nearby watercourses</li> </ul>	Water quality and quantity	Decommissioning	<ul style="list-style-type: none"> <li>Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas;</li> <li>Movement of demolition machinery and vehicles should be restricted to designated access roads;</li> <li>Options to deal with AMD include the following:</li> <li>Treating AMD decant to acceptable water quality levels prior to discharge into the natural stream; and</li> <li>Neutralisation of AMD effluent with calcium carbonate or lime at identified decant points to obtain water with acceptable quality;</li> <li>Backfilled, top-soiled areas should be re-profiled and revegetated to allow free drainage that is close to pre-mining conditions.</li> </ul>	<ul style="list-style-type: none"> <li>South African National Water Act, Act.36 of 1998 (NWA)</li> <li>Government Notice 704 (GN704) of the National Water Act, 36 of 1998 (NWA).</li> <li>South African National Environmental Management Act, 107 of 1998 (NEMA)</li> <li>The National Environmental Management: Waste Act, 2008 (Act No. 56 of 2008) (NEM: WA)</li> </ul>

## 12 Surface Water Monitoring Programme

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented.

The current monitoring plan provides a programme to detect any surface water impacts likely to occur during the operation and decommissioning phases of the proposed mine and subsequent rehabilitation of all associated sites within the Weltevreden mining right area. Post closure monitoring must be undertaken for at least three (3) years after the project has ceased, or until rehabilitation has reached a sustainable state with no further changes to the environment, as recommended by the DWS. Monitoring points are indicated in Figure 8.1 while monitoring frequencies are described in this monitoring plan. All water quality results should be benchmarked to the WUL standards and the South African Water Quality guidelines: (for domestic use, aquatic ecosystems, livestock watering and irrigation) to determine the impact of the proposed Weltevreden mining activities on the quality of water (positive/negative).

The surface water monitoring plan is summarised in Table 12-1.

**Table 12-1: Surface Water Monitoring Programme**

Monitoring Element	Comment	Frequency	Responsibility
Water quality	<p>Ensure water quality monitoring as per sampled and proposed monitoring locations (See <b>Error! Reference source not found.</b>). Parameters should include but not limited to pH; Electrical Conductivity; Sulphate; major cations (K, Ca, Mg &amp; Na); trace metals (Al, Fe, Zn, Cu, Mn, Co, Se, Mo, Cd, Ni, Cr (VI), Pb, Hg &amp; As); Anions (NO<sub>3</sub>, NO<sub>2</sub>, NH<sub>4</sub>, Cl, F, PO<sub>4</sub>); Total Dissolved Solids; Total Suspended solids.</p> <p>It is also recommended to monitor water quality within the mine water dams or water containment facilities to determine the concentration levels in case of an overflow or need for discharge.</p>	<p>Monthly monitoring during construction, operation, decommissioning and for at least three (3) years after closure, or until rehabilitation has reached a sustainable state with no further changes.</p>	<p>Environmental Officer</p>

Monitoring Element	Comment	Frequency	Responsibility
Sedimentation	Inspect construction sites, sites where infrastructure is demolished and rehabilitated sites for traces of erosion to ensure no entrance of sediment occurs into nearby watercourses, especially after rainfall events. Temporary silt fences, soil stabilization blankets should be installed and maintained until vegetation is established.	After rainfall event, until the establishment of vegetation on all rehabilitated sites	Environmental Officer
Water quantity and water balance	Monitoring or measuring of all the water inflows into the mine, reticulation within the mine and the outflows from the mine. This can be achieved by installing automatic flow meters to ensure real time measurements of water.	In operational areas where automatic flow meters are in place, daily records need to be kept	Environmental Officer
Physical structures and Storm Water Management Plan (SWMP) performance	<p>Personnel should have a walk around facilities to determine the facilities conditions and pick out any anomalies such as leaks or overflows and system malfunctions.</p> <p>Storm water channels, and existing mine dams are inspected for silting and blockages of inflows, pipelines for hydraulic integrity; monitor the overall SWMP performance.</p>	Continuous process and yearly formal report	Environmental Officer

## 13 Conclusions and Recommendations

The Project site is characterised by a temperate climate with dry winters and warm summers. The MAP and MAE for the Project site were determined to be 742 mm and 1414 mm, respectively. The region clearly experiences higher evaporation than precipitation, giving rise to distinctly dry winters and wet summers. The MAR depth was calculated to be 80.91 mm, and this accounts for approximately 7.4% of the MAP for the area.

Baseline water quality was assessed and benchmarked against DWS standard limits for domestic use, aquatic ecosystems, livestock watering and irrigation as these were identified as dominant water uses in the area. EC, TDS, major cations and P are below the DWS standard limits. All assessed trace elements including Al, Cd, Cu, Mn, Se, Zn exceed the DWS standard limits.

Modelled floodlines indicate that the proposed mine infrastructure is outside the 1:100-year floodline except for part of the western OC2 Pit which slightly encroaches by 130m into the headwaters of a non-perennial tributary of the Klein-Komatirivier. Reducing the size of the OC2 Pit on its southern fringe will remove it from the 1:100-year exclusion zone.

The study also involved assessment of storm water management on the Project site. The stormwater management plan addressed separation of clean and dirty water on site by a network of lined dirty water channels, clean water perimeter berms and containment facilities such as pollution control dams.

The water balance for the mine indicated total water inflows (rainfall, groundwater ingress and abstraction from boreholes) and outflows (evaporation and losses) to be 257 452 m<sup>3</sup>/annum and 224 564 m<sup>3</sup>/annum, respectively. The water that is circulating within the mine system was determined to be 32 888 m<sup>3</sup>/annum.

Impacts on surface water resources arising from proposed mining activities were identified for the construction, operation and decommissioning phases of the proposed Weltevreden Mine. The identified impacts include the following:

- Reduction of base flow arising from disturbed wetlands;
- Sedimentation and siltation of nearby watercourses;
- Increase of paved surfaces and subsequent increase in runoff and potential flooding;
- Surface water contamination leading to deterioration of water quality.
- Reduction of catchment runoff yield due to containment and interception of runoff and rainfall by open storage facilities; and
- Contamination of surface water resources by acid mine drainage.

Mitigation/management measures to prevent, and/or minimise the identified potential surface water impacts were described. It is recommended that the developed stormwater management plan, the monitoring programme for surface water quality, water use flows and volumes be implemented to ensure the reduction or outright prevention of the identified potential impacts. Should the mitigation and management measures be implemented, this project is unlikely to pose significant concerns to water resources within and around the project area. The following mitigation/management measures are recommended:

- That the mine should avoid placement of infrastructure or making excavations within the 100-year floodlines or 100 m buffer from watercourses, whichever is greater;
- Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;



- Dirty water from workshops and washbays must be channelled to a pollution control facility through oil separator to prevent possible contamination of the natural environment;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas;
- Dirt or gravel roads must be well compacted to avoid erosion of the soil into nearby streams;
- Dust suppression on haul roads and cleared areas must be undertaken regularly;
- Runoff from dirty areas should be directed to stormwater management infrastructure (drains and PCDs) and should not be allowed to flow into the natural environment, unless DWS discharge authorisation and compliance with relevant discharge standards as stipulated in the NWA is obtained;
- Water quality monitoring programme should be implemented to monitor water resources within and in proximity to the Project site to detect any contamination arising from operational activities;
- The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites;
- The hydrocarbon and chemical storage areas and facilities must be located on hard-standing area (paved or concrete surface that is impermeable), roofed and bunded in accordance with SANS1200 specifications. This will prevent mobilisation of leaked hazardous substances;
- Training of mine personnel and contractors in proper hydrocarbon and chemical waste handling procedures is recommended;
- Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas;
- Movement of demolition machinery and vehicles should be restricted to designated access roads to minimise the extent of soil disturbance;
- Backfilled, top-soiled areas should be re-profiled and revegetated to allow free drainage that is close to pre-mining conditions;
- Should Acid Mine Drainage (AMD) occur, post-closure, the mine should consider taking the following measures:
  - Neutralisation of AMD effluent with calcium carbonate or lime at identified decant points to obtain water with acceptable quality; and
  - Treating AMD decant in a Water Treatment Plant to acceptable water quality levels prior to discharge into the natural streams.

## 14 Reasoned Specialist Opinion

Should all the recommended mitigation and management measures be implemented, there is no hydrological reason why the Weltevreden project may not proceed.

## 15 References

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## Appendix A: Specialist CV

- **Professional Details**
  - Name: Daniel Fundisi
  - Profession: Hydrologist (Pr.Sci.Nat)
  - Department: Water Services
  - Company: Digby Wells Environmental
- **Education**
  - MSc in Hydrology, Centre for Water Resources Research, University of KwaZulu-Natal, Pietermaritzburg, South Africa, 2014.
  - BSc (Hons) Geography (Hydrology Major), Department of Geography and Environmental Science, University of Zimbabwe, 2007.
  - BSc in Geography and Environmental Studies, Department of Geography and Environmental Studies, Zimbabwe Open University, 2004.
  - Diploma in Science Education, University of Zimbabwe, 1994.
- **Short Courses**
  - River and Stormwater Modelling Course (2017) Stellenbosch University.
  - Design Flood Estimation Workshop (November 2016): Facilitators: Professor Jeff Smithers (UKZN) & Dr Kjeldsen – University of Bath (UK)
  - Streamflow Measurement Workshop (2015): Gareth Frost – Hatch Goba
  - PCSWMM & Urban Stormwater Drainage Modelling: E. Naidoo & Professor Neil Armitage – University of Cape Town.
  - Diploma in Microsoft Excel (November 2015, Shaw Academy).
- **Language Skills**
  - English and Shona (mother language): Fluent
  - Sepedi: Basic
- **Employment History**
  - Hydrologist at Digby Wells Environmental (August 2018 – Present);
  - Hydrologist at GCS Water and Environment (Pty) Ltd (July 2014 – July 2018);



- Hydrologist at IWR Waterresources (Pty) Ltd (September 2012 - June 2014); and
- Hydrologist at Zimbabwe National Water Authority (January 2005-June 2006)

- **Project Experience (Selected)**

**PROJECT** : Hydrological Assessment for the proposed Bougouni Lithium Project in Mali (2018).

The study involved baseline assessment which included rainfall-runoff modelling, stormwater management planning, water balance, water quality, floodlines modelling and surface water impact assessment. I was selected to be the lead hydrologist for Digby Wells undertaking the above-mentioned studies.

**PROJECT** : Hydrological assessment for the proposed Malingunde Flake Graphite Mining Project in Lilongwe Malawi (2017)

CLIENT: Sovereign Metals (Pty) Ltd

The study involves detailed hydrological assessment (hydro-meteorological analysis, stormwater modelling and management planning & water balance modelling) and catchment yield analysis.

The catchment yield analysis involved rainfall-runoff modelling for the greater Kamuzu Dam Catchment and the local Malingunde study site, in order to determine the impact of the proposed Flake Graphite Mine project on the available Kamuzu Dam water resources. I was the lead hydrologist responsible for the delineation and characterisation of subcatchments, hydrological modelling to determine catchment yield (WReMP), stormwater management planning (PCSWMM) and water balance calculation.

**PROJECT** : Surface Water Impact Assessment and Management Plan for the Closure of the North Block Complex (NBC) Coal Mines (Glisa, Strathrae and Eerstelingsfontein) (On-going project) CLIENT: Exxaro Coal Mpumalanga (ECM)

The study involves assessing the current status of surface water resources on 3 mine sites based on Surface Water Management measures indicated in the Environmental Management Plan Reports for the mines. This includes the evaluation of the implementation of on-site stormwater management measures to ensure minimal to no surface water quality issues arising from mine waste disposal, chemical pollutants including hydrocarbons. Mine closure based surface water management plans will be recommended based on the current status of surface water resources on project sites viewed against future requirements as stipulated in the Water Use Licenses (WUL) for the 3 NBC mines.

**PROJECT** : Hydrological Impact Assessment (EIA) for SM Diamond Mine in Lesotho (2016)





CLIENT: Environmental Impact Management Services (EIMS) (Pty) Ltd.

I was responsible for the surface water component including an extensive climate evaluation for the study. Climate data was evaluated to determine design precipitation depths which influence peak flows of specific return periods on the project site. The surface water study involved hydraulic modelling in HEC-RAS to determine the 1:50-year and 1:100-year flood lines, mine-wide water balance modelling, and water quality analysis in AquaChem and risk assessment.

**PROJECT** : Hydrological Impact Assessment for the Rietkuil Mine, in Mpumalanga, South Africa (2015/2016)

CLIENT: Total Coal South Africa (TCSA).

I was responsible, as a project team member, to undertake the hydrological assessment, flood lines modelling in HEC-RAS, water balance modelling and risk assessment for the study. The hydrological assessment was a key component in the study to provide input for flood lines modelling, stormwater modelling to compile the storm water management plan (SWMP) and for water balance modelling.

The risk assessment integrated findings of all the key components of the project including flood lines, SWMP, water quality analysis and water balance modelling to determine overall impacts on water resources and mitigation measures.

**PROJECT** : Integrated Water Resources Management for the Transnet Engineering Germiston Depot (2014/2015)

CLIENT : Transnet Engineering GCS Water and Environment (Pty) Ltd. (GCS) was requested by Transnet Engineering to develop an Integrated Water Resources Management Plan (IWRMP) and provide solutions to potential water use and water quality issues at their Germiston Rail site in the Gauteng Province of South Africa. This study involved assessment of surface water impacts resulting from operations at the Transnet Engineering Germiston Depot in terms of water quantity and quality. The main aim was to regularise water use and waste water disposal activities at the site to comply with the South African National Water Act, 36 of 1998, including Department of Water and Sanitation (DWS) Water Quality Guidelines Volumes 1 to 8, SANS 2015 Standards as well as with the Ekurhuleni Municipality legislation and guidelines.

I was responsible for undertaking the hydrological analysis, stormwater modelling (PCSWMM) and management planning, water quality analysis (AquaChem), water balance computations and risk assessment. Water quality issues were identified as viewed against the aforementioned guidelines and standards and mitigation measures were recommended in order to ensure compliance with National and Municipal Standards and guidelines. A static



water balance calculation was also compiled to determine optimum water supply and use requirements for the Transnet Depot.

**PROJECT** : Baseline Hydrological Assessment for the Proposed Waterberg JV Project (2014/2015)

CLIENT : Platinum Group Metals (PTM) GCS Water and Environment (Pty) Ltd. (GCS) was appointed by Platinum Group Metals (PTM) (Pty) Ltd. to undertake a baseline hydrological assessment study for the Waterberg JV Project on Ketting 368 and Goedetrouw 366 Farms. Main components of the study included hydro-meteorological analysis and flood lines assessment for Sepabana and Mokudung Rivers proximal to the proposed project site. The study site is located within the Limpopo Water Management Area (WMA1) and in quaternary catchment A62H.

I was the lead surface water specialist and project manager responsible for undertaking extensive climate evaluation, detailed runoff calculations to determine 1:50-year and 1:100-year flood peaks for the project site using various recommended and widely used methodologies in South Africa. The peak flows methods used included the Rational Method (Alternative 3), Standard Design Flood (SDF) method and Midgely and Pitman (MIPI) method. Representative peak flows were then used as input in HEC-RAS for hydraulic modelling to determine flood lines for the site.

- **Professional Registration and Affiliations**

- Pr.Sci.Nat (SACNASP) Reg. No. 400034/17;
- Water Institute of Southern Africa, WISA (29979); and
- Golden Key Society of South Africa.

- **Publications**

- Desktop provisional eco-classification of the temperate estuaries of South Africa, L VanNiekerk, S Taljaard, JB Adams, D Fundisi, P Huizinga, SJ Lamberth, S Mallory, GC Snow, JK Turpie, AK Whitfield & TH Wooldridge. WRC Report No. 2187/1/15, April 2015.
- Application of hydro-pedological insights in hydrological modelling of the Stevenson-Hamilton Research Supersite, Kruger National Park, South Africa (2015) van Tol, J.J., Van Zijl, G.M., Riddell, E.S. and Fundisi, D. Water SA Journal, Volume 41 No. 4, 525 – 533.
- Ephemeral Hydrological Processes in Savannas (2014) Riddell, E.S., Nel, J., Fundisi, D., Jumbi, F., Van Niekerk, A. and Lorentz, S.A. WRC Report No. TT 619/14, December 2014. Pretoria.



- **Conference Presentations**

Estuaries Eco-Classification 2012: Stellenbosch University

SANCIAHS 2012: University of Pretoria

Savannah Science Network Conference 2013: Kruger National Park

WISA Conference: Durban ICC 2016

## Appendix B: Impact Assessment Methodology

Based on international guidelines and South African legislation, the following criteria are considered when examining potentially significant impacts:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long-term, permanent(irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

$$\text{Significance} = \text{Consequence} \times \text{Probability} \times \text{Nature}$$

Where

$$\text{Consequence} = \text{Intensity} + \text{Extent} + \text{Duration}$$

And

$$\text{Probability} = \text{Likelihood of an impact occurring}$$

And

$$\text{Nature} = \text{Positive (+1) or negative (-1) impact}$$

**Note:** In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.



The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in **Error! Reference source not found..** The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in **Error! Reference source not found..**, which is extracted from **Error! Reference source not found..** The description of the significance ratings is discussed in **Error! Reference source not found..**

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.



**Table 15-1: Impact Assessment Parameter Ratings**

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	<u>International</u> The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	Great improvement to the overall conditions of a large percentage of the baseline.	<u>National</u> Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.





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RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
5	Very serious widespread natural and / or social baseline changes. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	<u>Province/ Region</u> Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social significance.	Average to intense natural and / or social benefits to some elements of the baseline.	<u>Municipal Area</u> Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	<u>Local</u> Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.



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RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
2	Minor natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	Low positive impacts experience by a small percentage of the baseline.	<u>Limited</u> Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	<u>Very limited</u> Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.



### Table 4-15-2: Probability/Consequence Matrix

Probability	Significance																																								
	7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147		
	6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126		
	5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105		
	4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84		
	3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63		
	2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42		
	1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
		-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21		
		Consequence																																							



**Table 15-3: Significance Rating Description**

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Substantial (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Major (positive)
36 to 72	An positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Major (negative)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Substantial (negative)