Hydrological Scoping Report for the Wonderstone Driekuil Mine Expansion

Project Number:

ENG042

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DECLARATION OF INDEPENDENCE

I, Andy Pirie declare that:

- I act as an independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have the expertise in conducting the specialist study relevant to this application, including knowledge of the various acts, regulations and any guidelines that have relevance to the proposed project;
- I will comply with the acts, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the study;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; and
- All particulars furnished by me in this report are true and correct.

....

Andy Pirie
Hydrologist
Pr.Sci.Nat. (reg no. 114988)

ACRONYMS AND ABBREVIATIONS

BPG	Best Practice Guideline
CMA	Catchment Management Agency
DWS	Department of Water and Sanitation
DTM	Digital Terrain Model
EC	Electrical Conductivity
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
GIS	Geographical Information Systems
GN704	Government Notice No. 704 - Regulations on the Use of Water for Mining and Related Activities aimed at the Protection of Water Resources
LoM	Life of Mine
mamsl	metres above mean sea level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
mbgl	Metres below ground level
MR	Mining Right
MRA	Mining Right Area
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
PCD	Pollution Control Dam
Pr.Sci.Nat.	Professional Natural Scientist
ROM	Run of Mine
RQO	Resource Quality Objective
RWD	Return Water Dam
SANS	South African National Standards
SACNASP	South African Council for Natural Scientific Professions
SAWS	South African Weather Service
S-Pan	Symons Pan
SWMP	Stormwater Management Plan
Tc	Time of concentration
WMA	Water Management Areas
WR2012	Water Resources of South Africa, 2012 Study
WRD	Waste Rock Dump
WUL	Water Use Licence
WULA	Water Use Licence Application

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1 INTRODUCTION AND BACKGROUND

Hydrospatial (Pty) Ltd has been appointed by EnviroGistics (Pty) Ltd (hereafter “EnviroGistics”) to undertake a surface water hydrological study for the proposed Wonderstone Driekuil Mine Expansion (hereafter referred to as the “project”). This report has been prepared to inform the scoping phase of the Environmental Impact Assessment (EIA) process that is being undertaken by EnviroGistics.

1.1 Project Location

The proposed project is located approximately 8.5 kilometres (km) north of the town of Ottosdal in the North West province (Figure 1-1). The proposed project is located in quaternary catchment C31C in the Vaal Water management Area (WMA). The Driekuilspruit, which is a non-perennial (seasonal) stream, flows in a north-westerly direction adjacent to the proposed project.

1.2 Project Description

1.2.1 Current Status

Up until recently, Wonderstone Limited (hereafter referred to as “Wonderstone” or the “mine”) has been operating under the legal entitlement, Mining License: ML1-97, converted to Mining Right: NW 30/1/2/2/398 MR (Registered Right dated 23 December 2014). The issued mining right authorises the extraction of Pyrophyllite for a period of 30 years over Portion 44 of the farm Gestoptefontein 349 IO, measuring an area of 135.916 hectares (ha):

Mining takes place by means of open cast mining, comprising of hydraulic hammering and excavator loading with no drilling and blasting required.

In addition, Wonderstone also holds an approved New Order Mining Right (NOMR) NW30/5/1/2/2/397MR (signed 20 March 2019) over various portions of the farms Gestoptefontein IO and Driekuil 280 IP:

- Portion 5, 7, 9, 10, 11, 24 (portion of portion 5), remainder of portion 15 (a portion of portion 1), portion 20 and portion 40 (a portion of portion 41 now known as portion 44) of the farm Gestoptefontein 349 IO; and
- Portions 2, 4, remainder of portion 1, portion 7 (a portion of portion A) and the remainder of farm Driekuil 280 IP.

The mining rights combined cover an area of approximately 140 ha of which just under 30 ha has been disturbed by mining activities to date. A large portion of the northern section of the Wonderstone mining area on Gestoptefontein has been rehabilitated.

Wonderstone would like to combine its existing mining rights into one, consolidated right, in an attempt to ease the administrative duties and compliance requirements associated with multiple mining authorisations per site.

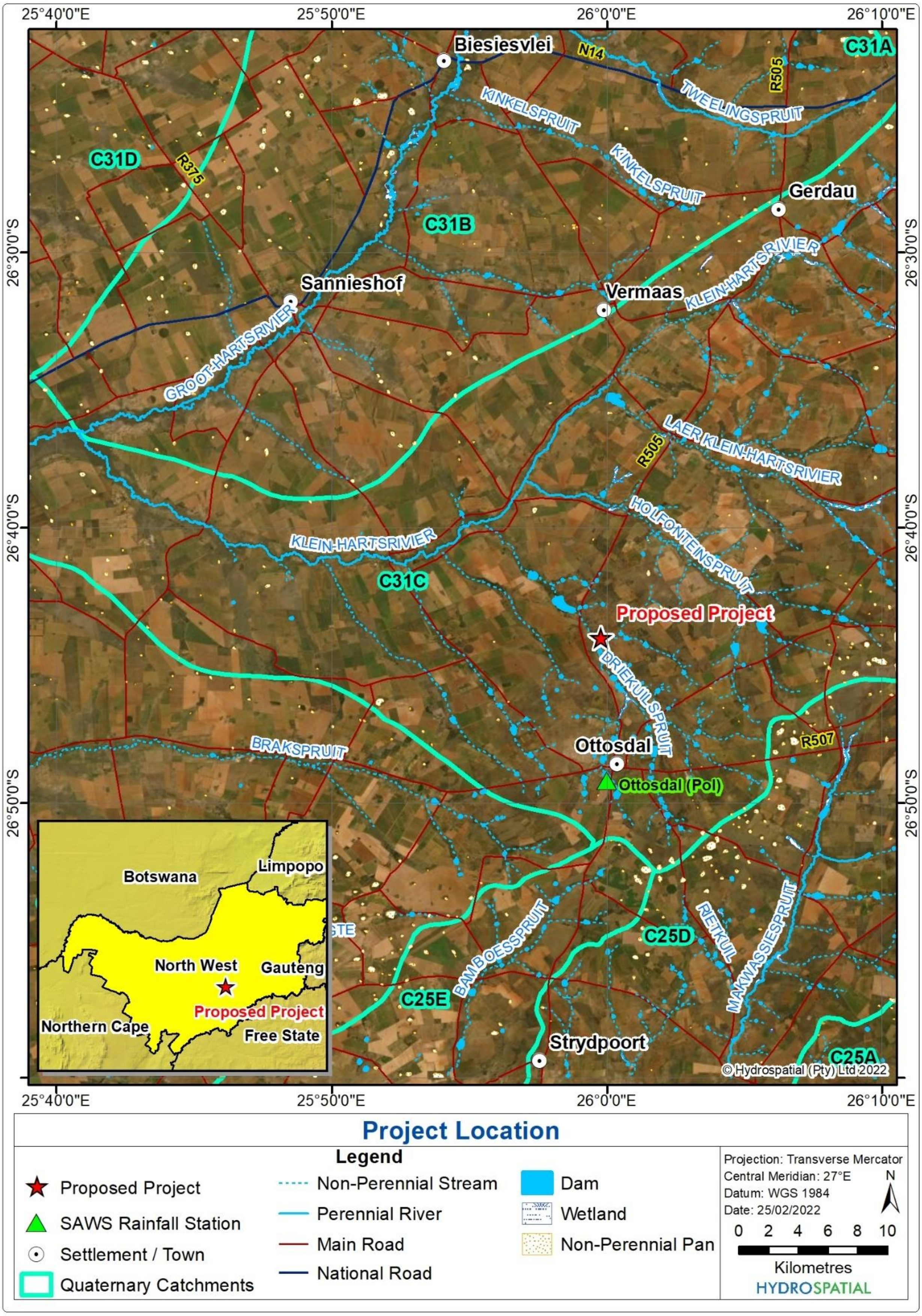

Figure 1-1: Location of the project

At the same time, the operation would like to abandon some of the areas currently included and authorised as part of the approved NOMR area. After an extensive study, Wonderstone forecasts only using a select portion of the already approved NOMR area in its future mining endeavours. Abandonment of the remainder of the approved NOMR areas will ensure future mining in these areas and prevent the sterilisation of said areas for future mining.

During a pre-application meeting with the Department of Mineral Resources and Energy (DMRE) on 15 November 2021, the Department indicated that Wonderstone will be expected to submit a Section 102 Amendment Application. The application will include the areas of one approved mining right into the existing area of the other approved right.

Wonderstone decided to apply for the extension of the Converted Mining Right (CMR) (397MR) area by adding Portions of the approved NOMR (397) areas to the CMR area. At the same time, the additional proposed areas of the NOMR, portions of the approved portions will be abandoned to allow for future mining.

1.2.2 Proposed Project Activities

The mine will continue mining from the existing Wonderstone Opencast Pit, but propose to include five (5) additional mining blocks or areas as indicated on Figure 1-2. The mineral to be mined is Pyrophyllite, an aluminium silicate of the phyllosilicate family, with the chemical formula $Al_2Si_4O_{10}(OH)_2$.

The pyrophyllite is opencast mined with a Hydraulic hammer mounted on an Excavator that loosens the stone. The loose stone is then loaded onto dump trucks that transport usable stone to the plant for further processing and un-usable stone to the low-grade stockpile. In areas where there is topsoil present, the topsoil, if any, will first be stripped to open the pyrophyllite, this topsoil will on completion of mining process be used during the rehabilitation process. Historically, there is little to no topsoil on the Wonderstone deposits. The Pyrophyllite will be mined using an excavator equipped with a hydraulic hammer that will break the stone loose, an excavator with a shovel will load the usable stone on dump trucks that will transport the stone to the processing plant. Unusable stone will be transported to the low-grade stockpile (currently the Waste Rock Dump) for possible use in future. Mining will be done using the bench method, with benches not higher than 5 meters (m).

Existing haul roads will be used but will have to be extended to the new mining area.

No electricity is required in the proposed new areas.

Dust control on haul roads will be done with the mine's own water bowser and water will be extracted from Driekuilspruit dam, that is included in the mine's existing Water Use License. There are, however, existing boreholes that can be developed should the need arise.

Current mining operations are planned up until 2027, however, the proposed new project will allow for mining up until 2045 (additional 18 years).

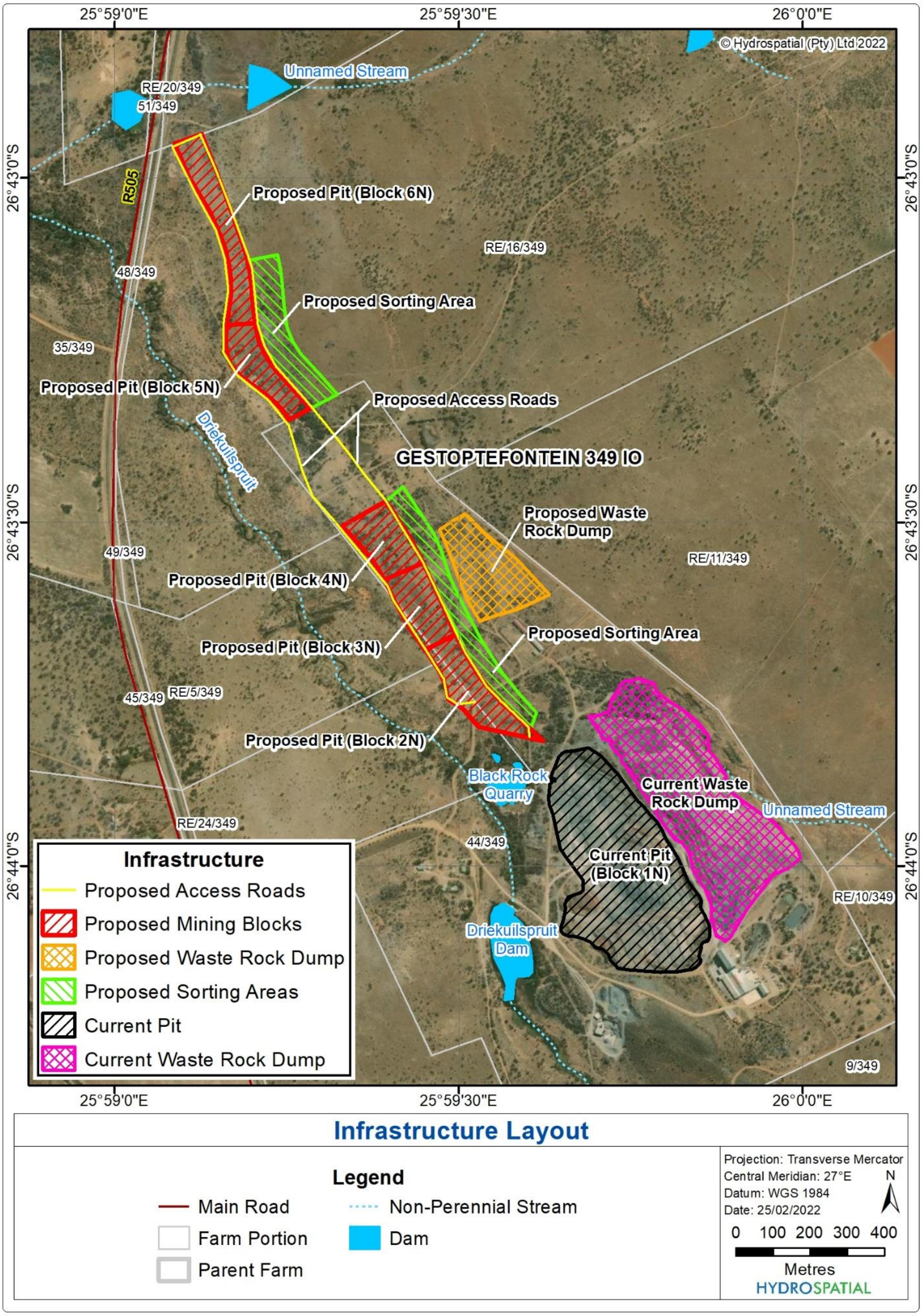

Figure 1-2: Infrastructure layout

The proposed project will involve:

- Mining:
  - Mining of the existing area (Block 1N – about 15 ha in extent); and
  - Five mining blocks (2.5 ha, 2.1 ha, 2.1 ha, 2 ha, 2.9 ha in extent), which will be mined at different time intervals via opencast mining methods).
- Proposed new Waste Rock Dump (WRD) and associated Pollution Control Dam (PCD).
- Sorting areas.
- Two gravel access roads of approximately 6 m in width (eastern and western roads).

1.3 Legislative Requirements and Guidelines

The following key legislative requirements and guidelines are relevant to this study:

- National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Regulations on the Use of Water for Mining and Related Activities aimed at the Protection of Water Resources (published under Government Notice 704 (GN704) in Government Gazette 20119, 4 June 1999);
- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and associated Environmental Impact Assessment (EIA) 2014 Regulations;
- Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA);
- Classes and Resource Quality Objectives (RQOs) of Water Resources for Catchments of the Lower Vaal (Government Notice No. 470, 22 April 2016); and
- Department of Water and Sanitations (DWS) Best Practice Guideline documents.

1.4 Site Investigation

A site investigation was undertaken on 2 and 3 February 2022. The purpose of the site investigation was to take surface water samples and to assess the hydrological characteristics of the proposed project area.

1.5 Details of the Specialist

The study was undertaken by Andy Pirie who is a senior hydrologist at Hydrospatial (Pty) Ltd. Andy graduated with a Master of Science (M.Sc.) in Water Resource Management (cum laude). He is registered as a Professional Natural Scientist (Pr.Sci.Nat) (registration number: 114988) in Water Resources Science with the South African Council for Natural Scientific Professions (SACNASP). Work experience includes rainfall – runoff modelling, floodline determinations, stormwater management plans, water and salt balance modelling, setup of water monitoring networks and programmes, analysis of surface water quality and quantity, and surface water specialist studies for environmental and social impact assessments. He has worked on projects in South Africa, Cameroon, Senegal, Mali, Democratic Republic of the Congo, Botswana, Zambia and Namibia. Andys curriculum vitae is provided in Appendix A.

2 SCOPE OF WORK

The scope of work included the following:

- Provide the baseline hydrological description of the current proposed project area; and
- Provide the initial anticipated surface water impacts and proposed mitigation measures.

3 BASELINE HYDROLOGY

3.1 Climate

3.1.1 Rainfall

3.1.1.1 Monthly Rainfall

Monthly rainfall data for the project area was obtained from the South African Weather Service (SAWS) station Ottosdal (Pol) (location indicated on Figure 1-1), as well as rainfall measured at the mine. A summary of the details of the rainfall stations are provided in Table 3-1.

Table 3-1: Summary of the details of the monthly rainfall used for the study

Station Name	Station Number	Distance & Direction from Mine	Rainfall Record	MAP (mm)
Ottosdal (Pol)	0434888 W	9.4 km south	Oct 1911 – Sep 2010	564
Rainfall Gauge at Wonderstone	-	Located at the mine	Jan 2002 – Jun 2020	524

The mean monthly rainfall for both stations is indicated in Figure 3-1. The Ottosdal (Pol) station has a Mean Annual Precipitation (MAP) of 564 mm, whilst the Wonderstone gauge has an MAP of 524 mm. Rainfall for the area is highest over the summer months of October to April, with December to February being the wettest months. Rainfall is lowest over the months of May to September, with June to August being the driest months.

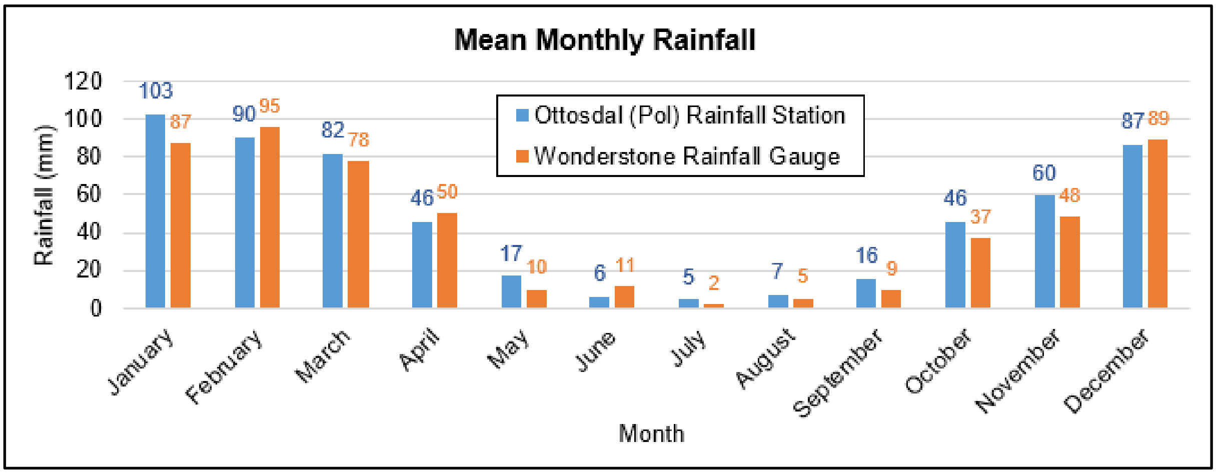

Figure 3-1: Mean monthly rainfall

3.1.1.2 Annual Rainfall

The annual rainfall totals for the area over the past 40 years is indicated in Figure 3-2. Rainfall has generally been below average at the mine between 2011 – 2020, with 2015, 2016 and 2018 being particularly dry years. Above average rainfall occurred during 2014, 2017 and 2019, with 2019 being a particularly wet year, receiving 731 mm of rainfall.

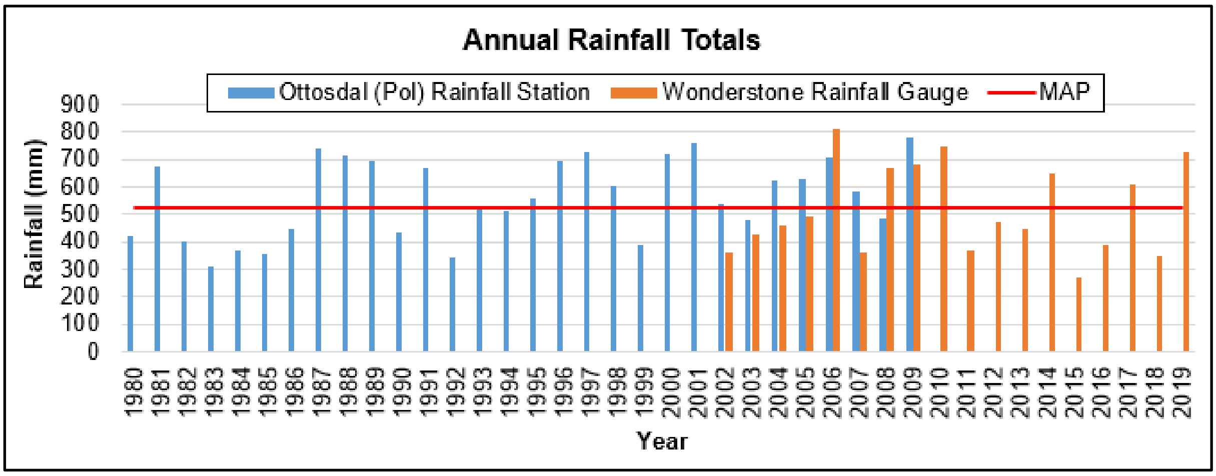

Figure 3-2: Annual rainfall totals

3.1.1.3 Storm Rainfall Depths

The storm rainfall depths for the project area were extracted using the Design Rainfall Estimation in South Africa software programme (Smithers and Schulze, 2002). The programme uses the six closest rainfall stations to a user specified position to calculate the storm rainfall depths. The extracted storm rainfall depths for the mine are indicated in Table 3-2.

Table 3-2: Storm rainfall depths for the project area

Storm Duration	Storm Rainfall Depth (mm)						
	1:2 yr	1:5 yr	1:10 yr	1:20 yr	1:50 yr	1:100 yr	1:200 yr
5 min	9	13	15	18	21	23	25
10 min	14	19	23	26	31	34	38
15 min	18	24	29	33	39	43	48
30 min	22	31	36	42	49	54	60
45 min	26	35	41	48	56	63	69
1 hr	28	39	46	53	62	69	76
1.5 hr	33	44	52	60	71	79	88
2 hr	36	49	58	67	78	87	96
4 hr	42	57	68	78	92	102	113
6 hr	46	63	74	86	100	112	124
8 hr	49	67	79	91	107	120	132
10 hr	52	71	83	96	113	126	139
12 hr	54	74	87	100	118	131	145
16 hr	58	79	93	107	126	140	155
20 hr	61	83	98	112	132	147	163
24 hr	63	86	102	117	138	154	170
1 day	53	72	85	98	115	128	141
2 day	65	88	104	120	141	157	174
3 day	73	99	118	135	159	178	196
4 day	79	108	128	147	173	193	213
5 day	85	115	136	157	184	205	227
6 day	89	121	143	165	194	216	239
7 day	93	127	150	173	203	226	250

3.1.2 Evaporation

Monthly Symon's Pan (S-Pan) evaporation was obtained from the WR2012 study for quaternary catchment C31C. S-Pan evaporation measurements tend to be higher than evaporation from natural open water bodies. In order to convert S-Pan measurements to open water evaporation, monthly conversion factors were used, which were obtained from the WR2012 study. The monthly evaporation for the proposed project is indicated in Table 3-3. The open water Mean Annual Evaporation (MAE) is 1 594 mm, which is almost three times more than the MAP of the area. Evaporation is highest over the warmer months of October to March, and lowest over the cooler months of May to July.

Table 3-3: Mean monthly evaporation

Month	S-Pan Evaporation (mm)	Evaporation Factor	Open Water Evaporation (mm)
January	224	0.84	188
February	170	0.88	149
March	156	0.88	137
April	116	0.88	102
May	93	0.87	81
June	74	0.85	63
July	86	0.83	71
August	124	0.81	101
September	172	0.81	139
October	218	0.81	177
November	230	0.82	188
December	238	0.83	198
Total	**1 900**	**N/A**	**1 594**

3.2 Hydrological Setting

3.2.1 DWS Catchments and Drainage

The DWS have divided South Africa into primary, secondary, tertiary and quaternary catchments. Primary catchments are the largest defined catchments for South Africa, of which there are 22, and are assigned a letter ranging from A – X (excluding O). Secondary catchments are subdivisions of the primary catchments, and are the second largest catchments in South Africa, and are assigned the primary catchment letter within which they are located, and a number e.g. A5 (secondary catchment 5 located within primary catchment A). Similarly, tertiary catchments are subdivisions of secondary catchments, and are represented for example by A53 (tertiary catchment 3 located within secondary catchment A5). Lastly, quaternary catchments are the smallest defined catchments and are assigned the tertiary catchment number, along with a quaternary catchment letter e.g. A53D (quaternary catchment D located within tertiary catchment A53).

Further to the above, the DWS have divided South Africa into 9 Water Management Areas (WMAs). The 9 WMAs include the Limpopo, Olifants, Inkomati-Usuthu, Pongola-Mtamvuna, Vaal, Orange, Mzimvubu-Tsitsikamma, Breede-Gouritz and Berg-Olifants.

The proposed project is located in the upper Harts River catchment, within quaternary catchment C31C, in the Vaal WMA. The Driekuilspruit, which is a non-perennial (seasonal) stream, flows on the western side of the proposed project area and into the Klein-Harts River. The Driekuilspruit has it source approximately 7 km south-east of Ottosdal, where a number of natural pans occur along the quaternary catchment divide (Figure 1-1). The Klein-Harts River is a tributary of the Harts River, a NFEPA River according to the NFEPA (2011), which flows into the Vaal River near the town of Delportshoop. Further to the above, two unnamed non-perennial tributaries of the Driekuilspruit occur within the vicinity of the project. The first, located approximately 120 m to the north of mining Block 6N, flowing in a westerly direction. The second, flowing in a north-westerly direction towards the existing WRD, which has been historically constructed in its flow path, preventing it from directly flowing into the Driekuilspruit. Water currently ponds on the eastern side of the WRD, seeping through the WRD, to form an artificial wetland system on the western side, directly north of the Black Quarry Dam. A number of farm dams have been constructed on the Driekulspruit, including the mines Driekulspruit Dam, which is used to supply the mining operation with water.

3.2.2 Classes and Resource Quality Objectives

The NWA specifies that water resources are to be protected and managed through the classification of water resources and Resource Quality Objectives (RQOs) and the setting of the reserve. The Classes and RQOs of Water Resources for Catchments of the Lower Vaal (Government Notice No. 470, 22 April 2016) (DWS, 2016), was consulted to obtain the RQOs for quaternary catchment C31C. The present ecological status and recommended ecological category, as well as other details pertaining to quaternary catchment C31C, are indicated in Table 3-4.

Table 3-4: Present ecological status and recommended ecological category

Quaternary Catchment	River	Bio-physical Node	Gross Catchment Area (km^2)	Natural MAR (million m^3/a)	Present Ecological Status	Recommended Ecological Category
C31C	Klein-Harts River	LA1.2	1 554	12.18	C	C

The present and recommended ecological status is a class C, representing a moderately modified system, indicating that a loss and change of natural habitat and biota has occurred, but that the basic ecosystem functions are still predominantly unchanged. The natural Mean Annual Runoff (MAR), which is the runoff under natural catchment conditions (i.e. when all man-made land uses, abstractions and return flows are removed) is 12.18 million m^3/annum.

3.2.3 Topography

The elevation of the project area varies from 1 490 metres above mean sea level (mamsl) at the top of the existing WRD, to 1 430 mamsl where the Driekuilspruit flows under the R505 road. Steep slopes in excess of 50 % occur along sides of the current opencast area and existing WRD. The topography of the proposed infrastructure area dips in a south-westerly direction towards the Driekuilspruit. Moderate slopes occur along Blocks 5N and 6N as well as the adjacent sorting area. The other proposed infrastructure areas consist mostly of flat slopes. The general topography of the greater region is characterised by undulating plains. Figure 3-3 indicates the elevation and slope of the project area.

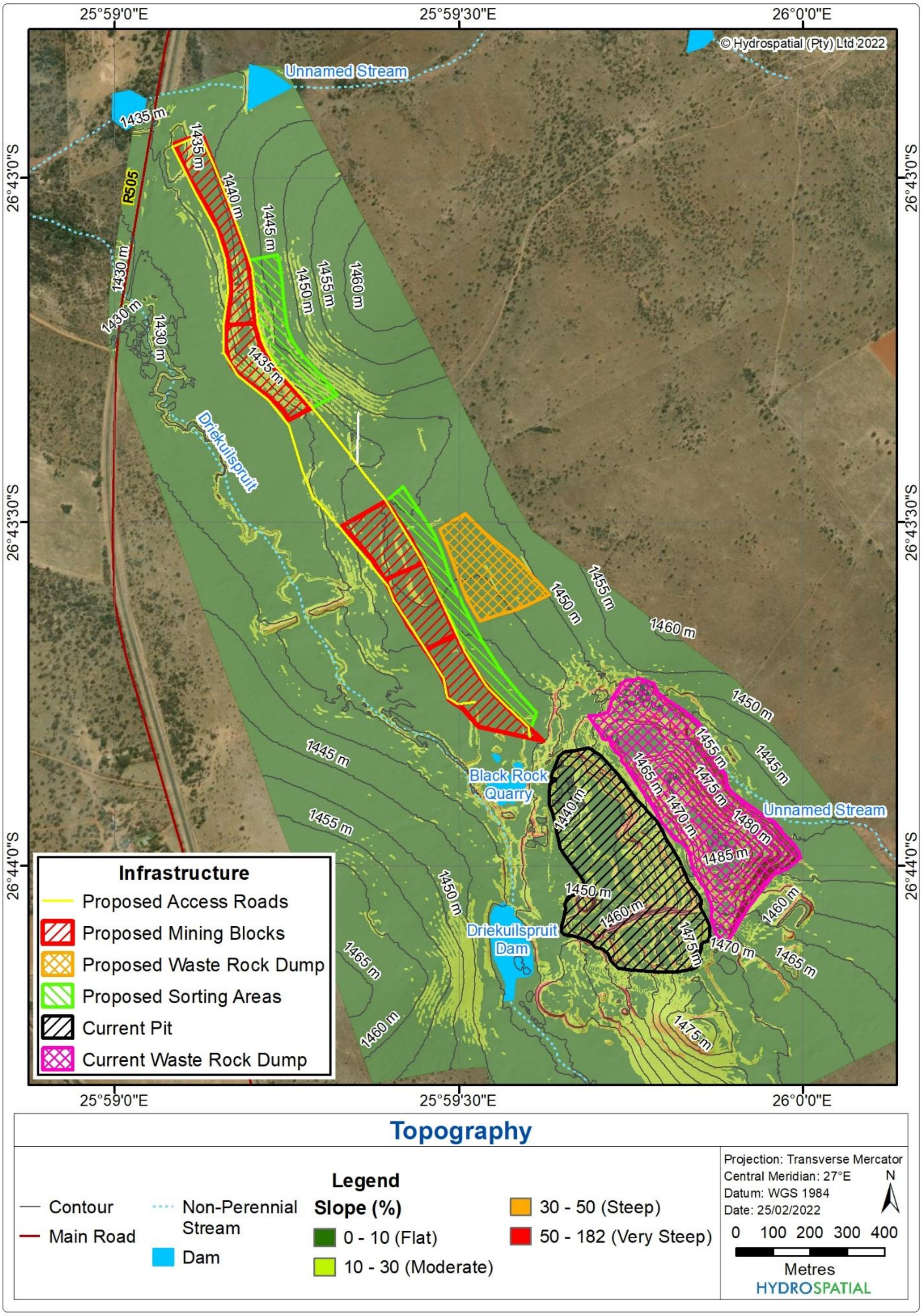

Figure 3-3: Topography of the project area

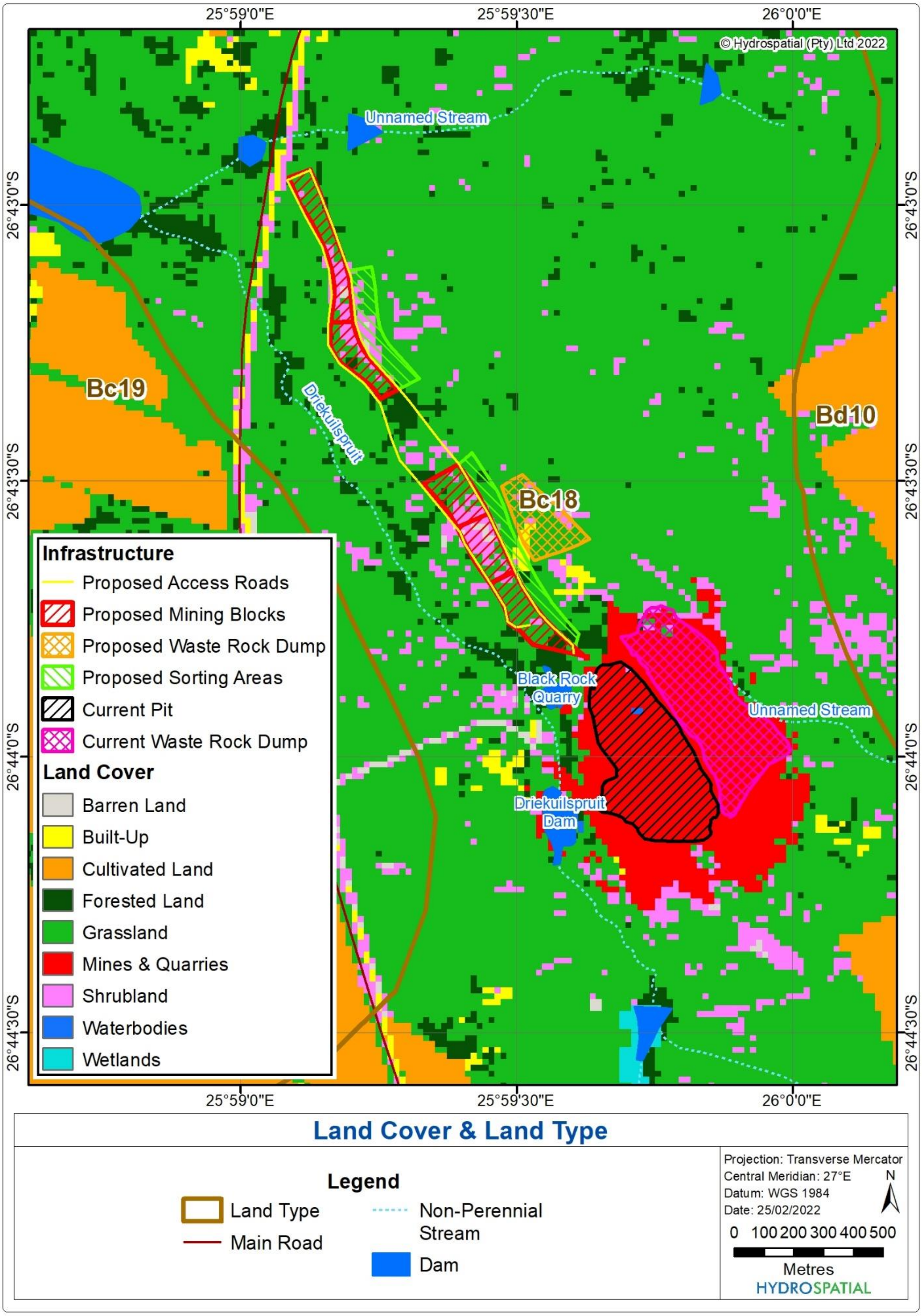

Figure 3-4: Land cover and Land Type

3.2.4 Land Cover and Use

The majority of the project area is located within the Klerksdorp Thornveld vegetation type, whilst the northern-most section of mining block 6N falls within the Western Highveld Sandy Grassland (Mucina and Rutherford, 2006). Klerksdorp Thornveld vegetation is characterised by open to dense *Acacia karoo* bush clumps in dry grassland, whilst the Western Highveld Sandy Grassland, is characterised by short dry grassland, with some woody species occurring in bush clumps (Mucina and Rutherford, 2006). The current disturbed area at the mine consists mostly of bare areas associated with the existing opencast and WRD areas. The proposed infrastructure areas are dominated by grassland with patches of shrubland and forested areas. Cultivated land consisting mostly of maize and sunflower is the dominant land use in the surrounding area. Figure 3-4 indicates the 2018 land cover (Thompson, 2019) of the project and surrounding area.

3.2.5 Soils

The existing and proposed infrastructure areas fall within Land Type Bc18 (Figure 3-4). Land Type data exists in the form of published 1:250 000 maps indicating delineated areas of similar terrain types, pedo-systems (uniform terrain and soil pattern) and climate (Land Type Survey Staff, 1972 - 2006). According to the Land Type database, Bc18 is dominated by Hutton, Mispah, Clovelly and Glenrosa soils, as well as rocky areas.

The scoping hydropedological study prepared by Zimpande Research Collaborative (ZRC, 2022), indicated that the proposed mining blocks, sorting areas and proposed WRD, are dominated by Mispah soils that are expected to be responsive shallow soils. The combination of relatively impermeable bedrock and shallow soil depth implies that these soils have a low storage capacity. They will saturate quickly following a rain event and contribute mostly to overland flow (ZRC, 2022). The lower lying areas around the Driekuilspruit is dominated by Katspruit soils, that are expected to be responsive saturated soils. These soils are characterised by prominent signs of prolonged wetness (Gleying), occurring within the permanent zone of the valley bottom wetlands. The soil morphological characteristics of the soils signify long periods of saturation (ZRC, 2022).

According to ZRC (2022), the hydropedological processes are deemed to have a limited contribution (if any) to the wetlands identified within the study area, due to the occurrence of shallow soils (less than 20 cm at most) which contribute to surface overflow during the rainy season. The anticipated dominant recharge mechanism of these wetlands is anticipated to be the shallow aquifer which manifests as springs.

3.2.6 Geology

According to WST (2008) and Letsolo (2019), the pyrophyllite (wonderstone) mined at the operations is hosted in a pale green acidic lava of the Syferfontein Formation of the Dominion Reef. The pyrophyllite is metamorphosed volcanic ash interbedded with the lava. The ore is grey to black in colour and was deposited as massive fine-grained body. On surface where weathering has taken place, the pyrophyllite is light grey in colour, but the colour gets darker deeper in the deposit. The ore body strikes in a north-south direction and dips at approximately 35° to the west. The thickness of the main lens of pyrophyllite is 190 m and includes small inclusions of lava up to 20 m thick. Geological action has tilted the deposit so that the laminations in the body dip at about 80°.

3.2.7 Waste Classification

A waste classification was undertaken by Umhlaba Environmental Consulting in 2015 (Umhlaba Environmental Consulting, 2015). The waste classification indicated that the waste rock is non-hazardous.

A further waste classification was undertaken by Letsolo Water and Environmental Services in February 2018 (Letsolo, 2018). Samples were collected from the WRD, Silt Trap, Pit and Powder Plant. The outcome was that all samples are classified as Type 3 waste, on the basis of the total concentration of at least one constituent exceeding TCT0 level (i.e. As (11.7-48.1 mg/kg), Ba (141-167 mg/kg), Cu (19.6-38.5 mg/kg) and V (290-363 mg/kg)), and none of the leachable constituents within all the waste samples exceeded LCT0. As per R 636 regulations, Type 3 waste should be disposed within a facility with a Class C barrier. According to SANS 10234, laboratory results indicated that all samples were non-hazardous in their current form. The results of the Whole Effluent Toxicity Test indicated that the samples analysed are not acutely toxic towards sensitive aquatic algae and fish species. The sensitive aquatic invertebrate species (*daphnia pulex*) bioassay result indicated negligible acute toxicity towards aquatic invertebrate species.

According to Letsolo (2018): *"Generally pyrophyllite is a potentially acid consuming mineral. Due to the nature of the rocks underlying this mine, there should not be acid mine drainage, or any potential thereof. The Wonderstone itself should not generate any poor quality leachate. Unless any accidental spillage occurs, no poor quality leachate should be encountered in the long term from this mine."*

3.2.8 Groundwater

3.2.8.1 Groundwater levels

The known groundwater levels in the vicinity of the project vary from 17.2 metres below ground level (mbgl) to the south-east of the existing WRD, to 0.4 mbgl near the Driekuilspruit directly north of the Driekuilspruit Dam. The general groundwater flow direction is from south-east to north-west (Digby Wells Environmental, 2020).

3.2.8.2 Groundwater Quality

The groundwater quality has primarily been monitored at borehole WBH10 near the existing Pit, which was previously used to supply domestic water to the mine employees (potable water is now transported in to the mine from external sources), as well as at borehole WBH13, located directly south-east of the existing WRD, which is used to supply the plant with process water (Figure 3-9). The pH at WBH10, has consistently been below the Water Use Licence (WUL) limit of 6, whilst WBH13 has been within the limits (Digby Wells Environmental, 2020). Other parameters being monitored such as Electrical Conductivity (EC), calcium, magnesium, sodium, chloride, sulphate and nitrate have been within the WUL limits since 2016 (Digby Wells Environmental, 2020). Fluoride exceeded the WUL limit on two occasions in 2016 at WBH10, but has since been within the limit. WBH10 shows contamination from the Pit, however, the impact zone is restricted within the Pit area and does not extend to the natural environment (Digby Wells Environmental, 2020).

3.2.9 Surface Water Use

The mine abstracts water from the Driekuilspruit Dam for its operation. According to the mines WUL (Licence No. 09/C31C/ABCGI/2741), the authorised abstraction volume is 20 000 m^3/annum (m^3/a). Beyond the project area, the Driekuilspruit is most likely used for irrigation and livestock watering.

3.2.10 Zones of Regulation

A regulated zone is a legally stipulated area around the delineated freshwater ecosystems that:

- May be considered a ‘high sensitivity’ area, as deemed necessary by the specialist; and/or
- Would require authorisation by the relevant authorities for any activities (both construction and operation of any development) within the identified regulatory zone as applicable to a specific type of freshwater ecosystem (e.g. wetland or riparian).

The zones of regulation were determined by Scientific Aquatic Services (SAS) according to the following legislation:

- Regulations on the Use of Water for Mining and Related Activities aimed at the Protection of Water Resources (published under Government Notice 704 (GN704) in Government Gazette 20119, 4 June 1999);
- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA); and
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998).

The preliminary zones of regulation as determined in SAS (2022) are indicated on Figure 3-5. According to SAS (2022), the zones of regulation are provided for information purposes and may potentially change dependent on the outcome of a field verification assessment.

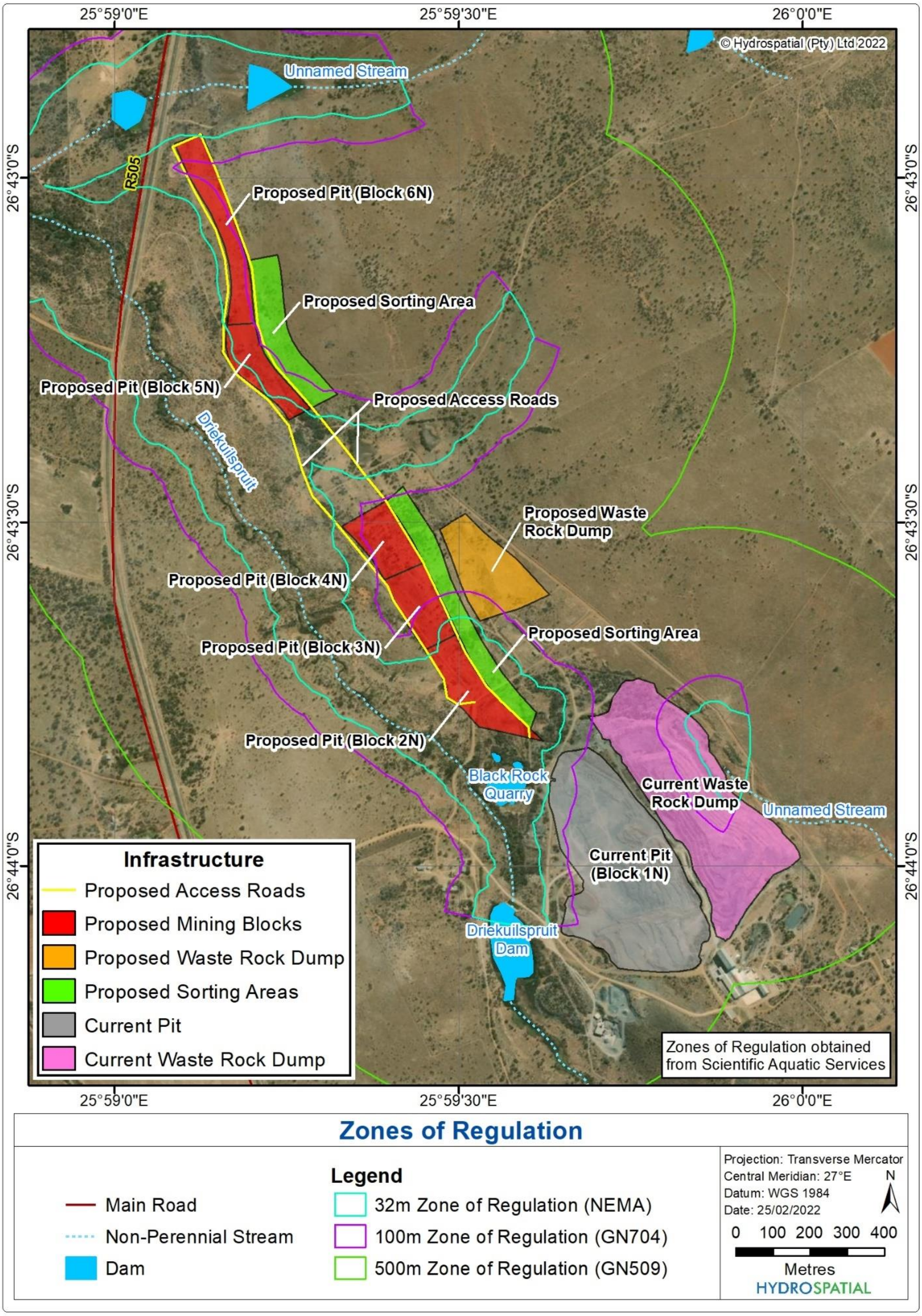

Figure 3-5: Zones of regulation

3.3 Runoff

3.3.1 Monthly Runoff

The mean monthly runoff volumes for the catchments of the Driekuilspruit Dam and the unnamed non-perennial stream to the east of the project, was estimated from the modelled runoff obtained from the WR2012 study for quaternary catchment C31C. The Driekuilspruit Dam has a catchment area of 128 km^2 (E-Tek Consulting, 2019), whilst the unnamed stream has a catchment area of 18 km^2 (Storm Water Solutions, 2016). Figure 3-8 indicates the catchments, whilst Table 3-5 provides the mean monthly runoff. Runoff is highest over the months of January to April, and lowest over the months of June to October. During dry years, the Driekuilspruit often ceases to flow over the low flow months.

Table 3-5: Mean monthly runoff for the Driekuilspruit Dam catchment and unnamed stream to the east of the project

Month	Driekuilspruit Dam Catchment Mean Runoff (m^3)	Unnamed Stream Mean Runoff (m^3)
January	218 825	30 772
February	289 756	40 747
March	194 457	27 346
April	129 823	18 256
May	55 161	7 757
June	17 630	2 479
July	10 649	1 497
August	9 140	1 285
September	7 958	1 119
October	13 084	1 840
November	31 474	4 426
December	60 202	8 466
Total	**1 038 160**	**145 991**

3.3.2 Peak Runoff

A floodline study for the Driekuilspruit was undertaken by E-Tek Consulting in June 2019 (E-Tek Consulting, 2019). The calculated peak runoff for various return periods for the Driekuilspruit Dam catchment is summarised in Table 3-6. In the recent past, a number of notable flood events have occurred. The first in 2010, when the Driekuilspruit Dam wall was washed away, resulting in the design and construction of the current wall (E-Tek Consulting, 2011). The second flood occurred in 2017, due to heavy rainfall and three upstream farm dams breaking (as per communication with Mr Schalk Burger), resulting in flooding of the river crossing below the Driekuilspruit Dam wall (Figure 3-6), as well as the overtopping of the bridge over the Driekuilspruit below the Black Rock Quarry. During 2019, heavy rains resulted in the backing up of water to the east of the WRD (Figure 3-7).

Table 3-6: Peak runoff for the Driekuilspruit Dam catchment (E-Tek Consulting, 2019)

Return Period	Peak Runoff (m^3/s)
1:20	107
1:50	153
1:100	205
1:200	226

Figure 3-6: Driekuilspruit river crossing below the Driekuilspruit Dam wall during the 2017 flood

Figure 3-7: Backing up of water to the east of the WRD during 2019

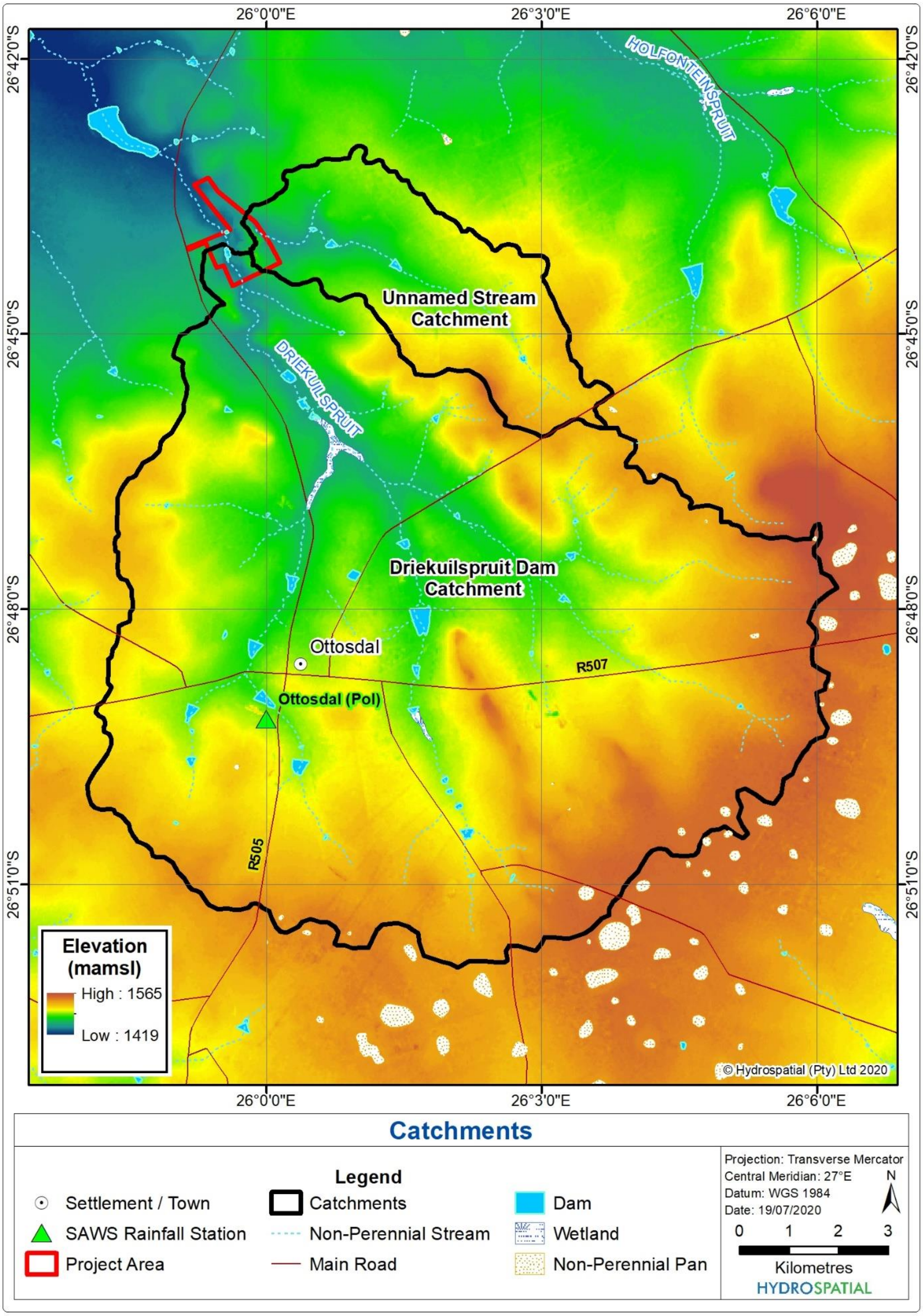

Figure 3-8: Catchments for the Driekuilspruit Dam and unnamed stream to the east of the project

3.4 Surface Water Quality

The water quality at Wonderstone is monitored as part of their monitoring programme in line with the conditions specified in the mines WUL. Four (4) surface water quality samples were taken on the site visit on 2 February 2022, to assess the water quality of the Driekuilspruit in the vicinity of the proposed infrastructure.

The sampling locations, frequency of monitoring, parameters, and a summary of the water quality is provided below.

3.4.1 Monitoring Locations

Details of the sampling locations are provided in Table 3-7. The sampling locations are indicated on Figure 3-9.

Table 3-7: Water sampling locations

Sampling Point	Surface/ Groundwater	Description	Latitude*	Longitude*
SW1	Surface Water	Site visit sample taken from the Driekuilspruit at the road below Driekuilspruit Dam	-26.733807	25.992648
SW2	Surface Water	Site visit sample taken from the Driekuilspruit at the bridge	-26.731010	25.991796
SW3	Surface Water	Site visit sample taken from the Driekuilspruit at the culvert below the R505 road	-26.719800	25.983721
SW4	Surface Water	Site visit sample taken from the inflow into the Driekuilspruit from the wetland below the WRD	-26.730845	25.991937
WSTSW4	Surface Water	Driekuilspruit River upstream of mine	-26.739436	25.995356
WSTSW5	Surface Water	Driekuilspruit Dam	-26.735144	25.992931
WSTSW6	Surface Water	Black Rock Quarry	-26.731544	25.992886
WSTSW7	Surface Water	Pit	-26.732972	25.995389
WSTSW8	Surface Water	Driekuilspruit River downstream of mine	-26.729686	25.989744
WSTSW10	Surface Water	WRD upstream (2nd Paddocks)/Tributary of Driekuilspruit River	-26.732172	25.999378
WSTSW12	Surface Water	Pollution Control Dam (PCD)	-26.733242	25.999967
WSTSW13	Surface Water	Return Water Dam (RWD)	-26.733639	25.999733
WSTSW14	Surface Water	Slurry pond	-26.734247	25.999894
WSTSW15	Surface Water	Silt Trap at plant	-26.735714	25.998661
WSTSW17A	Surface Water	Natural PCD	-26.733306	25.999972
WSTSW18A	Surface Water	2nd Black Rock Quarry	-26.730872	25.993139
WSTSW19A	Surface Water	Ponding behind WRD	-26.729678	25.993475
WSTBH1	Groundwater	Groundwater levels monitored only	-26.736090	25.993730
WSTBH2	Groundwater	Groundwater levels monitored only	-26.734128	25.993147
WSTBH3	Groundwater	Groundwater levels monitored only	-26.737840	25.993080
WSTBH6	Groundwater	Groundwater levels monitored only	-26.736040	25.992460
WSTBH7	Groundwater	Groundwater levels monitored only	-26.729290	25.992790
WSTBH8	Groundwater	Groundwater levels monitored only	-26.733240	25.993680

Sampling Point	Surface/ Groundwater	Description	Latitude*	Longitude*
WSBH9	Groundwater	Groundwater levels monitored only	-26.733250	25.993700
WBH10	Groundwater	Groundwater quality & levels monitored: supplies water to mine employees	-26.733110	25.994080
WSTBH12	Groundwater	Groundwater levels monitored only	-26.736680	26.002150
WBH13	Groundwater	Groundwater quality & levels monitored: abstraction point for process water	-26.733530	25.999590
WSTBH14	Groundwater	Groundwater levels monitored only	-26.736080	26.000150
WSTBH15	Groundwater	Groundwater levels monitored only	-26.725690	25.992310
WSTBH16	Groundwater	Groundwater levels monitored only	-26.724380	25.990080
WSTBH17	Groundwater	Groundwater levels monitored only	-26.733790	25.990610

*Decimal degrees, geographic coordinate system, WGS 1984 datum

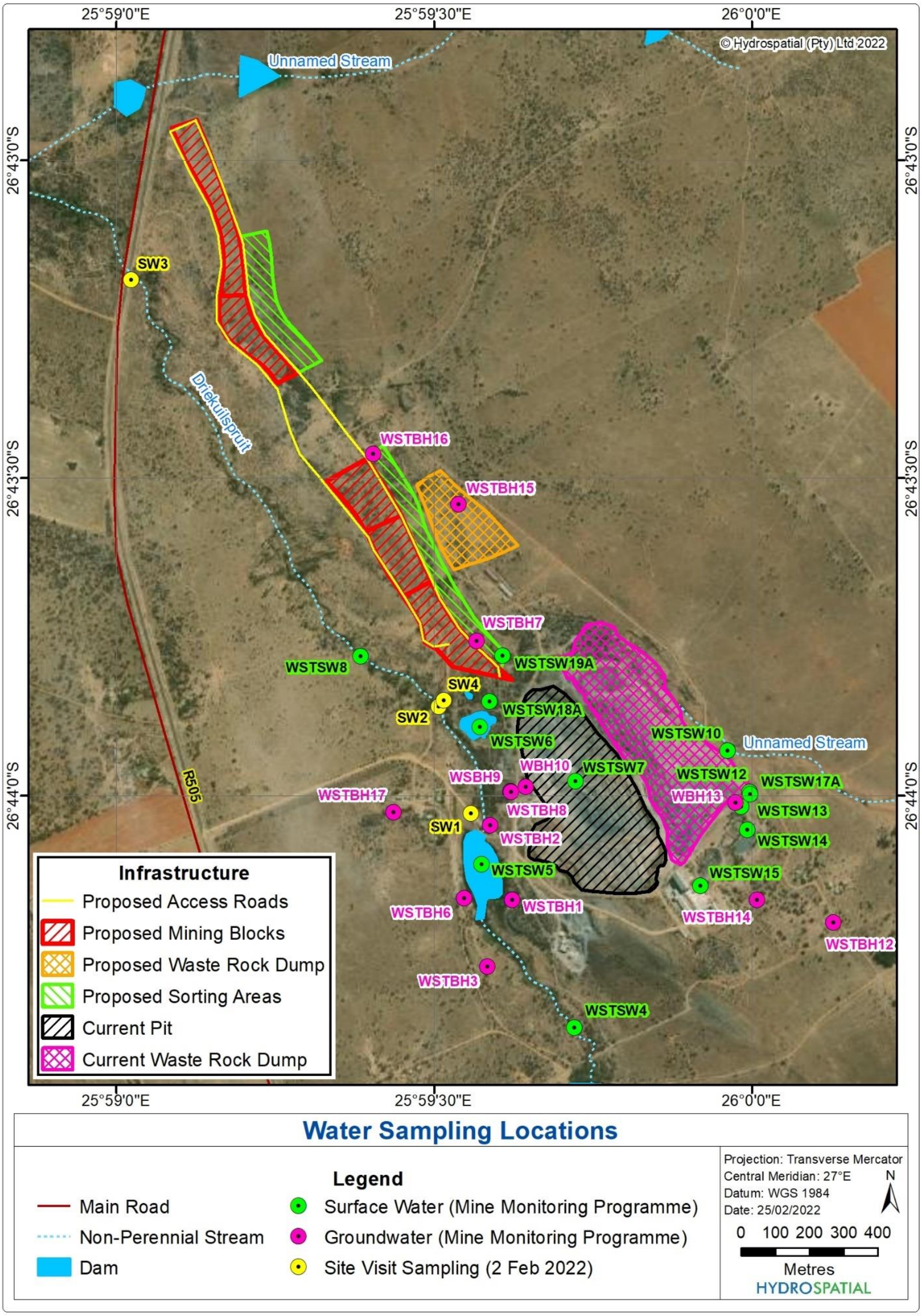

Figure 3-9: Water sampling locations

3.4.2 Monitoring Frequency

In order to create a sufficient baseline, water quality at the mine was monitored on a monthly basis from January 2016 to June 2019, and thereafter, on a quarterly basis in line with the mines amended WUL requirements.

Once off samples were taken on the site visit on 2 February 2022.

3.4.3 Water Quality Parameters

The parameters specified in the WUL that are currently being monitored at Wonderstone are indicated in Table 3-8. Turbidity and alkalinity are additional parameters to those specified in the WUL.

The site visit sampling parameters are indicated in

Table 3-8: Water quality parameters currently monitored at Wonderstone as part of the WUL conditions

Parameter	Units	Limits
pH	pH units	6 – 9.5
Electrical Conductivity (EC)	mS/m	150
Sulphate (SO_4)	mg/l	400
Chloride (Cl)	mg/l	200
Sodium (Na)	mg/l	200
Magnesium (Mg)	mg/l	100
Calcium (Ca)	mg/l	150
Fluoride (F)	mg/l	1
Nitrate (NO_3)	mg/l	10
Turbidity	NTU	–
Alkalinity	mg/l	–

3.4.4 Results and Discussion

3.4.4.1 Wonderstone Monitoring Programme

3.4.4.1.1 Water Quality Trends

The water quality results between January 2016 and January 2020 are discussed below:

- The trends in pH at the surface water monitoring points are indicated in Figure 3-10. The pH at all monitoring points was mostly within the required limits except at WSTSW7, which is the monitoring point in the Pit. WSTSW7 has consistently been below the required pH limit of 6 since 2016, indicating acidic conditions within the Pit water. An improving trend is noted with the pH at WSTSW7 increasing steadily from 3.2 in October 2016, to 4.4 in June 2019. Backfilling of the Pit with waste rock commenced in August 2018 (Digby Wells Environmental, 2020). The improvement in the pH could be as a result of the backfilling. Future monitoring will provide an indication of whether this is the case (should there be water available to sample in the pit, as the pit generally only has water after sufficient rainfall has occurred);

- The trends in Electrical Conductivity (EC) at the surface water monitoring points are shown on Figure 3-11. EC provides an indication of the salinity of water. EC at all monitoring points was within the specified limit of 150 mS/m. What is notable, is the increase in EC at the Driekuilspruit Dam (WSTSW5) over the 2018 period. The increase was attributed to decreasing dam levels as a result of evaporation and low rainfall in 2018 (Digby Wells Environmental, 2020). EC within the Driekuilspruit Dam significantly decreased in 2019, with increased rainfall occurring;

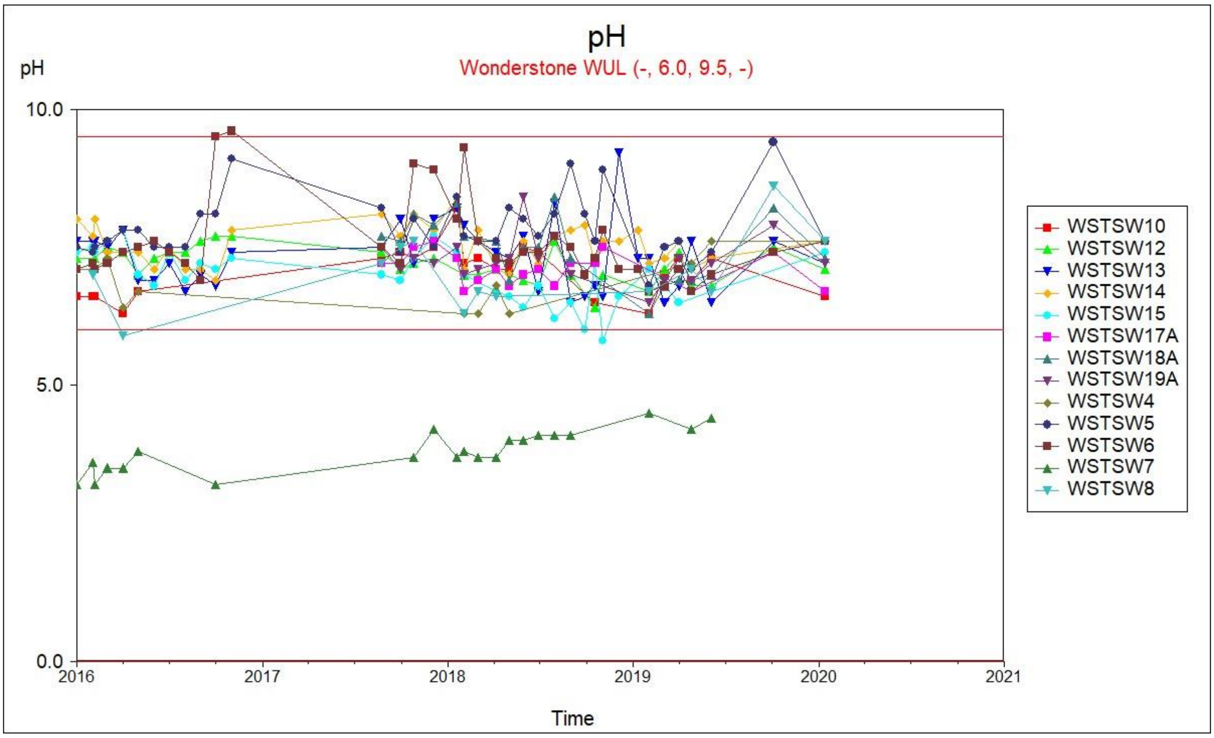

Figure 3-10: Trends in pH at the surface water monitoring points (Digby Wells Environmental, 2020)

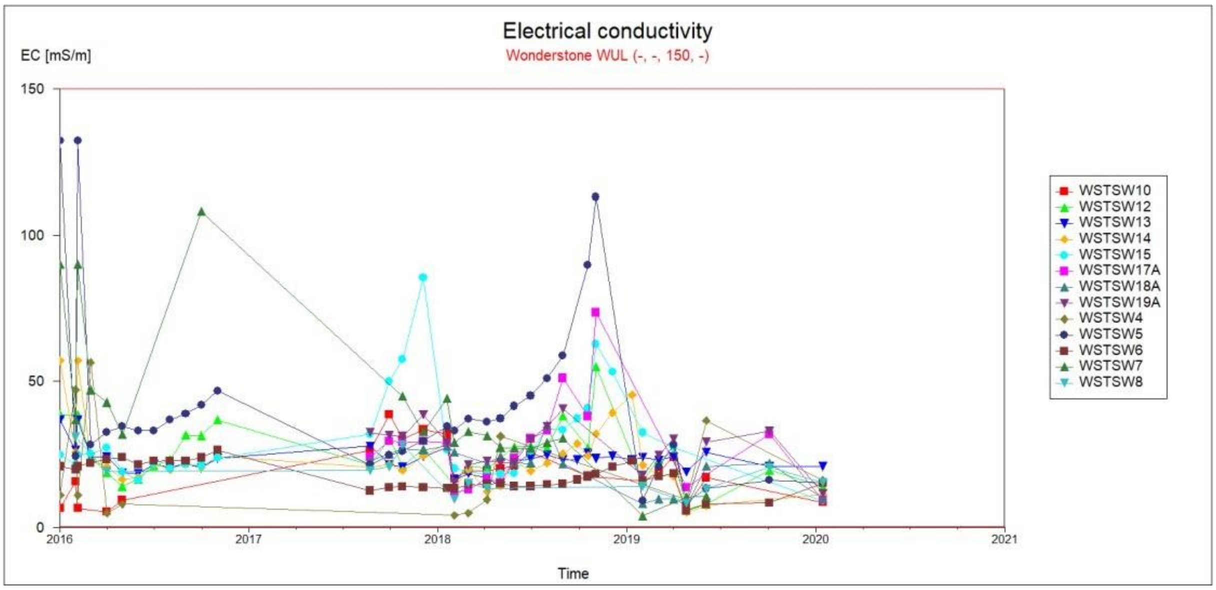

Figure 3-11: Trends in electrical conductivity at the surface water monitoring points (Digby Wells Environmental, 2020)

- The concentrations of calcium, magnesium and sodium have all been within the limit since 2016;
- Chloride (Cl) has also been within limit over the monitoring period, however, an increasing trend in Cl, much like that of EC, was evident over 2018 at the Driekuilspruit Dam (WSTSW5) (Figure 3-12). The Cl concentrations decreased significantly over 2019 due to increased rainfall, which provided dilution (Digby Wells Environmental, 2020);

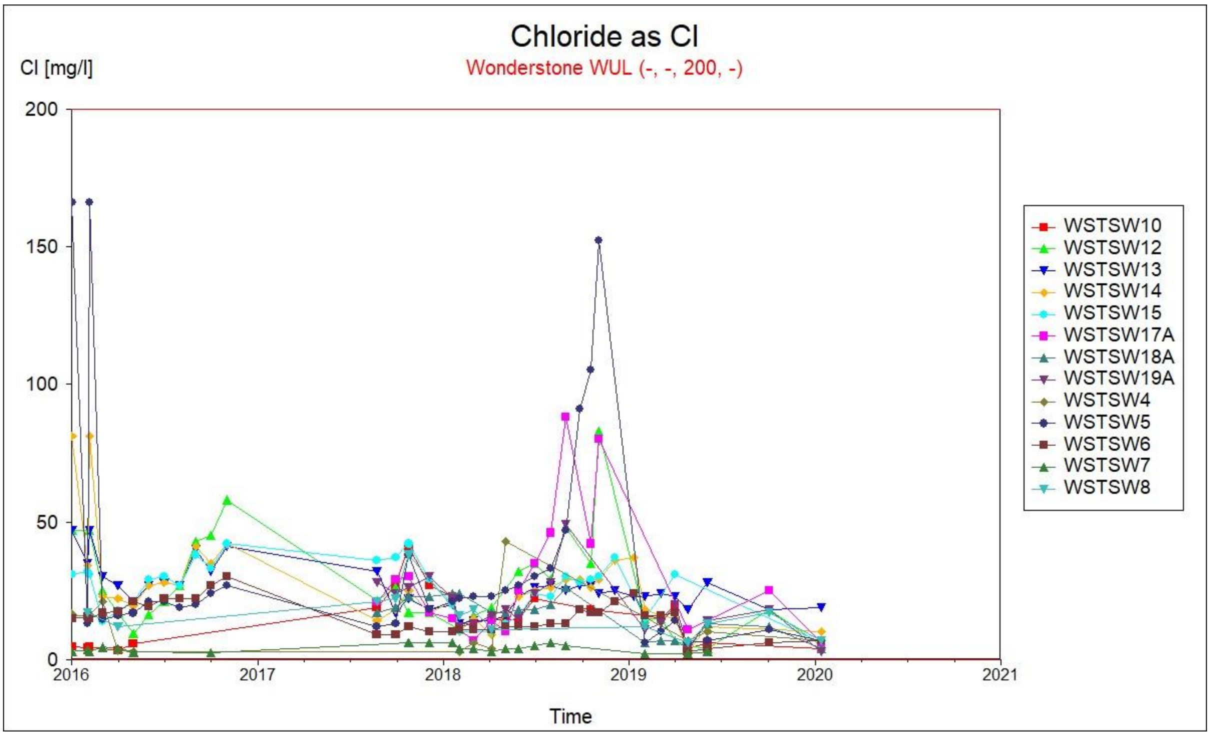

Figure 3-12: Trends in chloride at the surface water monitoring points (Digby Wells Environmental, 2020)

- Sulphate has also been within the limit at all monitoring points except at the Pit (WSTSW7), where it has been exceeded on three occasions (Figure 3-13). The sulphate concentrations have generally been higher at the Pit in comparison to the other surface water monitoring points;
- Nitrate has been within the limit at all monitoring points;
- Fluoride has been exceeded on three occasions at the Driekuilspruit Dam (WSTSW5), but has been within the limit at all other monitoring points since 2016. The exceedance of fluoride is not clearly understood (Digby Wells Environmental, 2020);

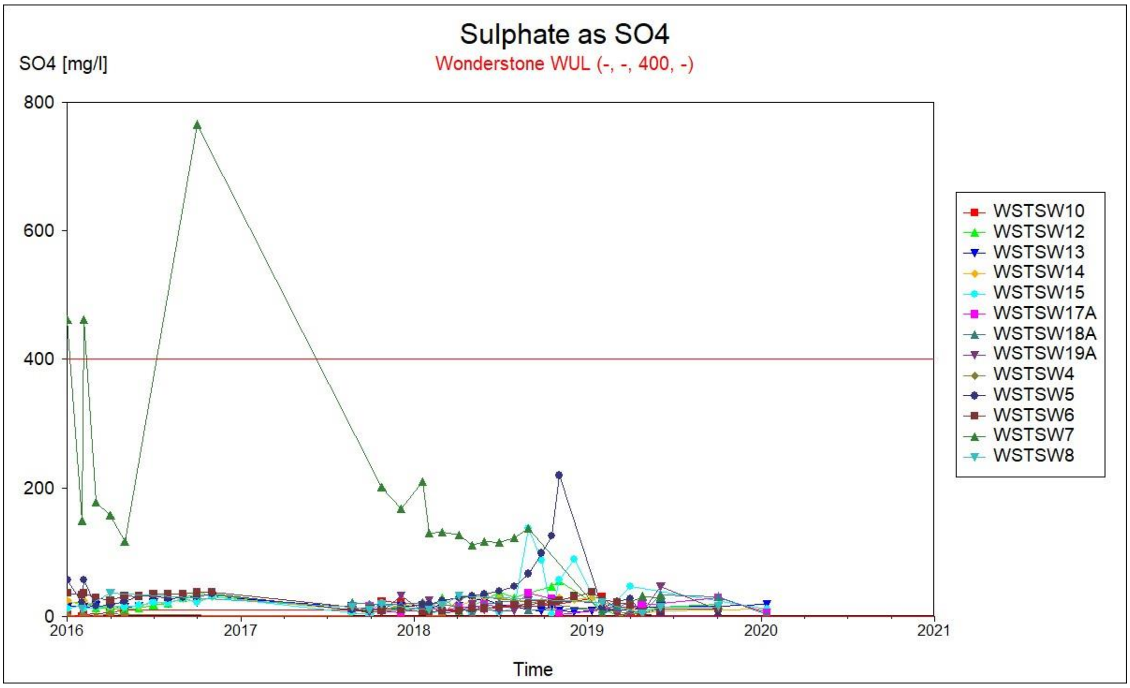

Figure 3-13: Trends in sulphate at the surface water monitoring points (Digby Wells Environmental, 2020)

- Metals such as aluminium, arsenic, boron, copper, iron, manganese, lead, zinc and chromium, do not form part of the current monitoring programme, which focuses on the WUL parameters specified in Table 3-8. However, these metals have been previously monitored on a monthly basis by Storm Water Solutions between January 2016 and May 2017 (Storm Water Solutions, 2017). Metal concentrations have been compared to the limits specified in the South African National Standard (SANS) 241:2015 for drinking water. A summary is provided below:
  - Aluminium exceeded the SANS limit of 0.3 mg/l at almost all of the surface water monitoring points. High levels of aluminium have occurred at the Pit (WSTSW7), Driekuilspruit Dam (WSTSW5) and upstream of the mine on the Driekuilspruit (WSTSW4). A maximum concentration of 98 mg/l occurred at the Pit in October 2016 (Figure 3-14), and coincides with the lowest pH of 3.2 recorded at the Pit;

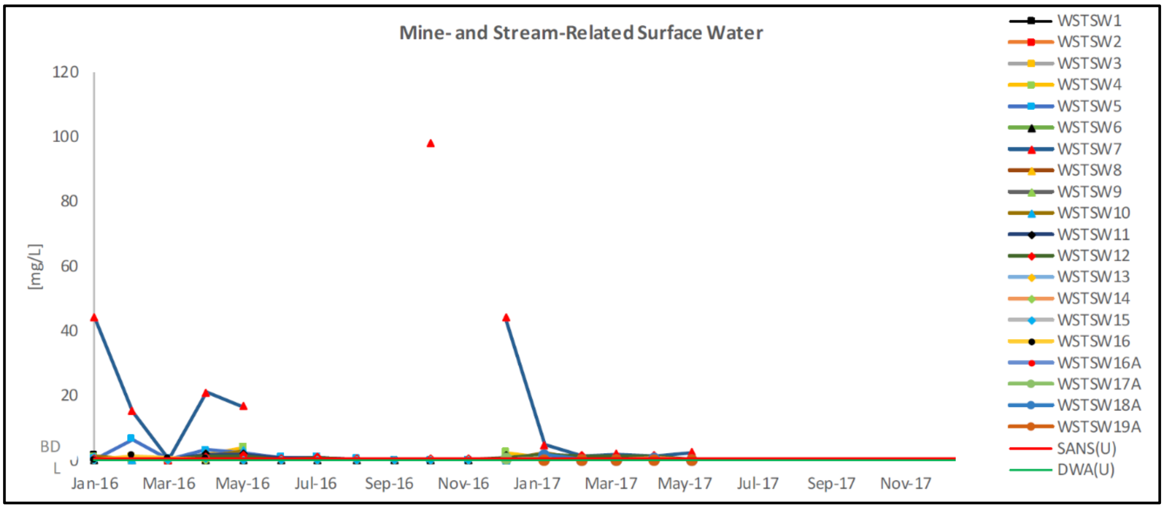

Figure 3-14: Trends in aluminium at the surface water monitoring points (Storm Water Solutions, 2017)

- Arsenic, boron and zinc were all within limits;
- Copper exceeded the SANS limit of 2 mg/l at the Pit (WSTSW7) on most of the sampling occasions, with a maximum of 131 mg/l occurring in October 2016 (Figure 3-15). The highest copper concentrations coincide with the lowest pH values at the Pit. Copper was within limits at all of the other monitoring points;

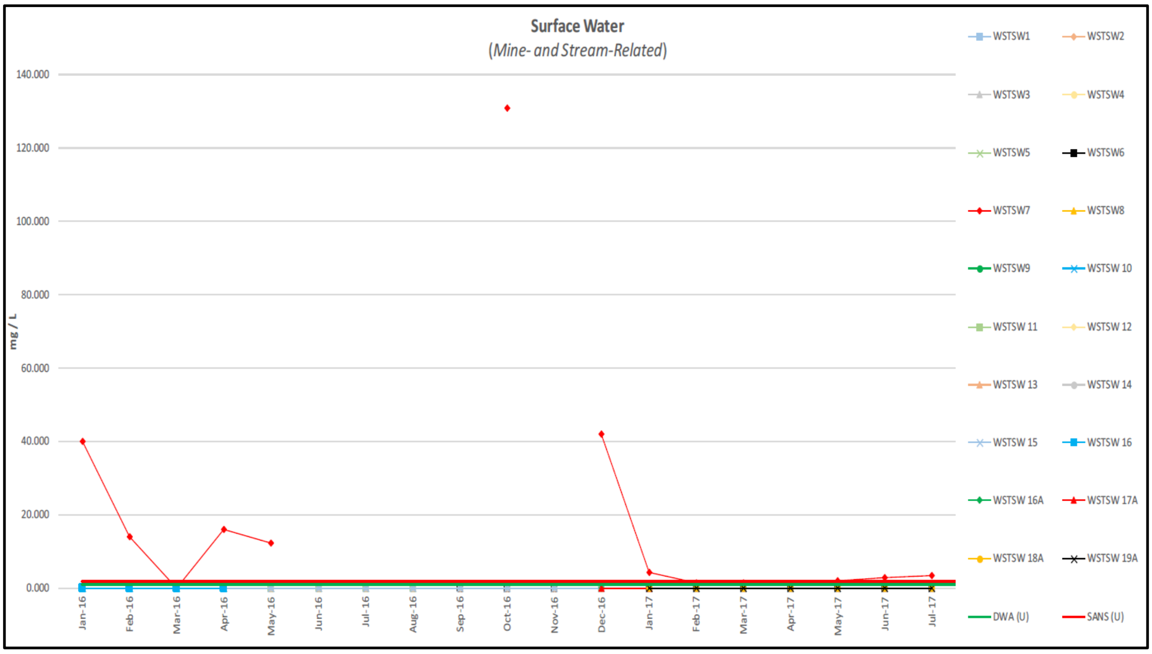

Figure 3-15: Trends in copper at the surface water monitoring points (Storm Water Solutions, 2017)

- Iron exceeded the SANS limit of 2 mg/l at the Pit (WSTSW7), Driekuilspruit Dam (WSTSW5), Driekuilspruit (WSTSW4) and where the unnamed stream meets the WRD to the east of the project area at WSTSW10. A particularly high iron concentration of 8.7 mg/l occurred upstream of the mine at WSTSW4 in May 2017 (Figure 3-16);

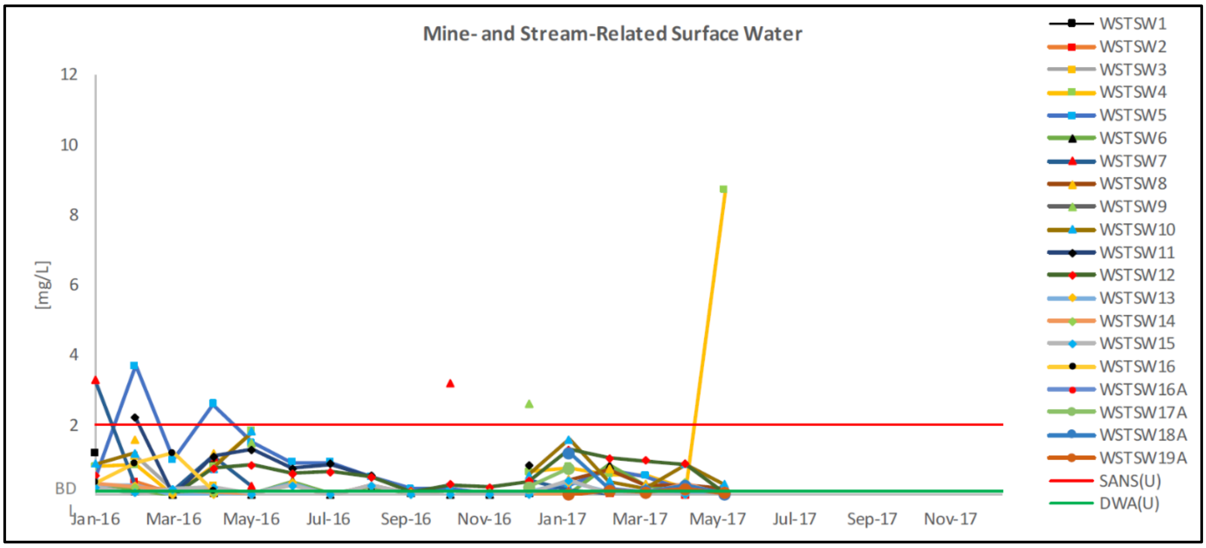

Figure 3-16: Trends in iron at the surface water monitoring points (Storm Water Solutions, 2017)

- Elevated levels of manganese exceeding the SANS limit of 0.4 mg/l occurred at the Pit (WSTSW7), upstream (WSTSW4) and downstream (WSTSW8) on the Driekuilspruit, as well as where the unnamed stream meets the WRD to the east of the mine. The highest recorded manganese concentration of 2.6 mg/l occurred upstream of the mine at WSTSW4. As with aluminium and copper, the highest manganese concentrations coincide with the lowest pH values at the Pit;

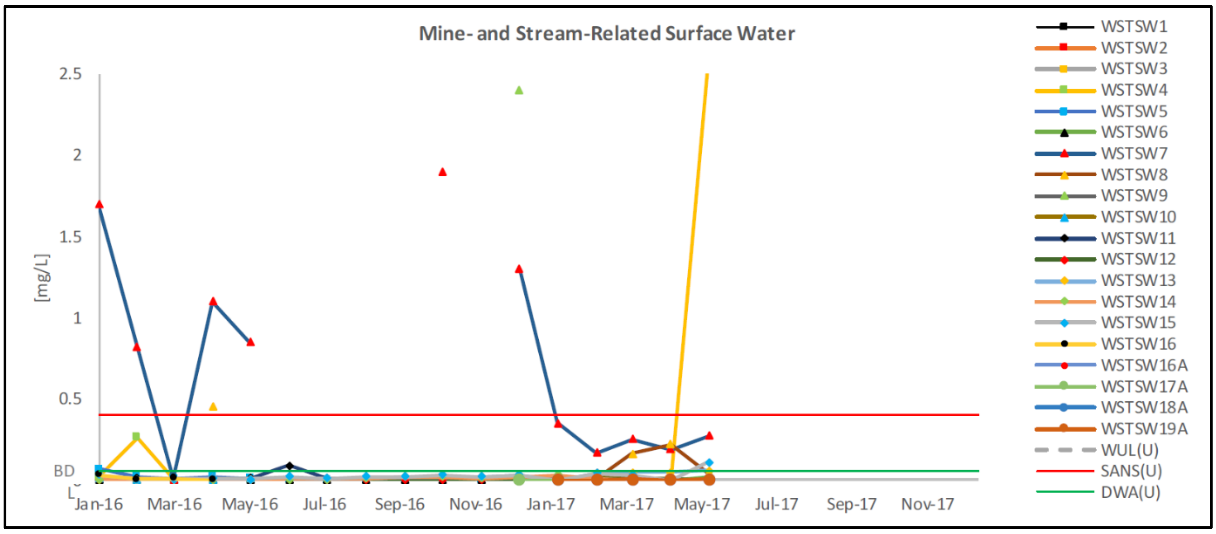

Figure 3-17: Trends in manganese at the surface water monitoring points (Storm Water Solutions, 2017)

- Lead has been within the SANS limit of 0.01 mg/l at all monitoring points except at the Pit on two occasions (Figure 3-18); and

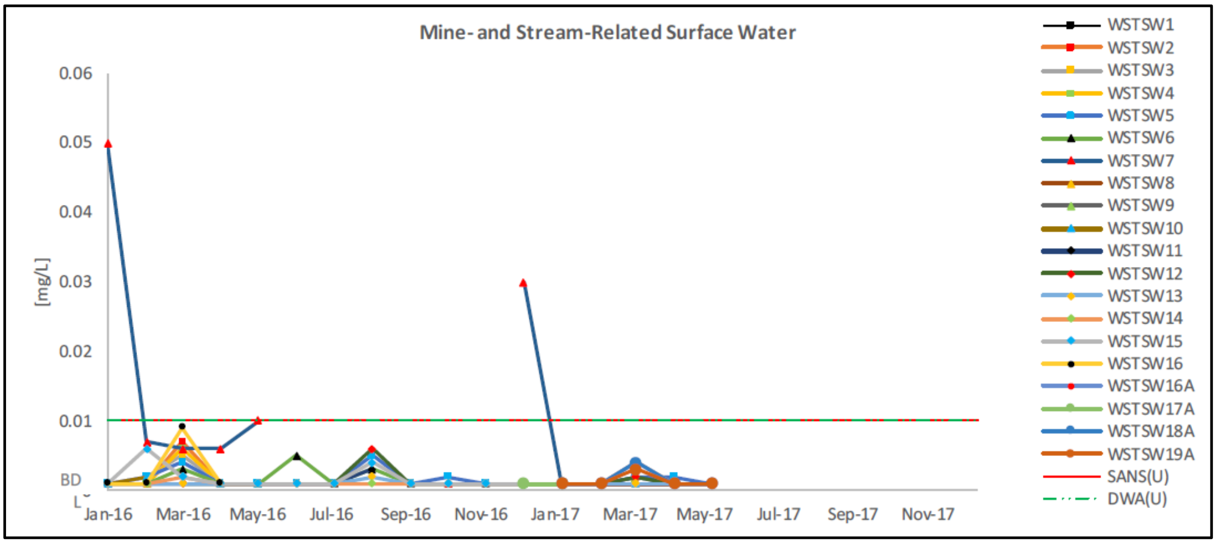

Figure 3-18: Trends in lead at the surface water monitoring points (Storm Water Solutions, 2017)

- Elevated chromium exceeding the SANS limit of 0.05 mg/l have occurred at most of the surface water monitoring points. The highest concentrations occurring at the 2nd Black Rock Quarry (WSTSW18A), Pit (WSTSW7), RWD (WSTSW13) and Silt Trap Silt Trap (WSTSW15).

3.4.4.1.2 Summary of Wonderstone Monitoring

In summary, the following are the main surface water quality findings:

- The pH of the Pit water is low and acidic, ranging between 3.2 and 4.4. The pH appears to have gradually improved since backfilling began in August 2018. Metal and sulphate concentrations have been higher at the Pit in comparison to the other monitoring points;
- The salinity of the Driekuilspruit fluctuates seasonally, with generally higher salinity levels occurring during the dry season (low flow months), due to lower dilution capacity;
- Elevated metals have mostly occurred at the Pit (WSTSW7), Driekuilspruit Dam (WSTSW5) and upstream of the mine on the Driekuilspruit (WSTSW4). The occurrence of elevated metals at WSTSW4 could be potentially from the geology of the area, runoff from the upstream Idwala Pyrophyllite Mine and discharges from the Ottosdal sewage works;
- The high metal concentrations at the Pit are linked to low pH values. This is as a result of acidic conditions within the Pit water which dissolve metals; and
- There appears to be no significant difference in the water quality between WSTSW4 located upstream of the mine, and WSTSW8 located downstream.

3.4.4.2 Site Visit Sampling

The water quality results from the site visit sampling undertaken on 2 February 2022 are indicated in Table 3-9. The water quality results were compared to the following guideline limits:

- Wonderstone WUL limits;
- Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 4: Agricultural Use: Irrigation;
- Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 5: Agricultural Use: Livestock Watering; and
- South African National Standards (SANS) 241:2015 Drinking Water Quality Standards.

In summary, only turbidity exceeded the SANS 241:2015 limits. This, however, is not of concern, as total suspended solids were low and within the limit. Furthermore, the Driekuilspruit was flowing strongly due to high rainfall that had been received prior to the site visit, which may have resulted in slightly elevated turbidity.

Table 3-9: Water quality results from the site visit sampling

Parameter	Units	WUL Limit	DWS TWQR: Irrigation Limit	DWS TWQR: Livestock Watering Limit	SANS 241:2015 Limit	SW1	SW2	SW3	SW4
pH	pH	6-9.5	6.5-8.4	-	5-9.7	7.89	7.89	8.07	7.28
Electrical Conductivity (EC)	mS/m	150	90	153	-	27.8	27.4	27.2	17.5
Total Dissolved Solids (TDS)	mg/l	-	585	1000	1 200	202	195	211	138
Total Alkalinity	mg $CaCO_3$/l	-	-	-	-	145	140	99.6	99
Chloride (Cl)	mg/l	200	100	1500	300	18	17.8	17.6	3.96
Sulphate (SO_4)	mg/l	400	-	1000	500	<0.141	<0.141	40.2	3.81
Nitrate (NO_3) as N	mg/l	10	-	100	11	0.342	0.309	0.311	0.318
Ammonium (NH_4) as N	mg/l	-	-	-	-	0.097	0.101	0.083	0.072
Orthophosphate (PO_4) as P	mg/l	-	-	-	-	0.053	0.04	0.046	0.017
Fluoride (F)	mg/l	1	2	2	-	<0.263	<0.263	<0.263	<0.263
Calcium (Ca)	mg/l	150	-	1000	-	22	21.3	21.3	18
Magnesium (Mg)	mg/l	100	-	500	-	11.2	10.8	10.8	7.37
Sodium (Na)	mg/l	200	70	2000	200	29	27.7	28.1	10.7
Potassium (K)	mg/l	-	-	-	-	5.89	5.72	5.78	5.54
Aluminium (Al)	mg/l	-	5	5	0.3	<0.002	<0.002	<0.002	0.058
Iron (Fe)	mg/l	-	5	10	2	0.33	0.223	0.27	1.69
Manganese (Mn)	mg/l	-	10	10	0.4	<0.001	<0.001	<0.001	0.082
Chromium (Cr)	mg/l	-	-	-	0.05	<0.003	<0.003	<0.003	<0.003
Copper (Cu)	mg/l	-	0.2	0.5	2	0.007	0.007	0.007	0.006
Nickel (Ni)	mg/l	-	0.2	1	0.07	<0.002	<0.002	<0.002	<0.002
Zinc (Zn)	mg/l	-	1	20	5	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	mg/l	-	0.05	1	-	<0.003	<0.003	<0.003	<0.003
Cadmium (Cd)	mg/l	-	0.01	0.01	0.003	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/l	-	0.2	0.1	0.01	<0.004	<0.004	<0.004	<0.004
Turbidity	NTU	-	-	-	5	6.36	6.63	5.21	10.4
Total Hardness	mg $CaCO_3$/l	-	-	-	-	101	98	98	75
Total Suspended Solids (TSS)	mg/l	-	50	-	-	14	13	10	14
Arsenic (As)	mg/l	-	0.1	1	0.01	<0.006	<0.006	<0.006	<0.006
Barium (Ba)	mg/l	-	-	-	0.7	0.016	0.02	0.022	0.04

Parameter	Units	WUL Limit	DWS TWQR: Irrigation Limit	DWS TWQR: Livestock Watering Limit	SANS 241:2015 Limit	SW1	SW2	SW3	SW4
Vanadium (V)	mg/l	-	0.1	1	-	<0.001	<0.001	<0.001	0.001
Total Oxidised Nitrogen as N	mg/l	-	-	-	-	0.342	0.309	0.311	0.318

4 ANTICIPATED SURFACE WATER IMPACTS AND MITIGATION MEASURES

The anticipated surface water impacts and proposed mitigation measures for the project are provided in Table 4-1.

Table 4-1: Anticipated surface water impacts and proposed mitigation measures

Activity	Impact Description	BEFORE MITIGATION SIGNIFICANCE	Mitigation measures / Recommendations	AFTER MITIGATION SIGNIFICANCE
Construction Phase				
Removal of vegetation.	Erosion and sedimentation of drainage lines.	Medium	• Clearance of vegetation must be limited as far as possible. • The SWMP must be implemented as a first step during the construction phase.	Low
Alteration to the natural topography (e.g. pit excavations, stockpiles, placement of infrastructure, etc.)	Alteration in surface water drainage patterns leading to erosion and consequent increase in Suspended Solids (SS) in surrounding watercourses.	Medium	• Stormwater management measures around the pits, stockpiles and dumps. • Water quality sampling must be implemented upstream and downstream of construction areas. Specific parameters that should be monitored include SS and turbidity. They should be kept within the baseline water quality range.	Low
Use of heavy machinery, trucks and vehicles for construction purposes.	Potential hydrocarbon spillages washed into downslope watercourses impacting on water quality.	Medium	• Machinery, trucks and vehicles must be well maintained and serviced regularly as per the recommended service guide. • Refuelling must be undertaken over hard park bunded areas that adequately capture and contain spillages. • Machinery and vehicles should be parked on appropriately lined areas. • Drip trays must be used under leaking machinery. • Spillages should be reported immediately, and spill kits should be readily available at all times.	Low

Activity	Impact Description	BEFORE MITIGATION SIGNIFICANCE	Mitigation measures / Recommendations	AFTER MITIGATION SIGNIFICANCE
			• Monitoring of the Driekuilspruit upstream and downstream of the proposed infrastructure.	
Operational Phase				
Creation of pits and the implementation of a closed SWMP.	Loss of runoff and water quantity to downstream users.	Low	• Runoff from upslope undisturbed areas must be diverted around dirty areas.	Low
Use of heavy machinery, trucks and vehicles during the operational phase.	Potential hydrocarbon spillages washed into downslope watercourses impacting on water quality.	Medium	• Machinery, trucks and vehicles must be well maintained and serviced regularly as per the recommended service guide. • Refuelling must be undertaken over hard park bunded areas that adequately capture and contain spillages. • Machinery and vehicles should be parked on appropriately lined areas. • Drip trays must be used under leaking machinery. • Spillages should be reported immediately, and spill kits should be readily available at all times. • Monitoring of the Driekuilspruit upstream and downstream of the proposed infrastructure.	Low

Activity	Impact Description	BEFORE MITIGATION SIGNIFICANCE	Mitigation measures / Recommendations	AFTER MITIGATION SIGNIFICANCE
Runoff from the pits and dumps reporting to the Driekuilspruit.	Impact on water quality of the Driekuilspruit.	High	Implementation of a closed SWMP.	Low
Closure & Rehabilitation Phase				
Exposure of soils during the closure and rehabilitation phase activities	Erosion and consequent sedimentation of surrounding watercourses	Medium	• Stormwater management measures should be in place while rehabilitation is taking place. • Revegetation of exposed areas.	Low

5 TERMS OF REFERENCE FOR THE EIA PHASE

The following is proposed to be undertaken during the EIA phase of the project:

- Development of conceptual Stormwater Management Plans (SWMP) in accordance with the DWS BPG G1: Storm Water Management and GN R704 regulations. The primary purpose of the SWMP is to ensure that clean (non-impacted mine water) and dirty water (mine impacted water) are clearly separated in accordance with the above-mentioned guideline and regulations;
- Determination of the 1:100 year floodline for the Driekuilspruit;
- Update of the mines water balance to include the proposed activities;
- An assessment of the potential surface water impacts and possible mitigation measures; and
- Development of monitoring plans that can be used to monitor potential impacts resulting from the proposed mining activities.

6 CONCLUSION

In conclusion, the scoping report has provided a detailed hydrological baseline description of the proposed project. It has further provided the anticipated surface water impacts and mitigation measures, which will be assessed in more detail during the EIA phase of the project. Lastly, the terms of reference for the hydrological study for the EIA phase of the project has been provided.

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APPENDIX A: CURRICULUM VITAE