HIGHLANDS HYDROLOGY (PTY) LTD

BASELINE HYDROLOGICAL ASSESSMENT FOR THE PROPOSED VYGENHOEK PLATINUM MINE, MPUMALANGA

July, 2020

Version 1

email: *luke@wiles.co.za* | **phone**: +27 72 129 4202

BASELINE HYDROLOGICAL ASSESSMENT FOR THE PROPOSED VYGENHOEK PLATINUM MINE, MPUMALANGA

Prepared For

Environmental Management Assistance

Prepared By

Highlands Hydrology (Pty) Ltd

July, 2020

Version 1

TABLE OF CONTENTS

1 INTRODUCTION....1

1.1 BACKGROUND 1

1.2 REGIONAL SETTING AND SITE LAYOUT.... 1

2 BASELINE ASSESSMENT....4

2.1 AVERAGE MONTHLY RAINFALL 4

2.2 1-DAY DESIGN RAINFALL DEPTHS 6

2.3 EVAPORATION 6

2.4 AVERAGE CLIMATE 7

2.5 HYDROLOGY AND TOPOGRAPHY 8

3 POTENTIAL HYDROLOGICAL IMPACTS 10

4 CONCLUSION AND RECOMMENDATIONS 11

5 REFERENCES....13

LIST OF FIGURES

FIGURE 1-1: REGIONAL SETTING 2

FIGURE 1-2: LAYOUT OF PROPOSED INFRASTRUCTURE....3

FIGURE 2-1: WEATHER STATIONS AND MEAN ANNUAL PRECIPITATION 5

FIGURE 2-2: AVERAGE MONTHLY CLIMATE FOR THE SITE....7

FIGURE 2-3: PHOTOS FROM SITE....8

FIGURE 2-4: REGIONAL HYDROLOGY AND TOPOGRAPHY 9

LIST OF TABLES

TABLE 2-1: AVERAGE MONTHLY RAINFALL (LYNCH, 2004)....4

TABLE 2-2: 24-HOUR STORM DEPTH....6

TABLE 2-3: MONTHLY A-PAN EQUIVALENT EVAPORATION (SCHULZE AND LYNCH, 2006)....7

BASELINE HYDROLOGICAL ASSESSMENT FOR THE PROPOSED VYGENHOEK PLATINUM MINE, MPUMALANGA

1 INTRODUCTION

1.1 BACKGROUND

Highlands Hydrology (Pty) Ltd has been appointed by Environmental Management Assistance (EMA), to undertake a baseline hydrological investigation for the proposed Vygenhoek Platinum Mine (hereafter referred to as the site), located on the northern boundary of Mpumalanga province, adjoining Limpopo province.

The scope of work was achieved by the following:

- Baseline Assessment: Baseline climatic data used in hydrological calculations. This includes the sourcing of appropriate rainfall data, site specific rainfall depth/duration/frequency analysis, evaporation, as well as a regional and local hydrological assessment;
- Site Visit: The site was visited by Mr Luke Wiles on 9th July 2020. This was necessary to understand the dominant hydrological flow regimes, as well as understand potential impact the proposed operation may have on receiving water resources;
- Potential Hydrological Impacts: High level potential hydrological impact discussion; and
- Technical report – detailing the achieved scope of work with appropriate discussion, conclusions, and recommendations.

1.2 REGIONAL SETTING AND SITE LAYOUT

The proposed site is positioned at approximately 25° 02' 11" S and 30° 09' 29" E, approximately 28km west of Lydenburg in the Mpumalanga Province. The regional setting of the proposed site is illustrated in Figure 1-1, with Figure 1-2 illustrating the layout of proposed infrastructure.

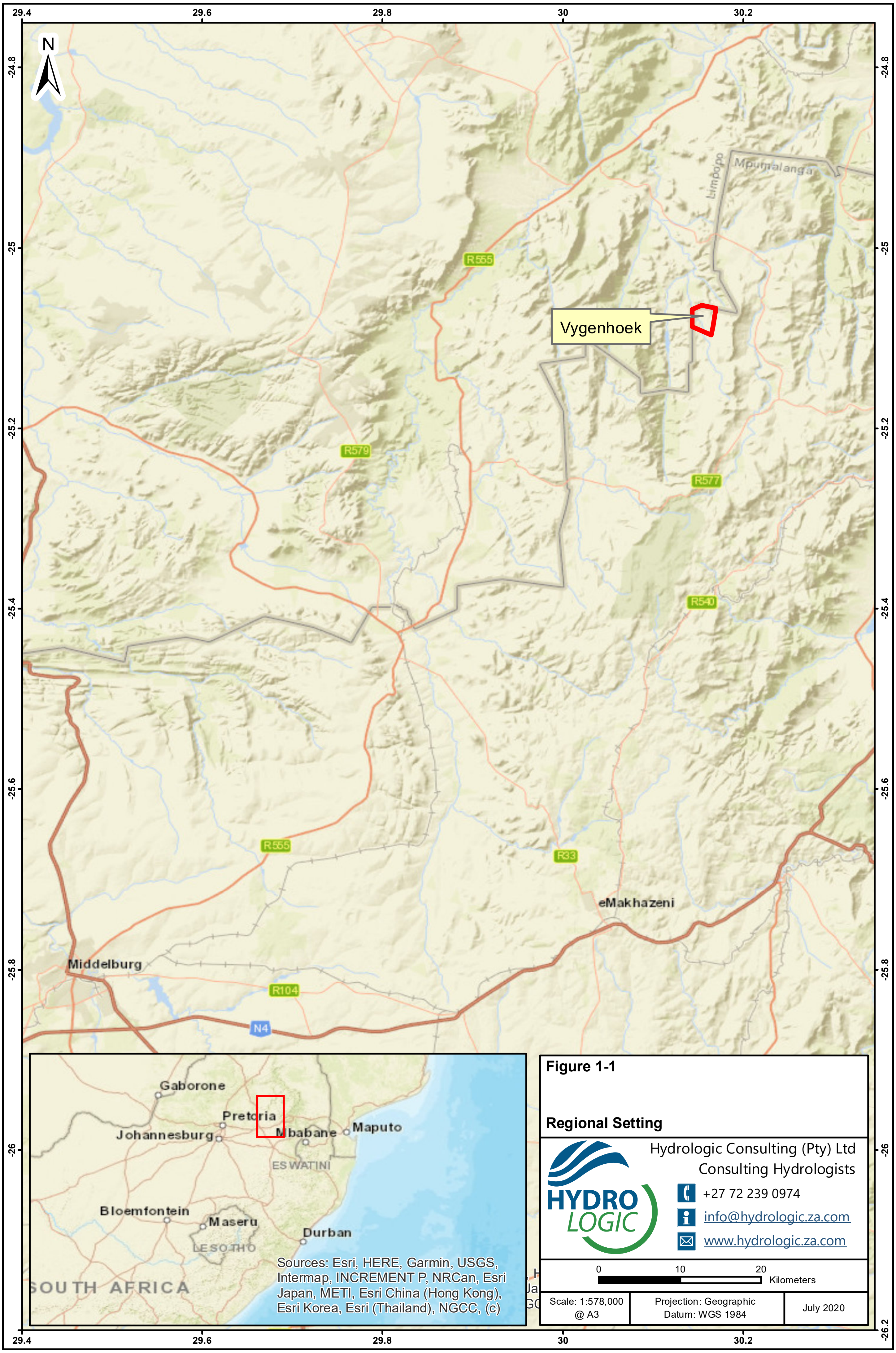


Figure 1-1

Regional Setting

Hydrologic Consulting (Pty) Ltd
Consulting Hydrologists

+27 72 239 0974
info@hydrologic.za.com
www.hydrologic.za.com

Scale: 1:578,000 @ A3	Projection: Geographic Datum: WGS 1984	July 2020

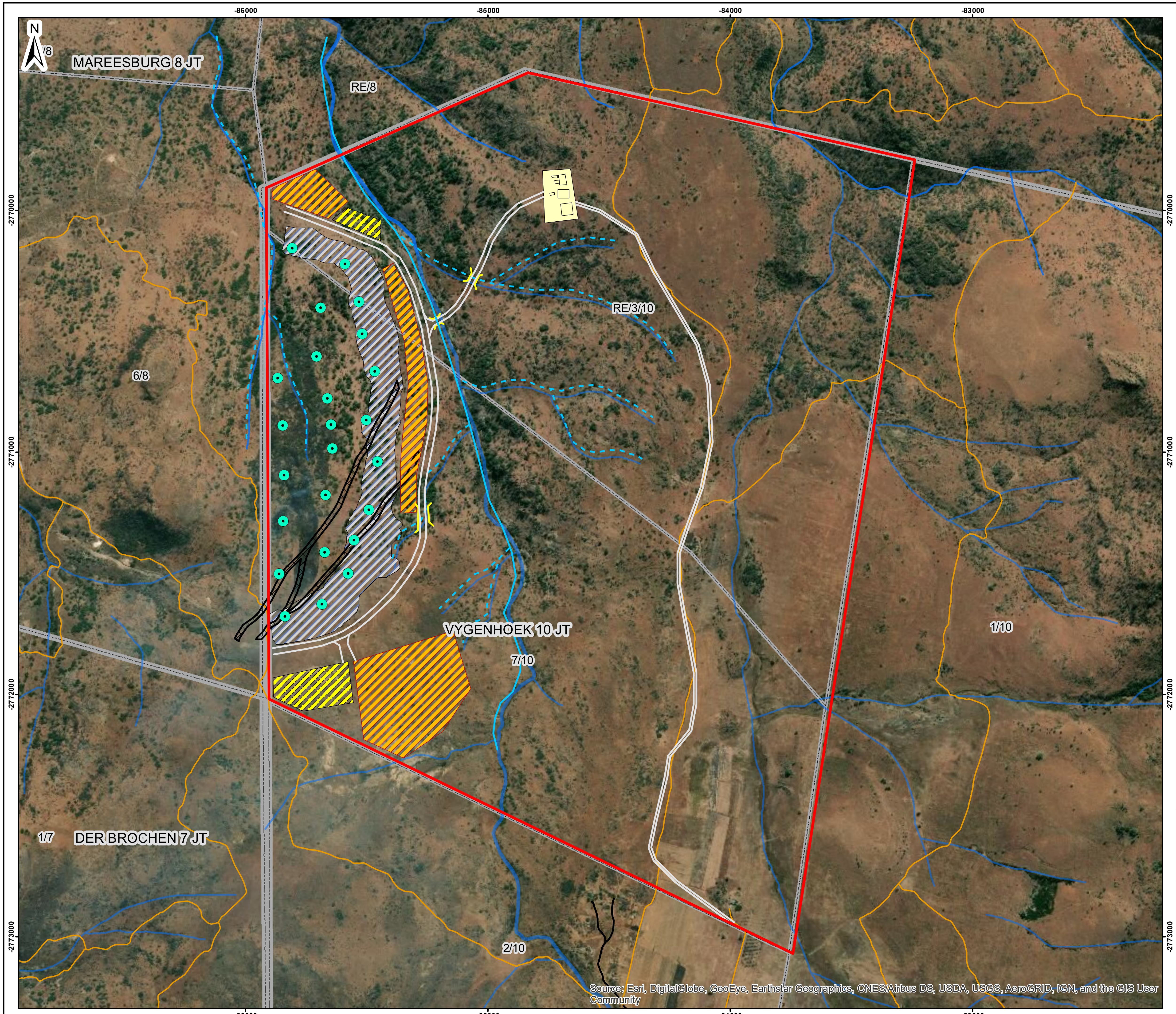


Figure 1-2

Layout

Hydrologic Consulting (Pty) Ltd
Consulting Hydrologists
+27 72 239 0974
info@hydrologic.za.com
www.hydrologic.za.com

0 500 Meters

Scale: 1:14,600 @ A3	Projection: Transverse Mercator Datum: Hartebeeshoek, LO31	July 2020

2 BASELINE ASSESSMENT

Baseline information in this section includes discussions on the rainfall, design event rainfall, evaporation, average climate, as well as regional and local catchment hydrology.

2.1 AVERAGE MONTHLY RAINFALL

Various weather stations managed by both the South African Weather Services (SAWS) and the Department of Water and Sanitation (DWS) are illustrated in Figure 2-1.

The closest SAWS rainfall station is 593419 W (Martenshoop Police Station), located approximately 9km north-east of the site and has an altitude of 1365m above mean sea level. This SAWS station has a record length of 90 years with a Mean Annual Precipitation (MAP) of 689mm. The closest DWS station is B4E003, located approximately 15km to the north-east of the site with a 43-year record and MAP of 679mm, comparing well to SAWS station 593419 W.

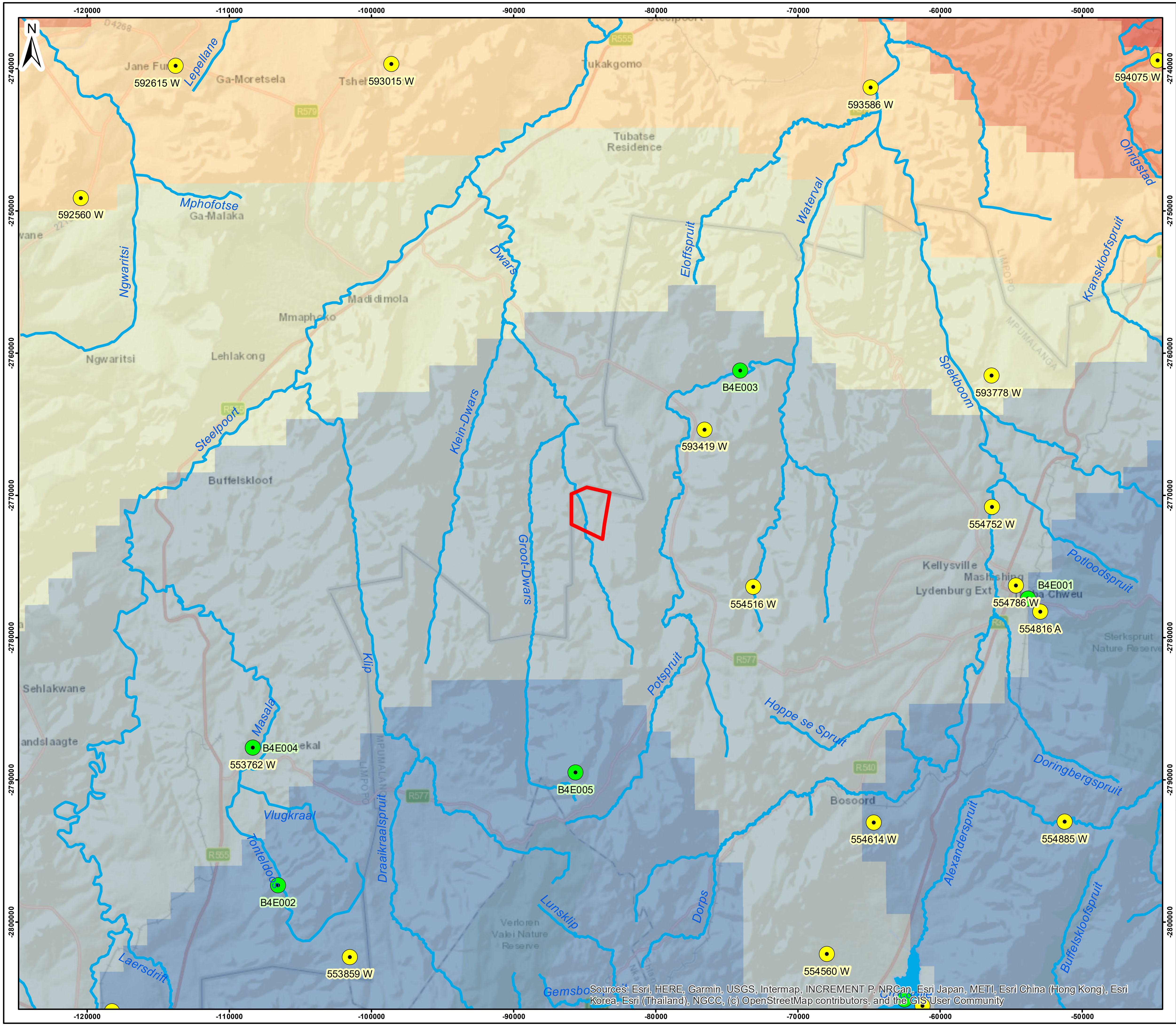
The potential for rainfall distributions to change over distance can be significant. Figure 2-1 presents the variation in mean annual precipitation (MAP) in the greater area, indicating a steady decrease in MAP from south to north. An alternative and site-specific source of rainfall data was therefore also used to provide average monthly rainfall values for the site as per Lynch (2004).

Lynch (2004) includes details on the development of a raster database of monthly rainfall data for Southern Africa. The resultant raster database utilises a geographically weighted regression which took account of factors including latitude, longitude, altitude, slope and distance from the sea when interpolating data from rainfall stations located throughout Southern Africa. Table 2-1 presents the average monthly rainfall estimates from Lynch (2004) indicating a MAP of 674mm, comparing well to both SAWS station 593419 W and DWS station B4E003.

TABLE 2-1: AVERAGE MONTHLY RAINFALL (LYNCH, 2004)

Month	Rainfall (mm)
Jan	113
Feb	91
Mar	76
Apr	43
May	15
Jun	7
Jul	6
Aug	8
Sep	22
Oct	60
Nov	114
Dec	119
Total	**674**

*Estimates were sourced from the centre of the site



Legend

Boundary

Raingauges

- SAWS
- DWS

Rivers (500K Topo)

Dams (500K Topo)

Quaternary Catchments

Mean Annual Precipitation (mm)

- < 500
- 500 - 550
- 550 - 600
- 600 - 650
- 650 - 700
- > 700

Figure 2-1

Weather Stations and Mean Annual Precipitation

Hydrologic Consulting (Pty) Ltd
Consulting Hydrologists
+27 72 239 0974
info@hydrologic.za.com
www.hydrologic.za.com

0 5 10 Kilometers

Scale: 1:250,000 @ A3	Projection: Transverse Mercator Datum: Hartebeeshoek, LO31	July 2020

2.2 1-DAY DESIGN RAINFALL DEPTHS

For the development of a storm water management plan, design rainfall was the most important rainfall variable to consider as it is the driver behind design (peak) flows.

Design storm estimates for various recurrence intervals (RI) and storm durations were sourced from the Design Rainfall Estimation Software for South Africa (DRESSA), developed by the University of Natal in 2002 as part of a WRC project K5/1060 (Smithers and Schulze, 2002). This method uses a Regional L-Moment Algorithm (RLMA) in conjunction with a Scale Invariance approach to provide site-specific estimates of design rainfall (depth, duration and frequency), based on surrounding station records. WRC Report No. K5/1060 (WRC, 2002) provides more detail on the verification and validation of the method. Table 2-2 presents the DRESSA design storm estimates for the site.

The design rainfall estimates (24-hour storm) using the above technique have been compared to that obtained in TR102 (Design Rainfall Depths at Selected Stations in South Africa) for the 593419 W (Martenshoop Police Station) rainfall station located approximately 10 km north-east of the site.

TABLE 2-2: 24-HOUR STORM DEPTH

Recurrence Interval (Years)	Rainfall Depth (24 hour) (mm)	
	DRESSA (Smithers/Schulze)*	TR102
2	57	53
5	78	73
10	94	87
20	109	101
50	131	122
100	148	138
200	167	155

* Estimates were sourced from the centre of the site

The DRESSA design storm estimates compare well to that of TR102 for the specific SAWS station. It is recommended that the DRESSA design storm estimates be used for all flood hydrology calculation and modelling due to them being site specific as well as the slight conservatism associated with them, compared to TR102.

It is important to note, that no allowances for climate change have been made. A risk analysis using the expected life of a structure or process will indicate the relevance of considering climate change (i.e. as the expected life increases the influence of climate change increases).

2.3 EVAPORATION

Evaporation data was sourced from the South African Atlas of Climatology and Agrohydrology (Schulze and Lynch, 2006) in the form of A-Pan equivalent evaporation. The average monthly evaporation distribution is presented in Table 2-3 and shows the site has an annual A-Pan equivalent evaporation of 1981mm which is considered high in comparison to other areas in South Africa.

TABLE 2-3: MONTHLY A-PAN EQUIVALENT EVAPORATION (SCHULZE AND LYNCH, 2006)

Month	Evaporation(mm) A-Pan Equivalent
Jan	203
Feb	164
Mar	171
Apr	147
May	133
Jun	109
Jul	118
Aug	154
Sep	182
Oct	200
Nov	197
Dec	203
Total	**1981**

* Estimates were sourced from the centre of the site

2.4 AVERAGE CLIMATE

The average climate for the site is presented in Figure 2-4 using the outcome of the investigation into rainfall and evaporation for the site. The combination of rainfall (Lynch, 2004), and evaporation and temperature (Schulze and Lynch, 2006), result in a warm temperate climate with dry winters and warm summers according to the Köppen-Geiger climate classification[1]. While evaporation is showing as greatly exceeding rainfall, this is representative of the maximum A-Pan equivalent potential evaporation that could occur assuming no limitations are placed on evaporative demand.

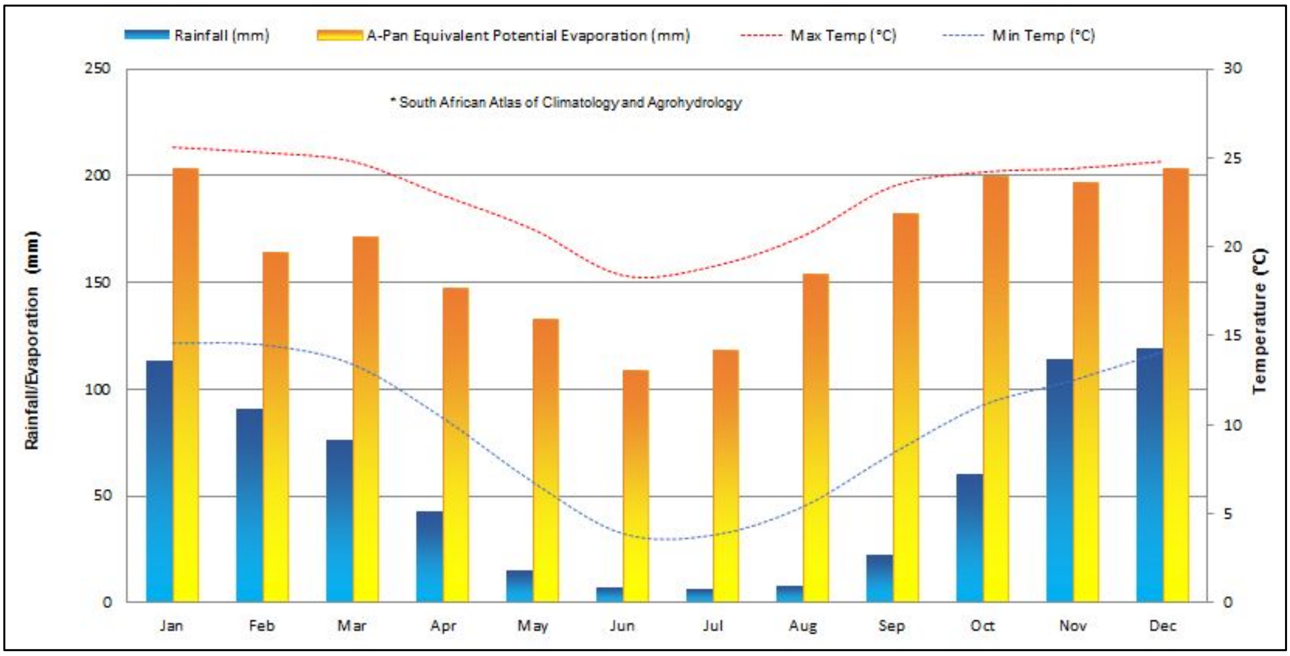


FIGURE 2-2: AVERAGE MONTHLY CLIMATE FOR THE SITE

[1] http://stepsa.org/climate_koppen_geiger.html

2.5 HYDROLOGY AND TOPOGRAPHY

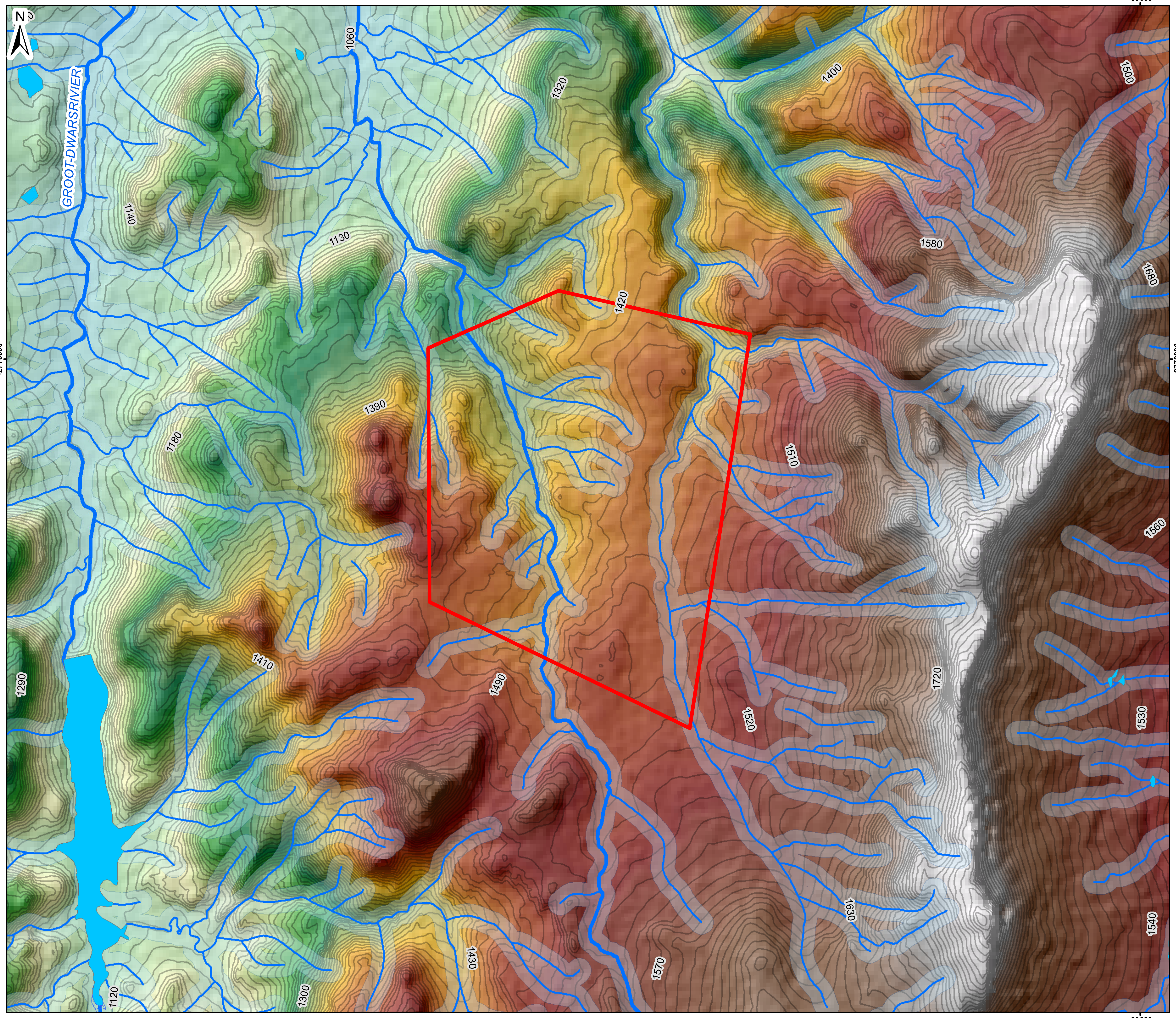
Figure 2-1 presents the river network of the greater region while Figure 2-4 presents the local hydrology about the site. The site is positioned within quaternary catchment B41G. The rivers at the site drain in a northerly direction joining the Groot-Dwars River approximately 5km downstream, which then joins the Dwars River, which flows into the Steelpoort/Tubatse River, the Olifants River, and ultimately Limpopo River before reaching the Indian Ocean.

There is one perennial river at the site which drains majority of the site. This perennial river has a network of non-perennial streams associated with it (Figure 2-3). The second largest stream located on the eastern side of the site is non-perennial (according to the 1:50 000 topographical data) but showed substantial flow emanating from it during the site visit which was done during the dry season (July). The combination of these two streams drains majority of the site.

The site is steep, particularly in the valleys associated with the streams. There is fairly large plateau area with gentle slopes located between the perennial stream and eastern non-perennial stream.

The runoff potential at the site is very high due to the combination of very steep topography, limited soil depth, and limited vegetation cover where parent rock is exposed at the surface. This results in a reduced capacity for water to infiltrate into the soil profile. Figure 2-3 below are some of the photos taken during the site visit, which help illustrate the discussion above.

FIGURE 2-3: PHOTOS FROM SITE



Legend

Boundary

5m Contour (50K Topo)

Non-Perennial River (50K Topo)

Perennial River (50K Topo)

Dam (50K Topo)

100m River Buffer

Elevation (mAMSL)

High : 1908

Low : 1045

Figure 2-4

Hydrology and Terrain

Hydrologic Consulting (Pty) Ltd
Consulting Hydrologists
+27 72 239 0974
info@hydrologic.za.com
www.hydrologic.za.com

0 500 1,000 Meters

Scale: 1:50,000 @ A3 | Projection: Transverse Mercator Datum: Hartebeeshoek, LO31 | July 2020

3 POTENTIAL HYDROLOGICAL IMPACTS

In terms of hydrological impacts, the following should be noted and considered in more detail during the detailed hydrological assessment and Environmental Impact Assessment (EIA):

- Alteration to natural stream flow volumes:
  - Clean and dirty areas will need to be kept separate as guided by Government Notice 704 (GN704). This means that dirty water generating catchments will need to be contained and reused in the process water circuit.
  - This will have a potential negative impact on both downstream water users as well as stream biodiversity.
- Alteration of natural drainage pattern:
  - Changes to catchment characteristics such as the removal of vegetation and associated increase in hardstanding at the site will increase runoff and erosion potential during rainfall events.
  - This will have a potential negative impact on both downstream water users as well as stream biodiversity.
- Alteration of natural water quality:
  - Water quality will be detrimentally affected by the proposed operation through potential chemicals used in the operation, including blasting.
  - Water quality will also be detrimentally affected though an increased sediment load resulting from increased erosion in catchments associated with the proposed operation.
  - This will have a potential negative impact on both downstream water users as well as stream biodiversity.

Based upon this initial baseline investigation as well as site visit (confirming green-field conditions and an associated pristine hydrological environment), it can be concluded that although there were no fatal flaws or red flags identified at this stage, there will be a negative impact resulting from the proposed operation on receiving water resources. Mitigation measures can however be put in place to help reduce this impact. At this stage, it is recommended that proposed infrastructure be limited as far as possible, so as to reduce the dirty water generating footprint. All infrastructure should be placed outside of any proposed buffers, and should be limited (as far as possible) to flatter plateau areas, where both runoff and erosion potential is lower. It must be noted that this report did not include a wetland investigation, or a baseline water quality assessment.

4 CONCLUSION AND RECOMMENDATIONS

Baseline information including rainfall, evaporation, design event rainfall, temperature, as well as site topography and regional and local catchment hydrology have been considered in this baseline hydrological assessment for the proposed Vygenhoek Platinum Mine.

This baseline assessment, together with first-hand knowledge of the major hydrological flow regimes gained through visiting the site indicate that the hydrological environment is presently in its natural state, baring a few cattle grazing in the area.

The runoff potential at the site is very high due to the combination of very steep topography, limited soil depth, and limited vegetation cover where parent rock is exposed at the surface.

The proposed development of the site will alter the natural flow regime in terms of both water quantity and water quality with potential negative impact to both downstream water users and stream biodiversity. Mitigation measures can however be put in place to help reduce this impact.

It can be concluded that although there were no fatal flaws or red flags identified at this stage, there will be a negative impact resulting from the proposed operation on receiving water resources. Mitigation measures can however be put in place to help reduce this impact. At this stage, it is recommended that proposed infrastructure be limited as far as possible, so as to reduce the dirty water generating footprint. All infrastructure should be placed outside of any proposed buffers, and should be limited (as far as possible) to flatter plateau areas, where both runoff and erosion potential is lower.

It is recommended that during the detailed hydrological investigation and EIA, the following items are addressed, with mitigation measures recommended where applicable:

- Floodline Modelling and Stream Buffers
- Conceptual Storm Water Management
- Mean Annual Runoff Assessment
- Static Water Balance
- Water Quality Monitoring
- Hydrological Impact Assessment

Luke Wiles	Fanie Botha	Mark Bollaert
(MSc, PrSciNat)	(PhD, PrSciNat)	(MSc, PrSciNat)
Project Manager/Author	Project Reviewer	Project Author

DISCLAIMER

Although Highlands Hydrology (Pty) Ltd exercises due care and diligence in rendering services and preparing documents, Highlands Hydrology (Pty) Ltd accepts no liability, and the client, by receiving this document, indemnifies Highlands Hydrology (Pty) Ltd and its members, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Highlands Hydrology (Pty) Ltd and by the use of the information contained in this document.

5 REFERENCES

Bailey, A.K. and Pitman, W.V., 2015, "*Water Resources of South Africa 2012 Study (WR2012)"*, WRC Report No. TT??, Water Research Commission, Pretoria

Department of Water Affairs and Forestry, 1998. *National Water Act, Act 36 of 1998*

Department of Water Affairs and Forestry, 1999. *Government Notice 704 (Government Gazette 20118 of June 1999)*

HRU – Hydrological Research Unit, 1978, *"A Depth-Duration-Frequency Diagram for Point Rainfall in southern Africa"*, Report 2/78, University of Witwatersrand, Johannesburg, South Africa

Lynch, S.D., 2004, "*Development of a Raster Database of Annual, Monthly and Daily Rainfall for Southern Africa*". WRC Report 1156/1/04. Water Research Commission, Pretoria, South Africa.

SANRAL., 2013 "*Drainage Manual - Sixth Edition*", The South African National Roads Agency Limited, Pretoria.

Schulze, R.E. and Lynch, S.E., 2006. "*South African Atlas of Climatology and Agrohydrology",* WRC Report 1489/1/06, Water Research Commission, Pretoria

Smithers, J.C. and Schulze, R.E., 2000, "*Long Duration Design Rainfall Estimates for South Africa*", WRC Report No. 811/1/00, Water Research Commission, Pretoria

Water Research Commission 2002. Design Rainfall Estimation in South Africa. WRC Report No. K5/1060