PHASE 2 BASELINE HYDROLOGICAL ASSESSMENT FOR THE PROPOSED TSHEDZA 3 INVESTMENTS (PTY) LTD DEVELOPMENT OF A 40 MW SOLAR PHOTOVOLTAIC AND ASSOCIATED INFRASTRUCTURE DEVELOPMENT, GAUTENG PROVINCE

Version 1

February 2022

HIGHLANDS HYDROLOGY (PTY) LTD

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Prepared For

Environmental Management Assistance (Pty) Ltd

Prepared By

Highlands Hydrology (Pty) Ltd

Version 1

February 2022

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1 INTRODUCTION

1.1 BACKGROUND

Highlands Hydrology (Pty) Ltd has been appointed by Environmental Management Assistance (EMA) to undertake a baseline hydrological assessment (in support of the environmental scoping report) for the proposed construction of a solar photovoltaic (PV) plant and associated infrastructure to generate up to 40 MW of energy by Tshedza 3 Investments(Pty) Ltd (referred to as 'Phase 2").Phase 2 will be situated on Ergo Mining owned land on the Farms Withok 131; Witpoortjie 117 and Withok Estates Agricultural Holdings of Brakpan within the City of Ekurhuleni Metropolitan Municipality, Gauteng Province, as assessed in this scoping baseline study.

The total proposed project is being developed to generate electricity for the ERGO Mining plant's power requirements. The Phase 1 (19.9MW)[1] assessment has been completed through a Basic Assessment application process (Ref: GP158MREA) and included solar panel development on the Farm Witpoortje 117 IR with associated power lines and 100MWh containerised battery storage, south of Brakpan, The solar project will be expanded to incorporate Phase 2 (40MW) resulting in a 59.9MW total production site. The proposed PV facility will generate electricity with battery storage, to interface with the Eskom grid to supply the ERGO Mining Brakpan Plant and the Brakpan/Withok Tailings Facility with a stable power supply through embedded generation. The generated electricity will be used when there is an interruption to Eskom's supply in energy.

1.2 SCOPE OF WORK

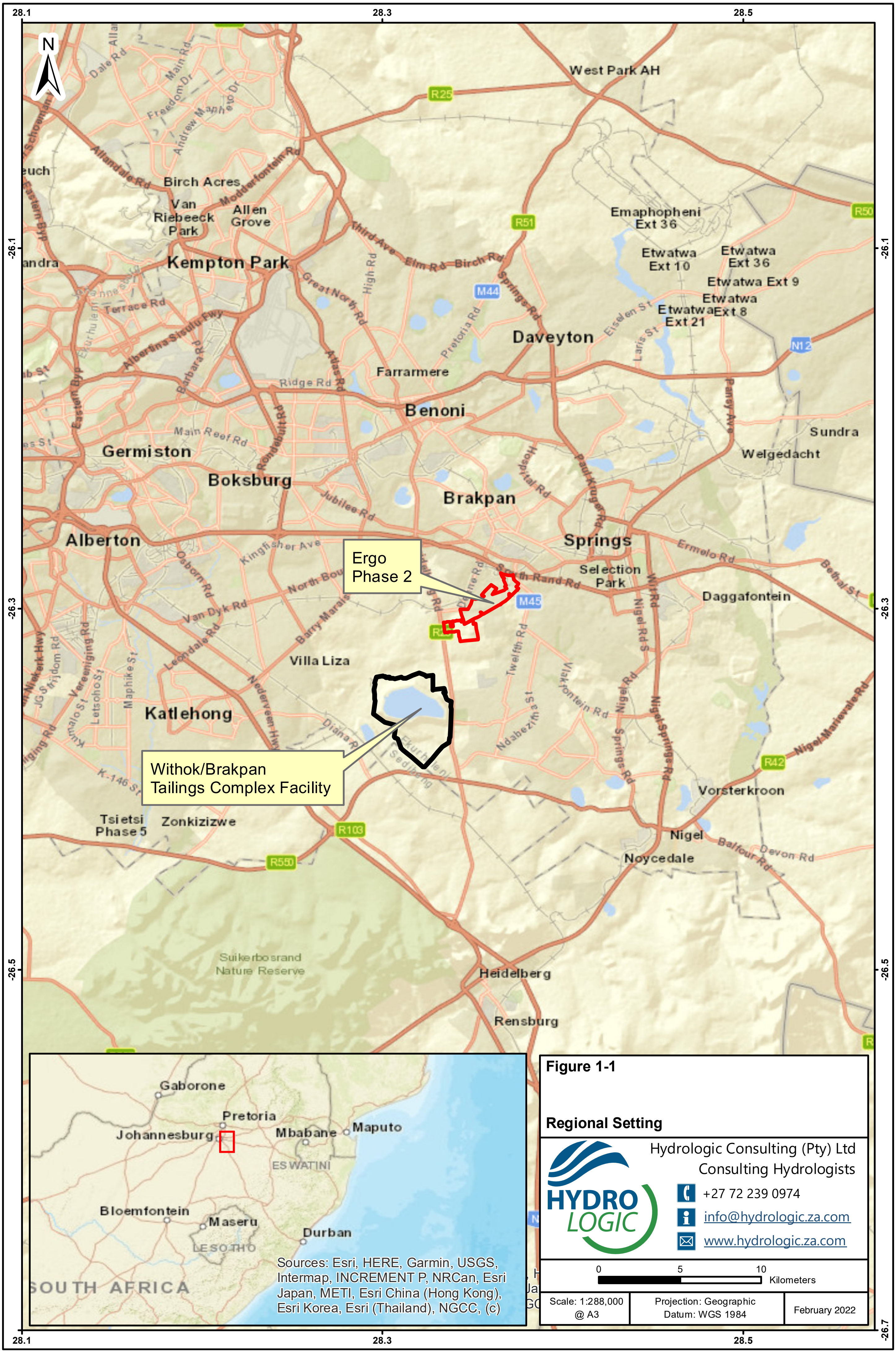
The scope of work for the hydrological assessment included the following deliverables:

- *Site Examination* – the site was visited by Luke Wiles (a registered hydrologist), on the 16th February 2021 as part of the phase 1 assessment This enabled the author to gain a better understanding of the dominant hydrological flow regimes and confirm model inputs;
- *Baseline Assessment* – baseline climatic and hydrological data were sourced for the site. This included the interrogation of rainfall data, site specific design rainfall (depth/duration/frequency), evaporation, average climate, topography, as well as a regional and local hydrology; and
- A technical report detailing the achieved scope of work.

[1] Phase 1, a 19.9MW PV facility with a 22kV Overhead power line and 100MWh Battery Energy Storage System (BESS) as previously assessed through a Basic Assessment Process).

1.3 REGIONAL SETTING AND LAYOUT

The proposed site is located at approximately 26° 17' 30" S and 28° 21' 50" E. Figure 1-1 illustrates the regional setting of the proposed site, while Figure 1-2 presents the site boundary and associated properties for the proposed development.



Ergo
Phase 2
Withok/Brakpan
Tailings Complex Facility
West Park AH
Birch Acres
Van Riebeeck Park
Allen Grove
Kempton Park
Emaphopheni Ext 36
Etwatwa Ext 10
Etwatwa Ext 36
Etwatwa Ext 9
Etwatwa Ext 8
Etwatwa Ext 21
Daveyton
Farrarmere
Benoni
Germiston
Boksburg
Brakpan
Alberton
Springs
Selection Park
Daggafontein
Sundra
Welgedacht
Villa Liza
Katlehong
Tsietsi Phase 5
Zonkizizwe
Vorsterkroon
Nigel
Noycedale
Suikerbosrand Nature Reserve
Heidelberg
Rensburg
Gaborone
Pretoria
Johannesburg
Mbabane
Maputo
ESWATINI
Bloemfontein
Maseru
Durban
LESOTHO
SOUTH AFRICA
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c)
Figure 1-1
Regional Setting
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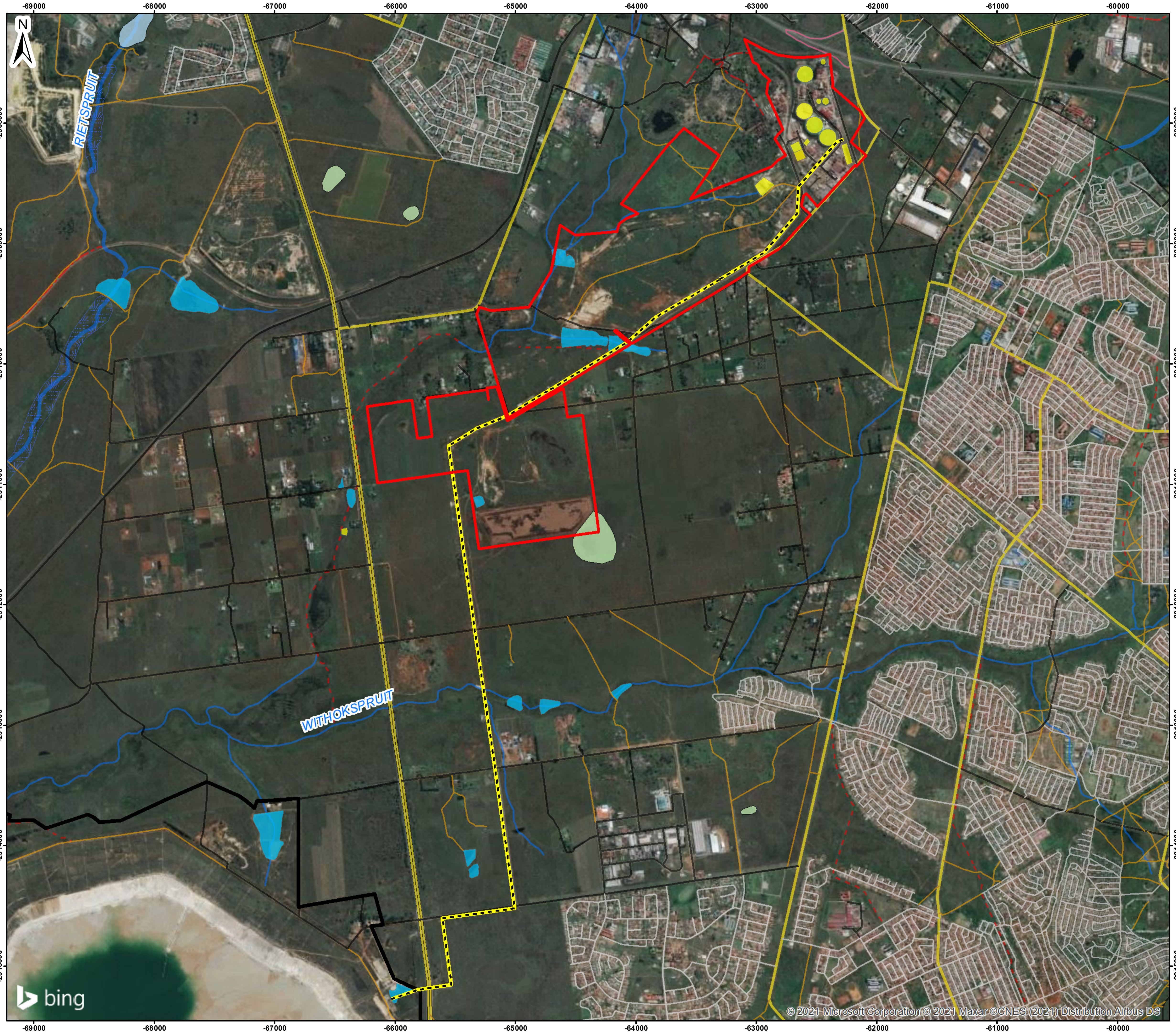
0 5 10 Kilometers
Scale: 1:288,000 @ A3
Projection: Geographic
Datum: WGS 1984
February 2022



Legend

- Boundary (Phase 2)
- Powerline
- Withok/Brakpan Tailings Complex Facility
- Arterial Road (50K Topo)
- Footpath (50K Topo)
- Main Road (50K Topo)
- On/OffRamp
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- Street (50K Topo)
- Dam (50K Topo)
- Non-perennial Pan (50K Topo)
- Open Reservoir (50K Topo)
- Perennial Pan (50K Topo)
- Vlei (50K Topo)
- Drainage Canal (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)

Figure 1-2

Layout

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0 1,000 Meters

Scale: 1:30,000 @ A3	Projection: Transverse Mercator Datum: Hartebeeshoek, LO29	February 2022

2 BASELINE INFORMATION

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

2.1 RAINFALL

Various weather stations managed by both the South African Weather Services (SAWS) and the Department of Water and Sanitation (DWS) were considered in this assessment. These, together with their proximity to the site can be seen in Figure 2-1. There are numerous SAWS stations located in relatively close proximity (10km radius) to the site, the closest of which to the proposed PV installation area is Station 476736W with a record length of over 96 years and a Mean Annual Precipitation (MAP) of 709mm. The nearest DWS station (C2E013) is located approximately 20km south of the site. The distance of this DWS station from the site and its associated short unreliable record length (2-3 years) render it unsuitable for use in this project. An additional more site-specific dataset was also utilised to assess site rainfall as described by Pegram *et al* (2016), rather than relying of a specific rain gauge which may, or may not be reliable or representative of rainfall at the site.

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. As such, an alternative and site-specific source of rainfall data was used to provide average monthly rainfall values for the actual site as per Pegram *et al* (2016). This eliminates any risk associated with relying on a single rainfall station which may or may not be representative of the site.

Pegram *et al* (2016) includes details on the development of a raster database of monthly rainfall data for Southern Africa. Table 2-1 presents the site specific average monthly rainfall estimates from Pegram *et al* (2016) indicating a MAP of 692mm, comparing well to the distribution of rainfall as illustrated in Figure 2-1, as well as SAWS station 476736W (709mm). Table 2-1 presents the average monthly rainfall estimates from Pegram *et al* (2016) for the site.

TABLE 2-1: AVERAGE MONTHLY RAINFALL DISTRIBUTION (MM)

Month	Pegram et al. (2016)
Jan	123
Feb	96
Mar	86
Apr	42
May	19
Jun	7
Jul	7
Aug	9
Sep	24
Oct	65
Nov	105
Dec	109
Total	**692**

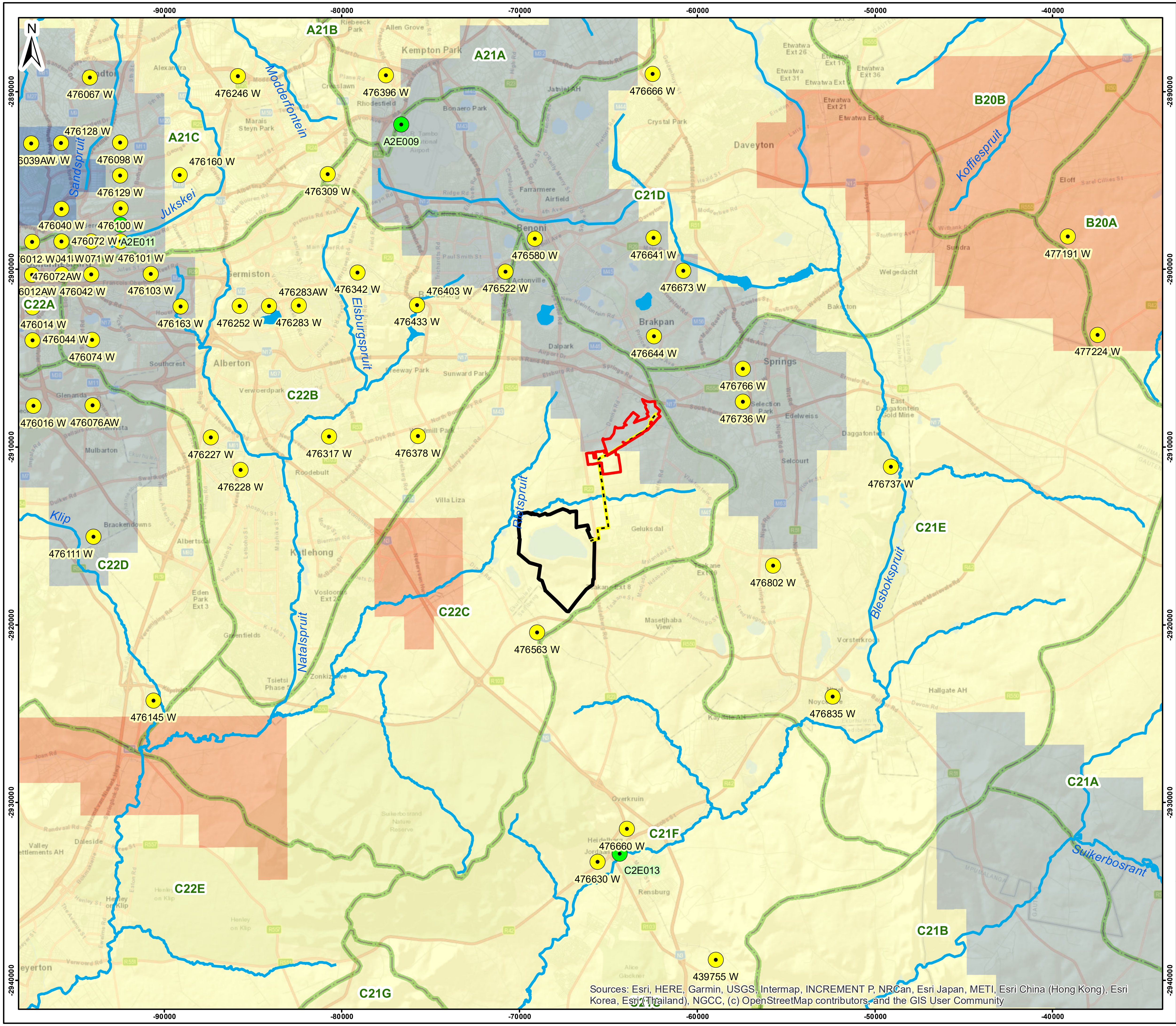

Figure 2-1

Weather Stations and Mean Annual Precipitation

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2.2 1-DAY DESIGN RAINFALL DEPTHS

Design rainfall estimates for various recurrence intervals and durations were sourced from the Design Rainfall Estimation Software for South Africa (DRESSA), developed by the University of Natal in 2002 as part of Water Research Commission project K5/1060 (WRC, 2002). This method uses a regional l-moment algorithm 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 (2002) provides more detail on this method of design rainfall estimation. Table 2-2 presents the average DRESSA design rainfall estimates for the site.

TABLE 2-2: DRESSA 24-HOUR RAINFALL DEPTH

Recurrence Interval (Years)	Rainfall Depth (24 hour) (mm)
2	60
5	83
10	100
20	118
50	145
100	167
200	192

It is important to note, that no allowances for climate change was included in this study. 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 potential evaporation. The average monthly evaporation distribution is presented in Table 2-3 and shows an annual potential evaporation of 2091mm.

TABLE 2-3: MONTHLY A-PAN EQUIVALENT POTENTIAL EVAPORATION

Month	Schulze & Lynch (2006)
Jan	216
Feb	177
Mar	177
Apr	145
May	123
Jun	102
Jul	114
Aug	156
Sep	202
Oct	230
Nov	221
Dec	228
Total	**2091**

2.4 AVERAGE CLIMATE

The average climate for the site is presented in Figure 2-2. While evaporation is illustrated 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. The combination of rainfall, evaporation and temperature result in a warm temperate climate with dry winters and warm summers according to the Köppen-Geiger climate classification[2].

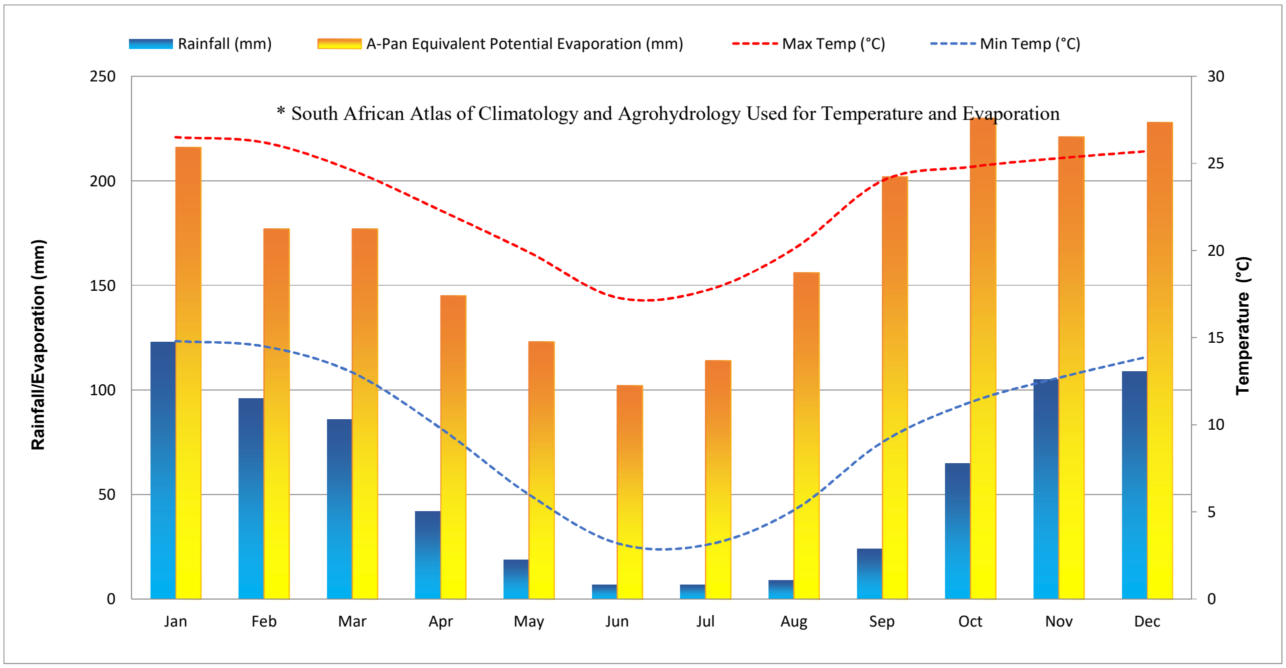


FIGURE 2-2: AVERAGE MONTHLY CLIMATE FOR THE SITE

2.5 TOPOGRAPHY

Two topographical (elevation) datasets were used for this study, namely:

- A 2m digital elevation model (DTM) ordered specifically for the project; and
- 30m AW3D30 (ALOS Global Digital Surface Model - DSM).

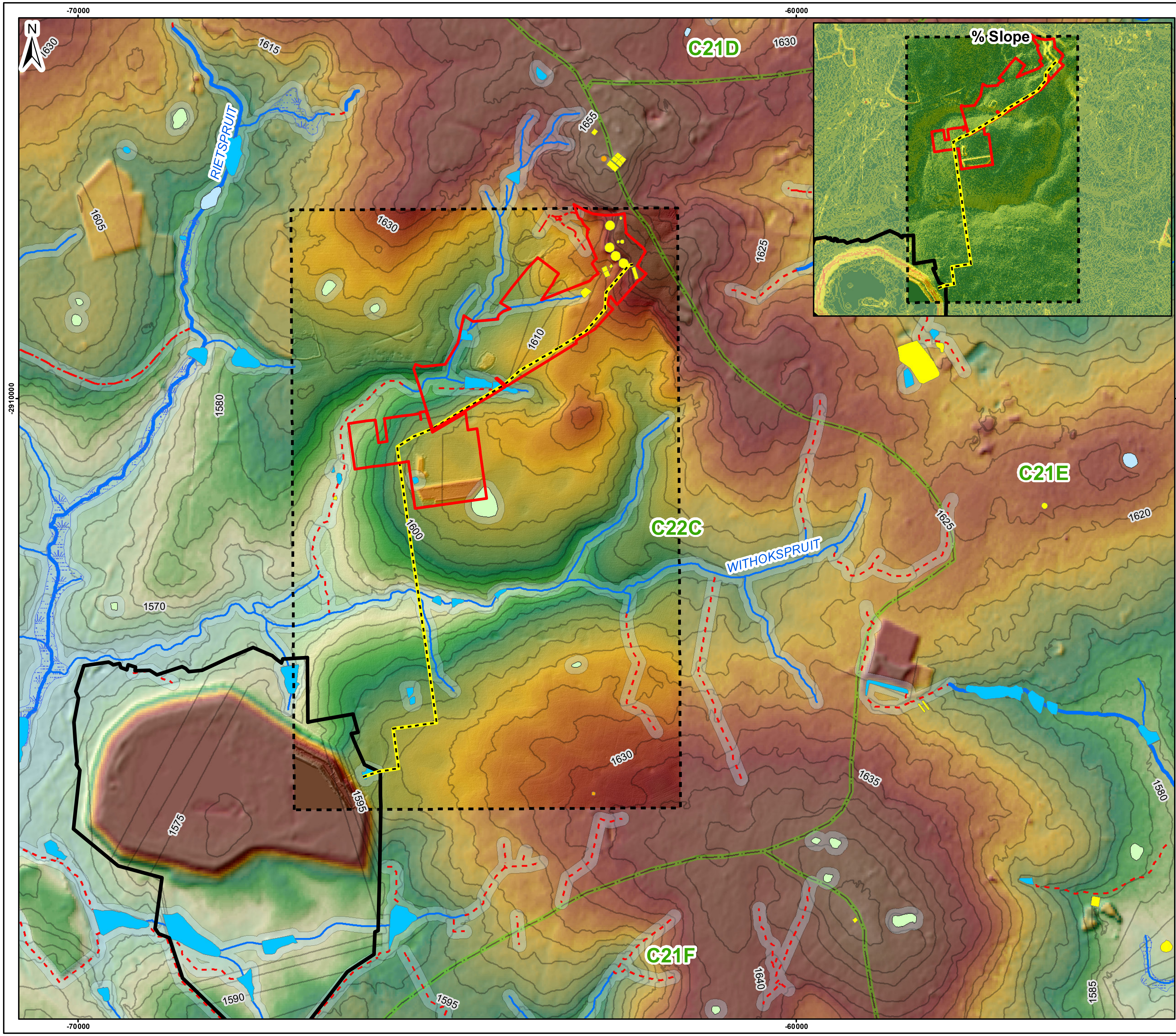
The 2m DTM provides a terrain (bare earth) dataset with a resolution of 2m and a vertical accuracy of 50cm and a horizontal accuracy of 1m. 95% of surface features (e.g. buildings and trees) taller than 1.5m are removed.

The 30m AW3D30 DSM provides continuous surface terrain (including buildings and vegetation) for the area not covered by the 2m DTM. Accuracy with regards to the DSM is reduced, with an elevation interval of 1m already indicating the maximum possible accuracy (of 1m vertical). Since the primary area of interest is largely covered by the 2m DTM, the use of the 30m DSM means that the results of this study area is largely unaffected by this less accurate DSM. Figure 2-3 presents the topography of the site.

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

2.6 HYDROLOGY

Figure 2-3 presents the hydrological setting of the site. The hydrology of the region is characterised by a mixture of perennial and non-perennial watercourses. The site falls within the upper reaches of quaternary catchment C22C of which the primary watercourse is the Rietspruit River. Drainage at the site is generally in a south-westerly direction into a combination of non-perennial streams, dams, as well as formalised furrows and drainage canals as defined by the NGI's 1:50,000 topographical map sheets. These then flow into the Withokspruit and subsequently the Rietspruit River as illustrated in both Figure 2-1 and Figure 2-3, with the latter also including 100m buffers on surface water features including streams, dams, canals and furrows.



Legend

- Boundary (Phase 2)
- Powerline
- Withok/Brakpan Tailings Complex Facility
- 2m DTM Extent
- 5m Contour (50K Topo)
- Closed Reservoir (50K Topo)
- Dam (50K Topo)
- Non-perennial Pan (50K Topo)
- Open Reservoir (50K Topo)
- Perennial Pan (50K Topo)
- Vlei (50K Topo)
- Drainage Canal (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)
- 100m Watercourse Buffer
- Quaternary Catchments

Percentage Slope

- < 3
- 3 - 10
- 10 - 30
- 30 - 50
- > 50

Elevation (mAMSL)

High : 1700

Low : 1550

Figure 2-3

Hydrology and Terrain

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0 1,000 2,000 Meters

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3 CONCLUSIONS AND RECOMMENDATIONS

A baseline hydrological assessment for the proposed solar development has been undertaken to support the application of appropriate environmental and water use authorisation processes. Baseline information including monthly rainfall, monthly evaporation, design event rainfall, as well as site topography and regional and local catchment hydrology were considered for the proposed development. Elevation data for the site was obtained in the form of a 2m DTM (bare earth) supplemented by a 30m AW3D30 DSM for areas not covered by the 2m DTM.

The hydrology of the region is characterised by a mixture of perennial and non-perennial watercourses. The site falls within the upper reaches of quaternary catchment C22C of which the primary watercourse is the Rietspruit River. Drainage at the site is generally in a south-westerly direction into a combination of non-perennial streams, dams, as well as formalised furrows and drainage canals as defined by the NGI's 1:50,000 topographical map sheets. These then flow into the Withokspruit and subsequently the Rietspruit River.

Flood buffers (100m) as well as flood lines for the 1:100 year recurrence interval event will need to be considered to inform the placement of proposed infrastructure. It is further recommended that a conceptual storm water management plan be developed once proposed infrastructure has been sited to ensure clean and dirty water can be managed accordingly. A surface water quality monitoring program can also be developed to ensure receiving surface water qualities are not detrimentally impacted through the establishment and operation of the proposed development.

Impacts relating to flood risk, the sedimentation and siltation of water courses as well as the alteration of the natural drainage patterns will need to be assessed during the impact assessment phase. The impact significance will be determined based on duration, extent, magnitude and probability of each considered impact. This will include details relating to cumulative impacts, residual impacts, reversibility as well as mitigation measures which can be considered to reduce impact significance.

All of the above considerations including flood line modelling, the development of a conceptual storm water management plan, surface water quality monitoring program, as well as the subsequent impact assessment will be undertaken according to governing legislation such as the National Water Act (Act 36 of 1998) and Government Notice 704 (Government Gazette 20118 of June) and used to inform and support the Water Use License (WUL) application.

Luke Wiles (MSc, PrSciNat) Mark Bollaert (MSc, PrSciNat)

Project Manager/Author/Reviewer Project Author

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