Floodline Delineation for the proposed Bushveld Vametco's Phase 2 Solar PV Park Project

Brits, North West Province

July 2023

CLIENT

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Report Name	**Floodline Delineation for the proposed Bushveld Vametco's Phase 2 Solar PV Park Project**
Submitted to	NSOVO Environmental Consulting
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Declaration

The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

Disclaimer

Findings, recommendations and conclusions provided in this report are based on the best available scientific methods and the author's professional knowledge as well as information at the time of compilation. The Biodiversity Company employees involved in the compilation of this report, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document - regardless of its application.

The modelled floodlines presented in this assessment are for indicative purposes only for the delineation of sensitive habitats, and not meant for any engineering designs - due to the course data used for modelling. As a result, the specialist cannot comment on any design aspects of a development such as potential heights a development should be raised to in order to avoid flooding. These aspects will require a certified engineer to comment on. No form of this report may be amended or extended without the prior written consent of the author and/or a relevant reference to the report by the inclusion of an appropriately detailed citation.

Declaration

I, Michael Ryan declare that:

- I act as the independent specialist in this assessment;
- I will perform the work relating to the assessment in an objective manner, even if this results in views and findings that are not favourable to the client;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this assessment, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the client 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 assessment by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Michael Ryan

Riverine Science and Hydrologist

(Cand. Sci. Nat. 125128)

The Biodiversity Company

July 2023

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1 Introduction

The modification of land use within a river catchment has the potential to degrade local water resources (Wepener *et al.,* 2005). Infrastructure which crosses or encroaches on a watercourse thus has the potential to negatively impact on local water resources and ecosystem services. For this reason conservation of these systems through habitat protection as well as an appropriate relationship between development and the mitigation hierarchy is crucial.

The Biodiversity Company (TBC) was appointed by Nsovo Environmental Consulting to undertake a floodline delineation as part of the Integrated Water Use License Application (IWULA) for the proposed for the Bushveld Vametco Energy Phase 2 Solar PV Park project near Brits, North West Province. The proposed 100 MW solar farm will occupy approximately 200 ha of the proposed site which occupies 400 ha. The property boundary for the Solar PV Park is presented in Figure 1-1.

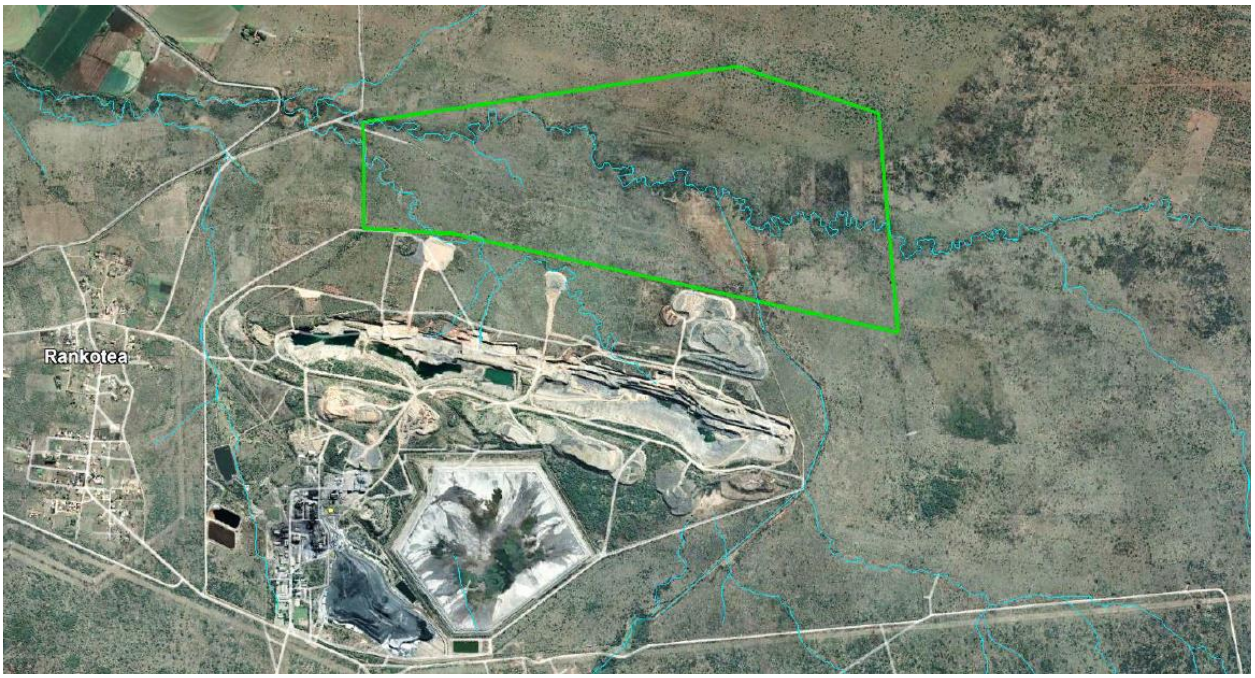

Figure 1-1: Google Earth imagery presenting project area locality and extent (green polygon = 400 ha)

The hydrological assessment aims to provide information to guide the construction and operation of the proposed Bushveld Vametco Energy Phase 2 Solar PV Park with respect to identifying sensitive habitat through the delineation of the attributed watercourses floodline. As part of this assessment, the following objectives were established:

- Delineation of the catchment drained to the proposed Solar PV Park;
- Determine the peak-run off for the watercourse at the proposed property boundary;
- Model the 1:50 and 1:100 year floodline for the watercourse; and
- Delineate the sensitive areas by taking other delineated habitat into consideration.

In order to achieve this a single freshwater survey was conducted on the 19th of May 2023, which constitutes an early wet season survey. The approach was informed by the Environmental Impact Assessment Regulations. 2014 (GNR 326, 7 April 2017) of NEMA. The approach has taken cognisance of the recently published Government Notices 320 (20 March 2020) in terms of NEMA, dated 20 March and 30 October 2020: "*Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation*" (Reporting Criteria).

This report presents the resultant delineated sensitive habitat after taking into consideration all aspects which constitute a watercourse. This report should be interpreted after taking into consideration the findings provided by the specialist herein. Further, this report should inform and guide the Environmental Assessment Practitioner (EAP) and regulatory authorities, enabling informed decision making, as to the ecological viability of the proposed project. The floodline delineation was completed in fulfilment to obtain a Water Use Licence (WUL) authorisation for the proposed solar facility and associated infrastructure for the project.

1.1 Overview of the Project

The second phase of the Vametco Hybrid Mini Grid project is being planned and will include the installation of a solar photo-voltaic (PV) plant up to 400 MW and a Vanadium Redox Flow Battery (VRFB) up to 200 MW/ 800 MWh. This phase of the project will enable Bushveld Vametco to produce most of their power and reduce the reliance on Eskom. The project will comprise of a solar field with the solar arrays and associated infrastructure including the VRFB's.

2 Project Area

Bushveld Vametco Holdings (Pty) Ltd (hereafter referred to as Vametco) is an open-cast mine situated approximately 5 km west of Ga-Rankuwa, and 10 km northeast from Brits town within the jurisdiction of Madibeng Local Municipality in the Northwest Province and has been operational since 1967. The mine is approximately 3.5 km long in an east-west direction and its Mining Right Area (MRA) is approximately 1507.7427 hectares (ha) in size. Vametco is regarded as a low-cost primary vanadium mining and processing company with a 186.7 metric tonnes (Mt) Joint Ore Reserves Committee (JORC) compliant resource averaging 1.98% vanadium pentoxide (V2O5) in magnetite grades (including 48.4 Mt in reserves). It utilises a well-established salt roast processing method to produce refined vanadium in the form of Nitrovan and Vanadium Oxide (NVO). The locality is presented in (Figure 2-2).

2.1 Hydrological Setting

The hydrological setting of the project area is presented in Figure 2-3. Vametco is situated in the A21J quaternary catchment, within the Limpopo Water Management Area (WMA - 1). These quaternary catchments were further divided by DWS into three smaller catchments as per Figure 2-1, with the project area located within the A21J2 catchment. The Vametco Solar Facility will be constructed in close proximity to the Rosespruit (A21J-00980 Sub Quaternary Reach) (SQR). The Rosespruit therefore forms the watercourse of focus flowing adjacent to the proposed development. The Rosespruit is a non-perennial river system. There are currently nine WMAs which were formed by consolidating the old nineteen WMAs, with the project area located within the old Croc (West) and Marico WMA (3). The Crocodile West and Marico WMA lies adjacent to the Botswana border to the north-west, predominantly within Limpopo. It is situated in a semi-arid part of the country with a mean annual precipitation of 400 to 800 mm. Its main rivers, the Crocodile and Marico Rivers, give rise to the Limpopo River at their confluence. The area is characterised by the urban and industrial complexes of northern Johannesburg and Pretoria and platinum mining north-east of Rustenburg, and activities include extensive irrigation development along the main rivers with grain, livestock and game farming. A substantial portion of the WMA water is transferred from the Vaal River with small transfers out of the WMA to Gaborone in Botswana and to Modimolle in the Limpopo WMA. Increasing quantities of effluent return flow from urban and industrial areas is a major cause of pollution in some rivers (StatsSA, 2010).

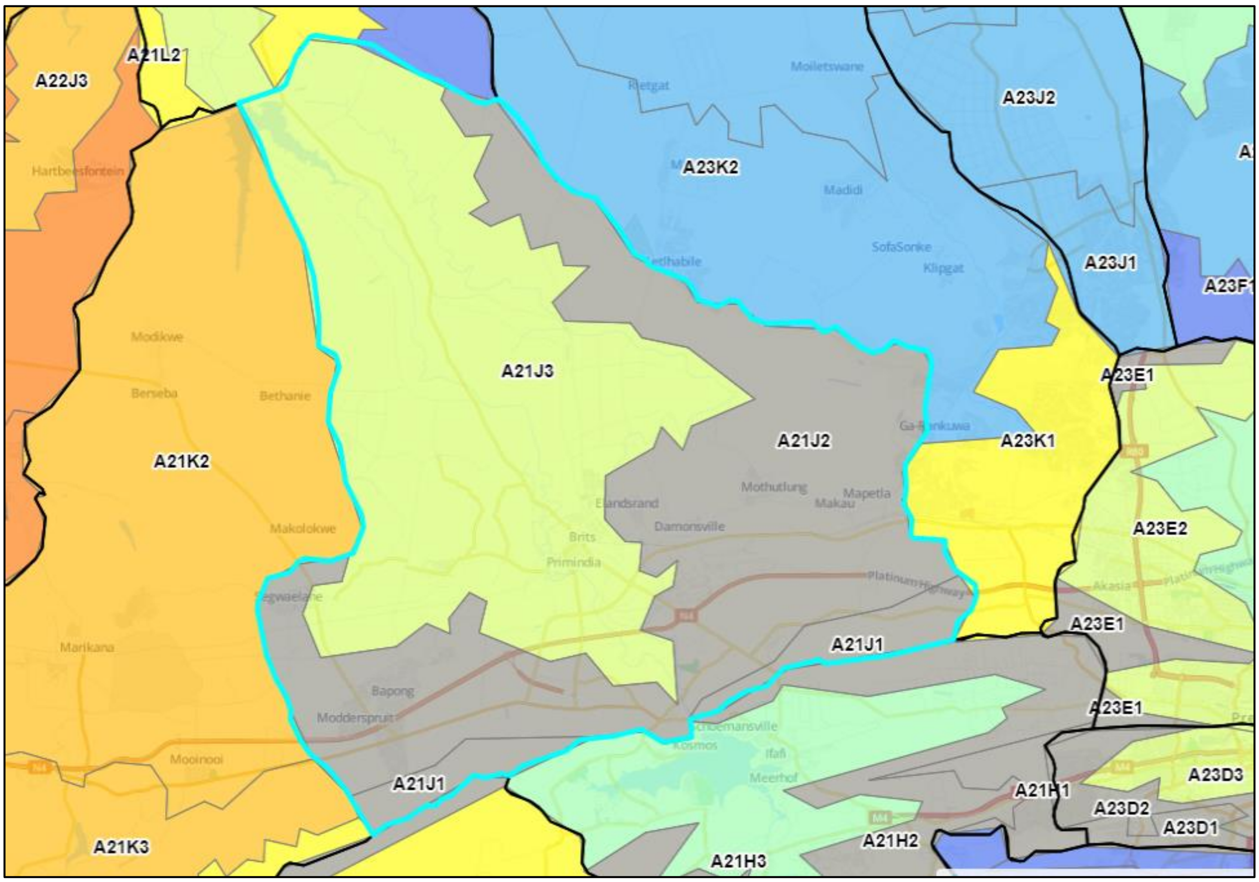

Figure 2-1: DWS (2023) divided quaternary catchments for the project area

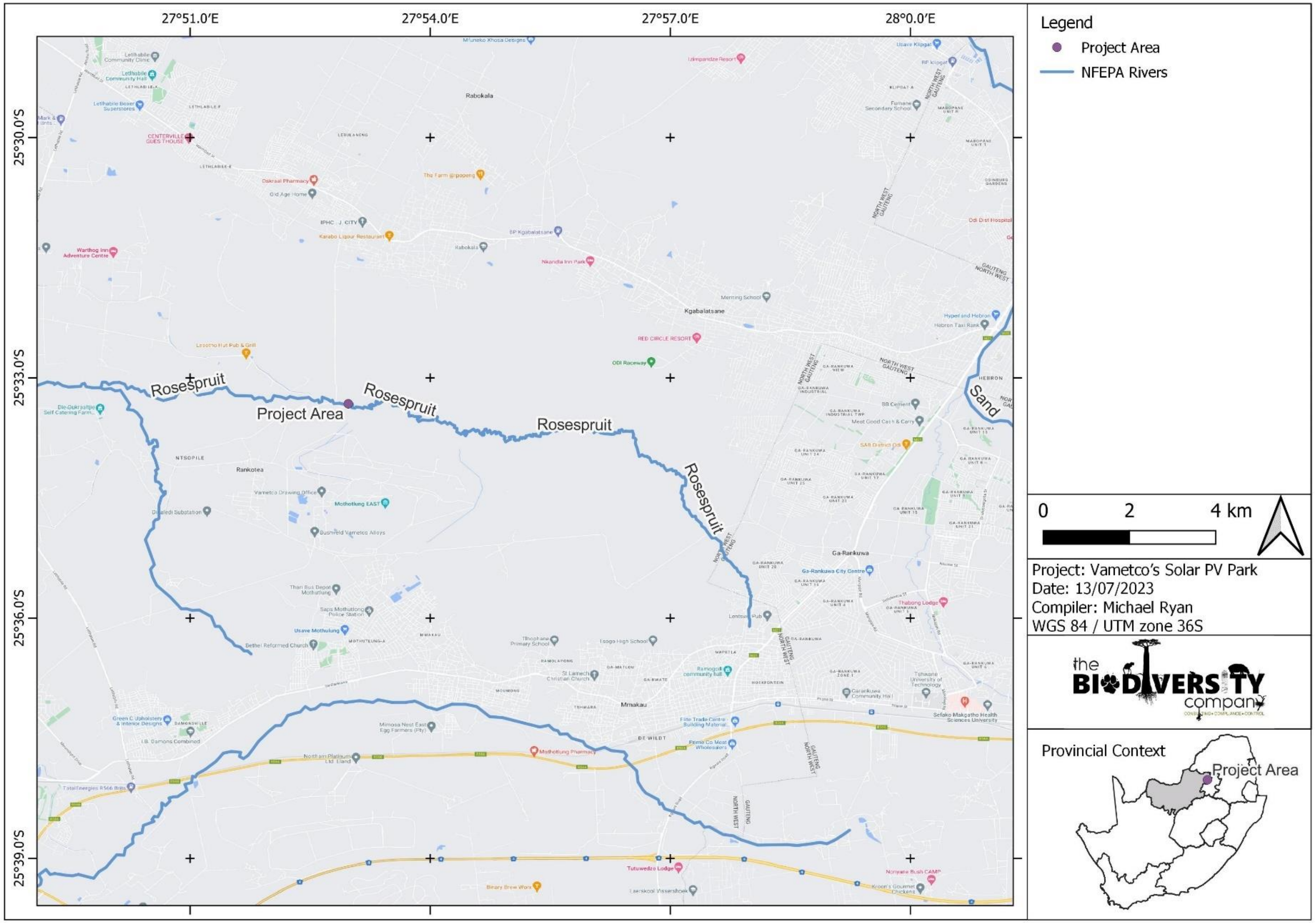

Figure 2-2: The location of the proposed Vametco's Phase 2 Solar PV Park Project

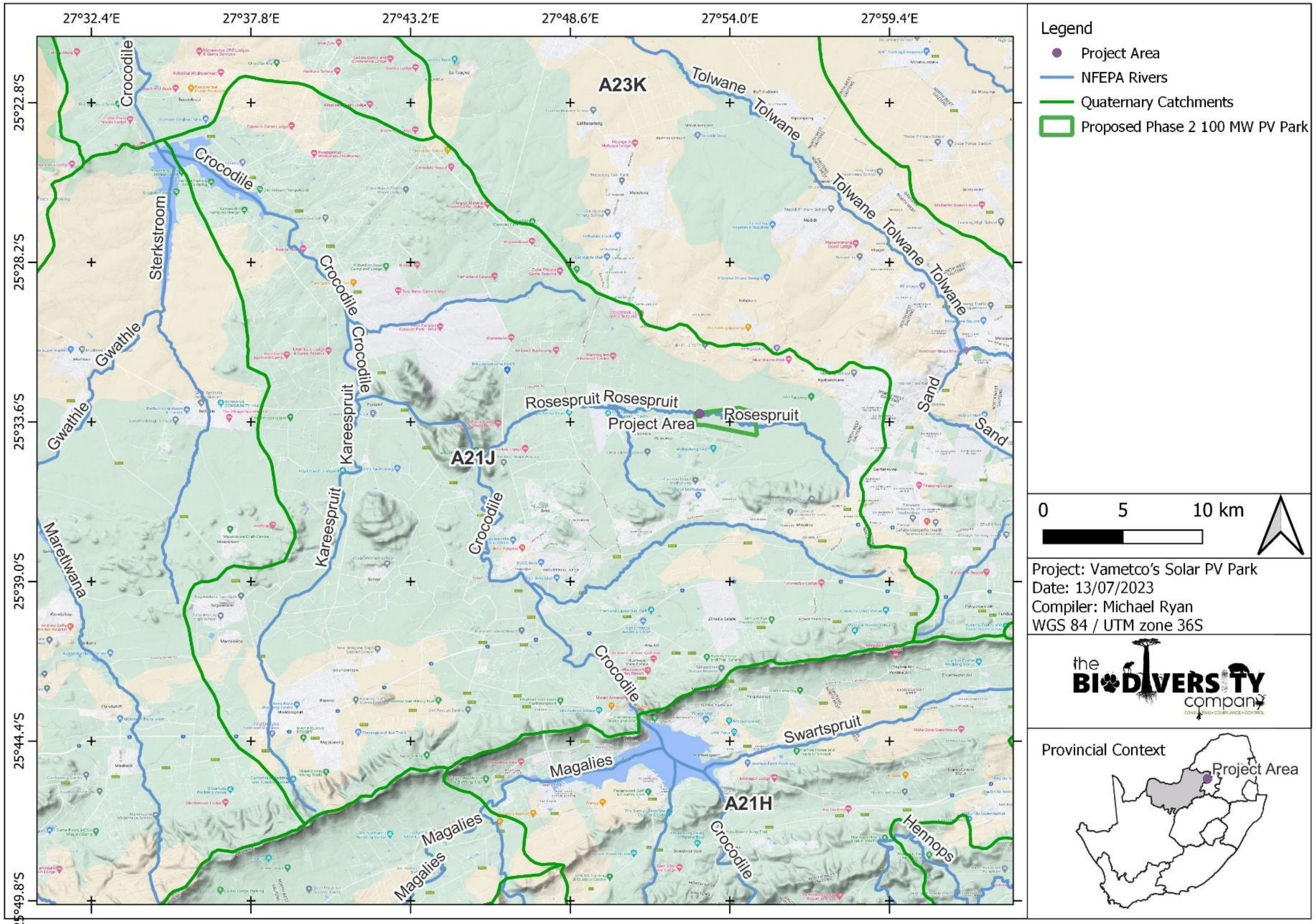

Figure 2-3: Hydrological context of the project area

3 Methodology

3.1 Hydrology

3.1.1 Flood Hydrology

The hydrological assessment completed in this determination was set out in line with the standards and methods stipulated in the SANRAL drainage manual (SANRAL, 2013). Based on the practical guidelines for the relevant catchment areas the following inputs were required for the peak flood calculations:

- Catchment Area;
- Slopes;
- Run-off characteristics;
- Land use, land type and underlying lithology;
- Mean annual precipitation;
- Mean annual evaporation;
- Longest flow paths;
- Catchment centroids; and
- Local hydraulic structures.

The supporting software Utility Programs for Drainage was utilised for the calculations of the various flood peaks in the appropriate 1:50 and 1:100 return periods. Data from the following sections below were used in the model to calculate the attributed peak flows.

3.1.2 Storm Rainfall Depths

Through the available software, Design Rainfall Estimation in South Africa (version 3), the storm rainfall depths were derived with data presented in Smithers and Schulze (2002). The method makes use of the rainfall stations near the project area. The storm rainfall depths for various return periods and storm durations were then calculated for the project area using the abovementioned software.

3.1.3 Elevation Data and Catchment Area

Topographic factors such as catchment size, slope, stream patterns and shape are known to have an impact on the nature of flood events. Steeper catchments may have higher flood peaks over a shorter critical duration, whereas a gentle catchment topography produces longer duration flood peaks (SANRAL, 2013).

Relief data was obtained for the 2629CA Quarter Degree Square dataset from the Department of Rural Development and Land Reform. The contour interval for this data was presented at 10 m. The clipped contour data was used to create a Triangular Irregular Network (TIN) which was used to create a Digital Elevation Model (DEM) for the catchment associated with the project area.

In addition to this topographic elevation data, the Advanced Land Observing Satellite (ALOS) elevation profiles were obtained. Elevation data created from the 10 m contours and ALOS elevation profiles was interrogated to form an assessment on which data source would provide comprehensive elevation profiles for the required terrain models.

Standard ArcGIS 10.5 hydrology tools were then used to generate the watersheds for the specific watercourses considered in this determination. The catchment characteristics were defined based on the ArcGIS methods stipulated in Gericke and du Plessis (2012). These characteristics included catchment slope, watercourse length and slope, longest flow path and catchment centroid.

3.1.4 Land Cover and Soils

Land cover types and lithology affects the rates of infiltration and runoff within a catchment. Land cover and soil coverages were used during the peak flow calculations. The land cover of the immediate project related catchment area upstream of the lowest point in the modelled river was assessed during the floodline determination. In addition, land cover classes from the 2013 – 2014 South African National Land-Cover dataset (Geoterraimage, 2015) and Google Earth imagery was also utilised to calculate the overall catchment land use coverages. Generalised soil coverages for the catchment area were derived based on the Land Type and Capability dataset from the Agricultural Resource Council – Institute for Soil, Climate and Water (ARC. 2014).

3.1.5 Manning's n Roughness Coefficients

The mannings n roughness was estimated for the project area based on Chow (1959) and supplemented with data presented in Arcement and Schneider (1989).

3.1.6 Hydraulic Structures

No hydraulic structures or storage was considered in this floodline or hydrological assessment.

3.1.7 Peak Flow Calculations

Peak flow calculations were completed through the Utility Drainage Programme software. Rational Method, Rational Method (alternative), Unit Hydrograph, Standard Design Flood (SDF) and Empirical methods were used to assess the peak discharge for the 1:100 and 1:50 flood periods for the watercourses associated with the project area (SANRAL, 2013).

3.1.8 Software Used

- ArcGIS 10.5 is a Geographical Information System (GIS) software programme used to view, edit, create and analyse geospatial data. ArcGIS was used to view spatial data and to create maps. Its extension 3D Analyst was used for terrain modelling purposes, for converting the elevation data into Digital Elevation Model (DEM) grid format;
- HEC GEORAS hydraulic model utilises the ArcGIS environment and is used for the preparation of geometric data (cross-sections, river profile, banks and flow paths) for input into the HEC-RAS hydraulic model. It is further used in post processing to import HEC-RAS results back into ArcGIS, to perform flood inundation mapping (US Army Corps of Engineers, 2021);
- Design Rainfall Estimation in South Africa (version 3);
- Utility Programme for Drainage (Van Vuuren and Van Dijk, 2017) Version 1.1.0; and

- HEC-RAS 5.0.7 (Brunner, 2010) was used to perform hydraulic modelling. HEC-RAS is a programme used to perform one/two-dimensional calculations for a range of applications.

3.1.9 Hydraulic Model Setup

The hydraulic model considered in this assessment was completed using the standard procedures stipulated in the HEC-RAS 2D Modelling User's Manual (US Army Corps of Engineers, 2016). The HEC-RAS 5.0.7 application was updated with functions in the RAS-Mapper which allows for the comprehensive construction of 2 and 1 dimension models and these were utilised. Considering that floodplain modelling and not specific 1 dimensional elevation was required for this assessment, the 2 dimensional model was used. Development of the hydraulic model included the following steps:

- Derivation of the 2 dimensional perimeter and refinement area (Figure 3-1);
- Establishment and enforcement of break-lines;
- Generation of 2 dimensional grids (50 m^2);
- Construction of internal and external boundary conditions; and
- Construction of a 1 dimensional cross sectional area for hydrograph generation at a location 500 m upstream of the proposed crossing structure (Figure 3-2).

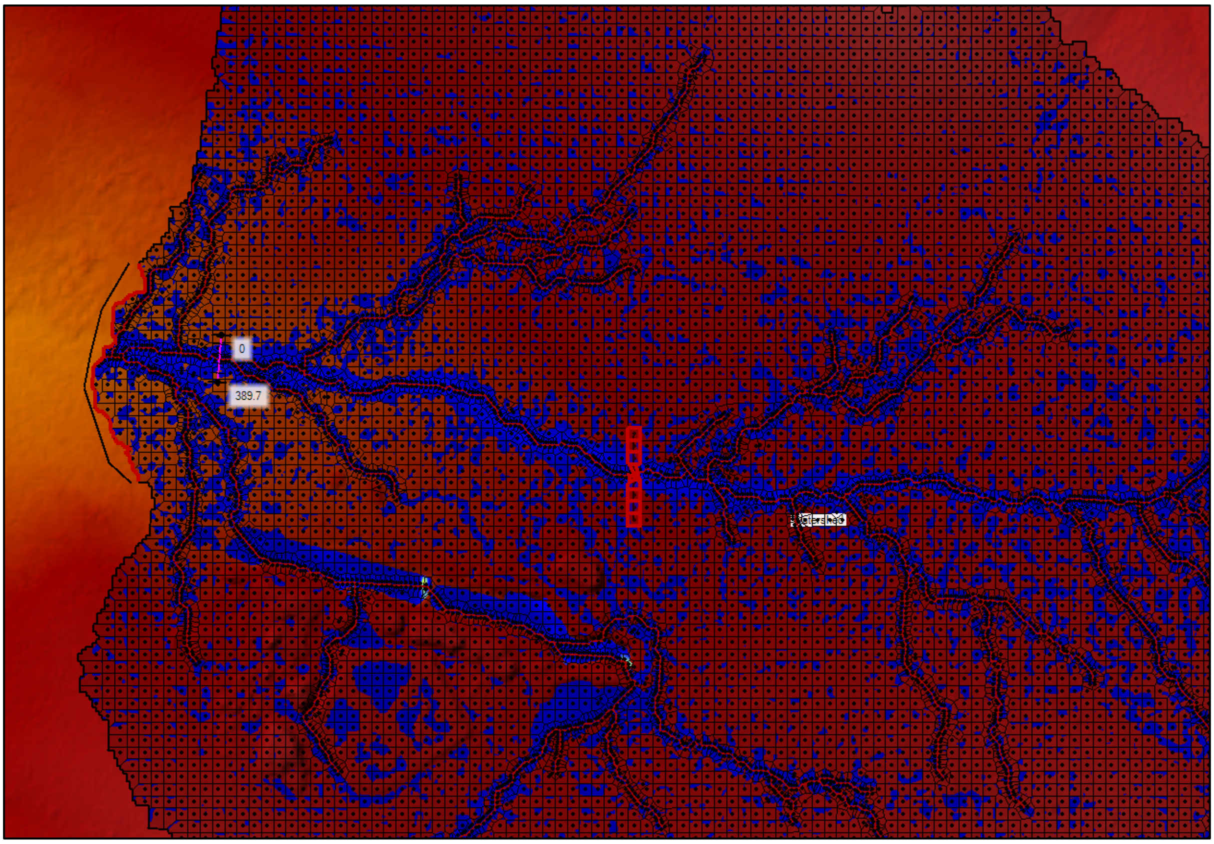

Figure 3-1: Extract of a typical 2 dimensional model completed in this assessment

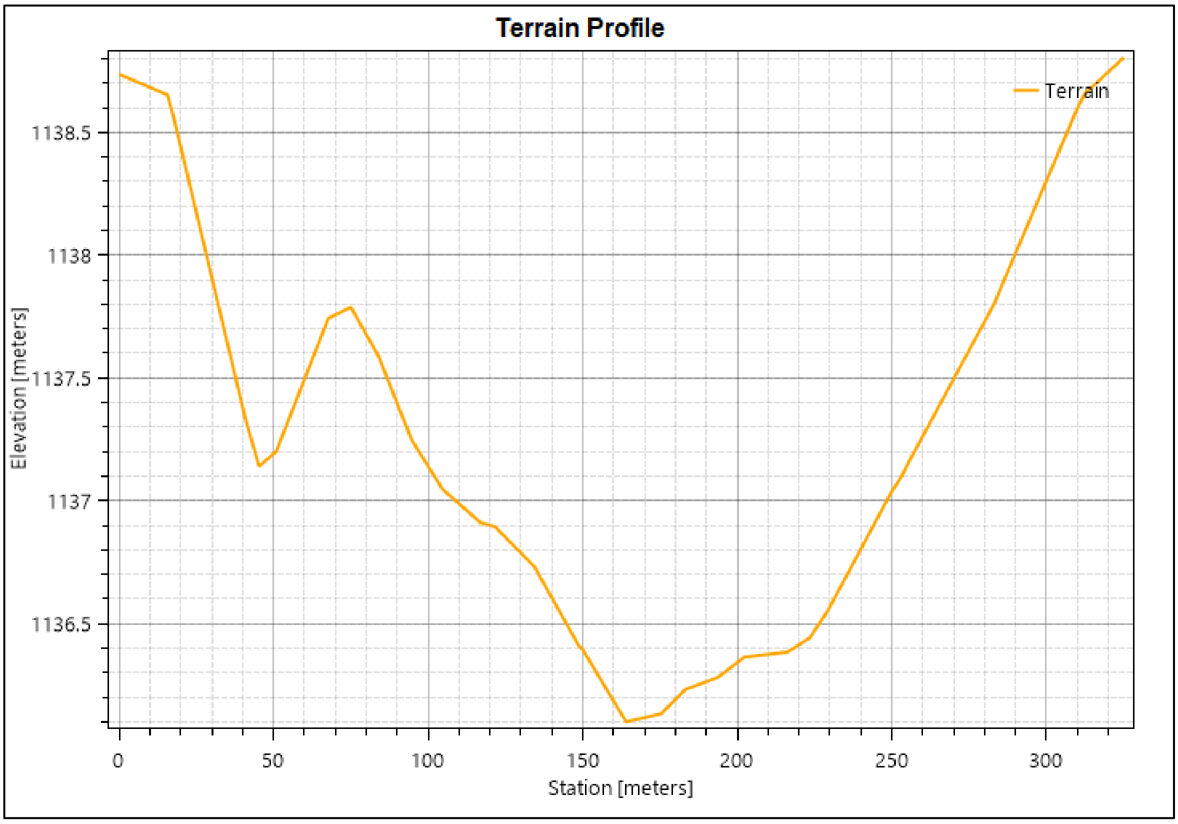

Figure 3-2: Established 1 dimensional cross section exert at 500 m upstream along the Rosespruit

A direct precipitation 2 dimensional unsteady flow simulation was completed for the floodline delineation. Precipitation volumes were obtained directly from the storm rainfall depths in Smithers and Schulze (2002). Based on the relevant time of concentration values derived for each watercourse considered in this assessment, design storm events were calculated and simulated.

Following the completion of the simulation, discharge volumes at the prescribed 500 m cross section upstream were utilised to calibrate the model to be in line with the calculated peak flows as per Section 6.4 of this report. These hydrographs represent the channel flow within the Rosespruit at the project area which the peak flow was calculated at. An example of the discharge rates and specified design flood hydrograph are presented in Figure 3-3. Following the completion of the simulation and calibration of the model, flood inundation extents were calculated and exported as presented in the results section of this assessment.

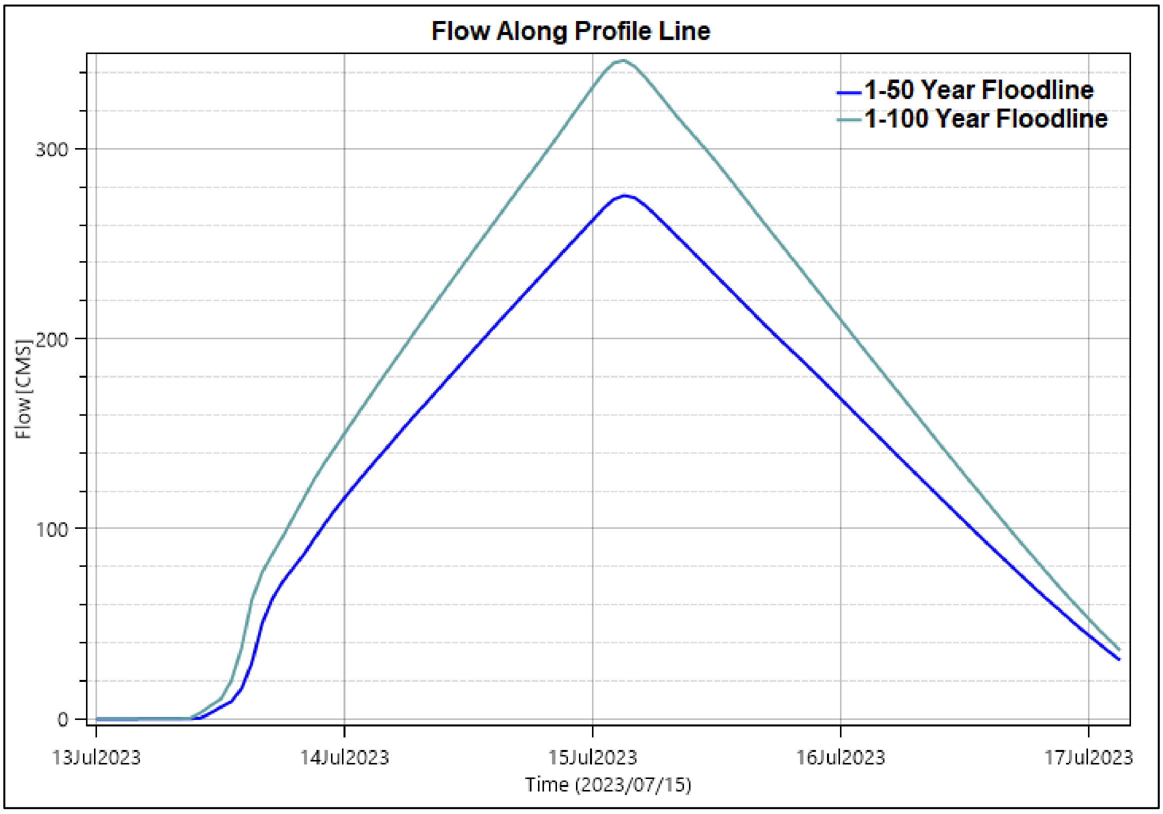

Figure 3-3: Design flood hydrograph for a cross section 500 m upstream of the project area

3.2 Limitations and Assumptions

The following limitations and assumptions are applicable:

- It is assumed that all information received from the client is relevant and correct;
- No water storage facilities (dams) were modelled upstream or downstream of the project area;
- No flood protection infrastructure was modelled;
- No wetland or riparian delineations were available for the total sensitivity map/ master layout. This map was therefore not produced;
- The floodline presented should only be used for indicative and environmental planning purposes, and not for detailed engineering designs, unless signed off by a suitably qualified and registered engineer;
- The floodline presented must only be considered within the 500 m regulated area up and downstream of each crossing point. This is the location where the flow hydrograph was calibrated. No detailed contour data (<1 m) was available for the modelling of the entire catchment areas and watercourse channels considered in this assessment with the information available restricted to the immediate crossings;
- No hydraulic structures such as weirs or culverts were considered in this assessment;
- The floodline areas modelled in this assessment should be interpreted with caution; given the overall low resolution elevation data utilised; and
- Data presented in the hydrological model represents a naturalised catchment.

4 Desktop Assessment

4.1 Catchment Description

4.1.1 Sensitivity

This approach has also taken cognisance of the recently published Government Notice 320 in terms of NEMA dated March 2020: "Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for Environmental Authorisation" (DWS, 2020). The National Web Based Environmental Screening Tool (NWBEST) has characterised the aquatic sensitivity of the project area as "very high" - requiring an assessment (Figure 4-1). The very high status was attributed due to the presence of NFEPA wetland and estuaries in the form of Central Bushveld Bioregion (Valley-bottom wetland). The Watercourse is also classified as an ecosystem support area (ESA1). The freshwater ecology of the immediate project area and further downstream areas are considered sensitive to disturbance from a hydrological and biological perspective. This will include all watercourses within the project area which are considered sensitive due to their relatively small spatial scale when compared to terrestrial habitat with a large demand for the ecosystem services which they provide for both aquatic and terrestrial biota.

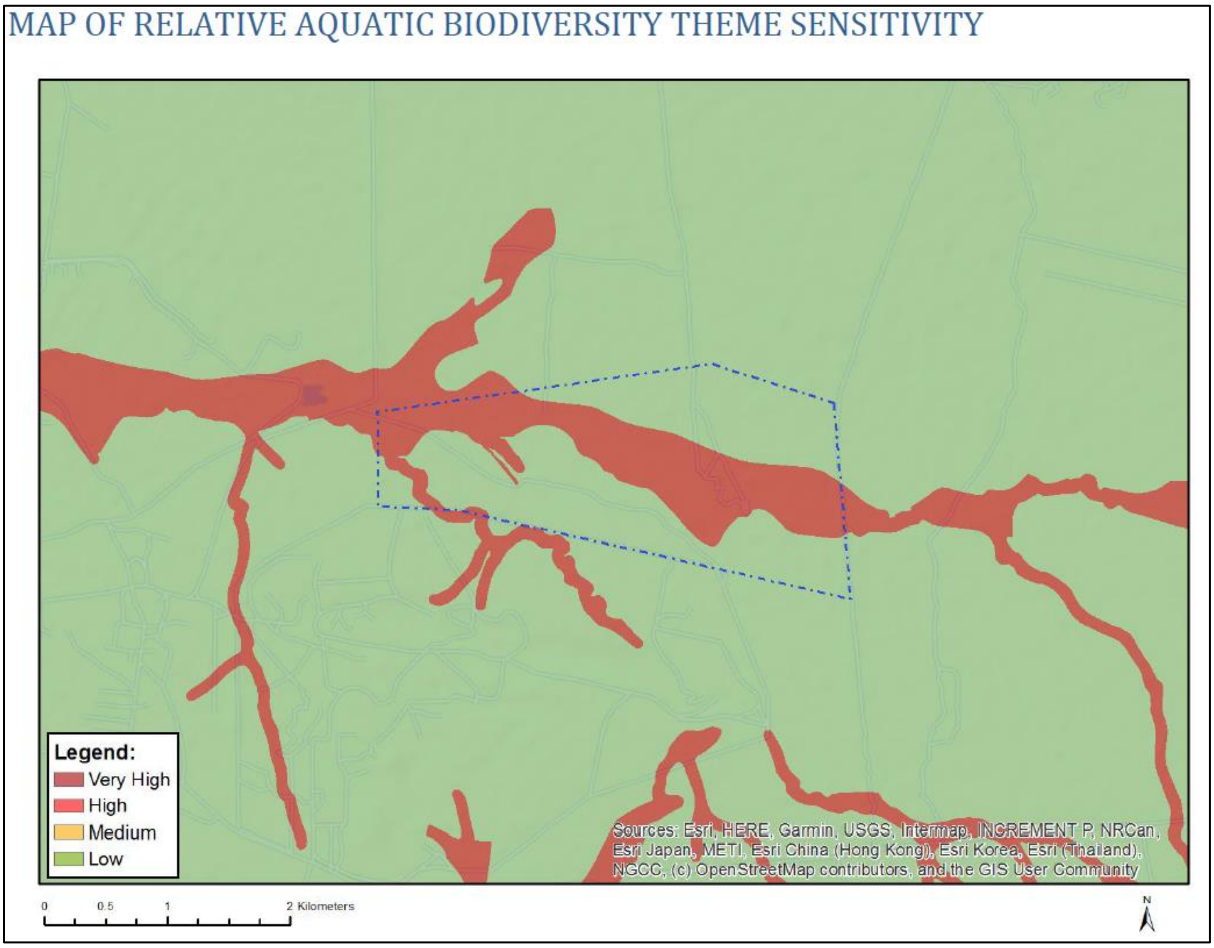

Figure 4-1: Aquatic Biodiversity Theme Sensitivity, Screening Report

4.1.2 Topography and Drainage

The delineated catchment forms part of the Rosespruit system adjacent the proposed Vametco's Solar facility. The topography of the delineated catchment varied from 1401 metres above mean sea level (mamsl) in the south at the source of the river to 1118 mamsl in the west of the catchment, downstream of the Solar facility. The catchment can be categorized as a very gentle terrain with an average catchment slope of approximately 0.01% (Figure 4-3). The river elevation profile for the Rosespruit is represented in Figure 4-2, which indicates the uniform gradient of the watercourse. The height difference along 10-85 slope and equal area slope are presented on the river profile. All details pertaining to river gradient and relevant stream lengths are provided in Table 5-2.

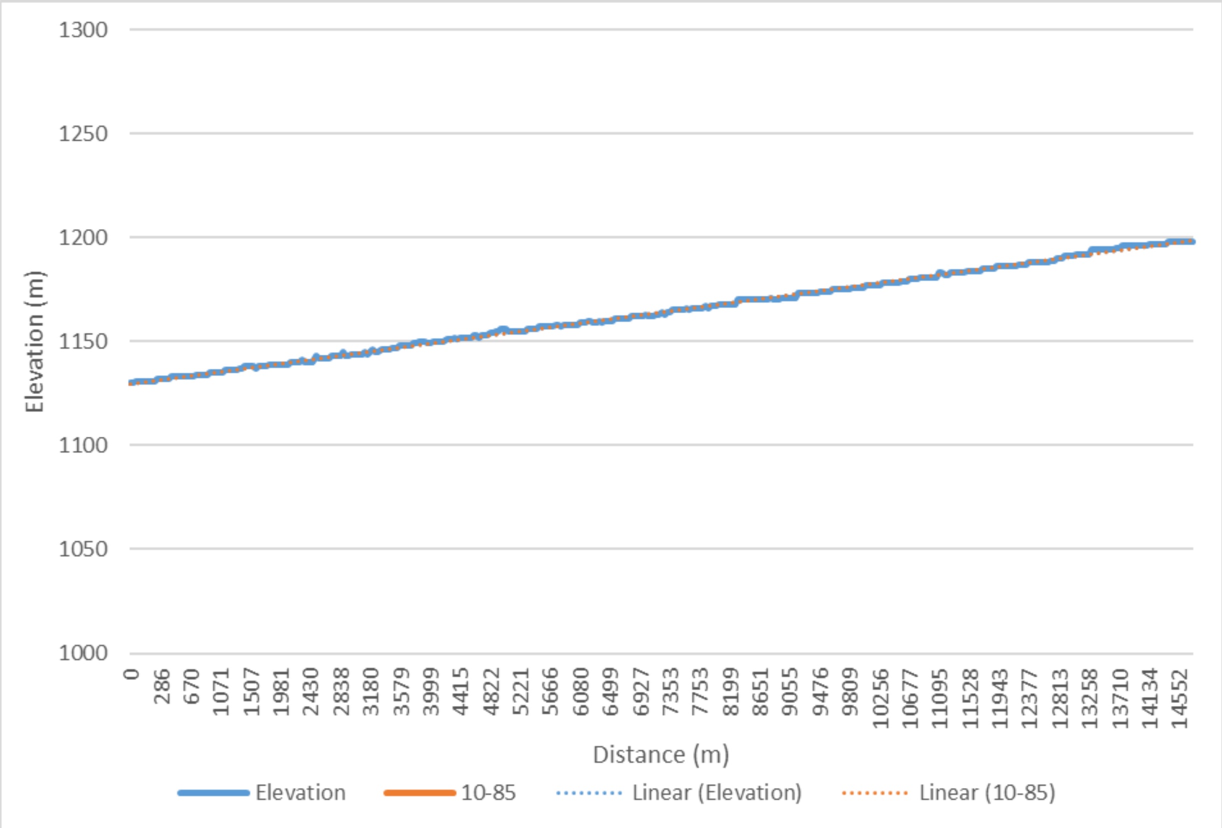

Figure 4-2: River profile of the Rosespruit upstream of the project area

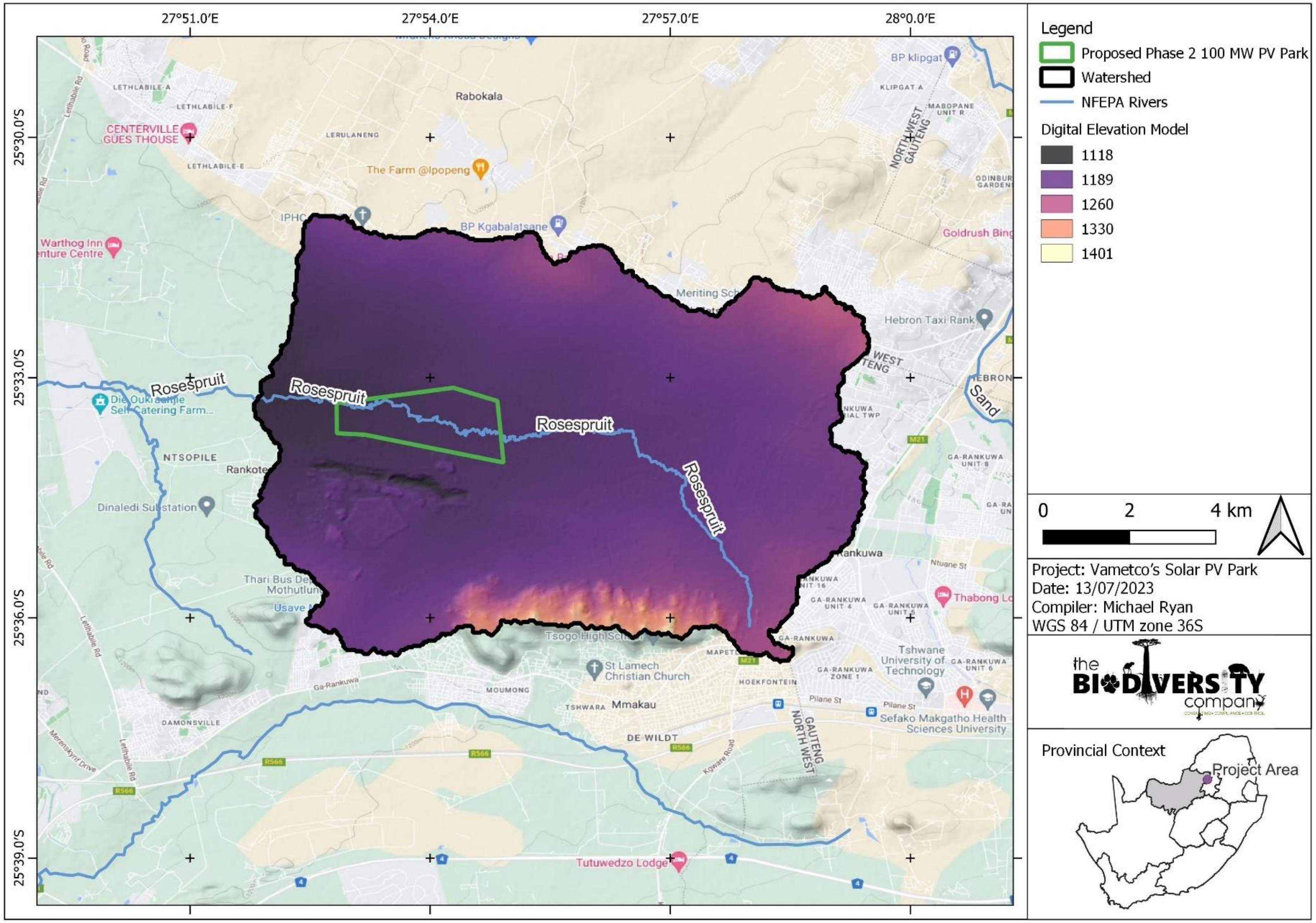

Figure 4-3: Digital Elevation Model for the respective catchment considered in this determination

4.1.3 Rainfall

The nearest weather station to the project area is the De Rust @ Hartbeespoort Dam station (A2E001) located at 25º44'54"S 27º49'56"E – 21 km south of the project area. The station has a temporal scale from 1926 to present and makes use of the NOTAPP calibration type. The monthly rainfall data from this station is presented in Figure 4-4. The closest major town to the project area is Brits, which has a MAP of 629 mm, receiving little rainfall throughout the year. Precipitation is the lowest in July (winter). The high rainfall period occurs in summer between December and February, with January the highest rainfall. The climate was considered warm and temperate which is classified as BSh (B – Dry, S - Semi-Arid or steppe, h Hot) in the Köppen-Geiger climate classification (Climatedata, 2023). The average temperature was 19.4°C associated to mostly cooler temperate climates.

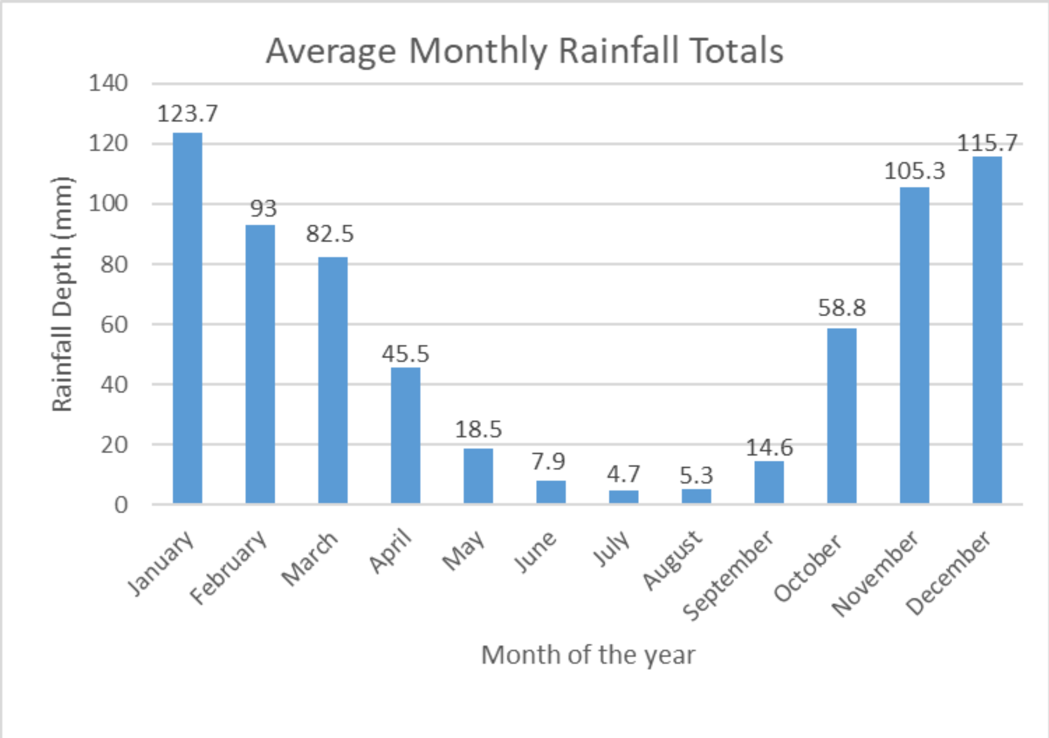

Figure 4-4: Monthly rainfall data from the De Rust @ Hartbeespoort Dam station (A2E001)

Figure 4-5 represents the catchment rainfall and the modelled future impacts of climate change on the rainfall trends for the A21J catchment. These diagrams indicate the average rainfall attained from historic data for the period of 1975 to 2006 which shows a MAP of 637.88 mm with a projected 1.1% decrease by 2045.

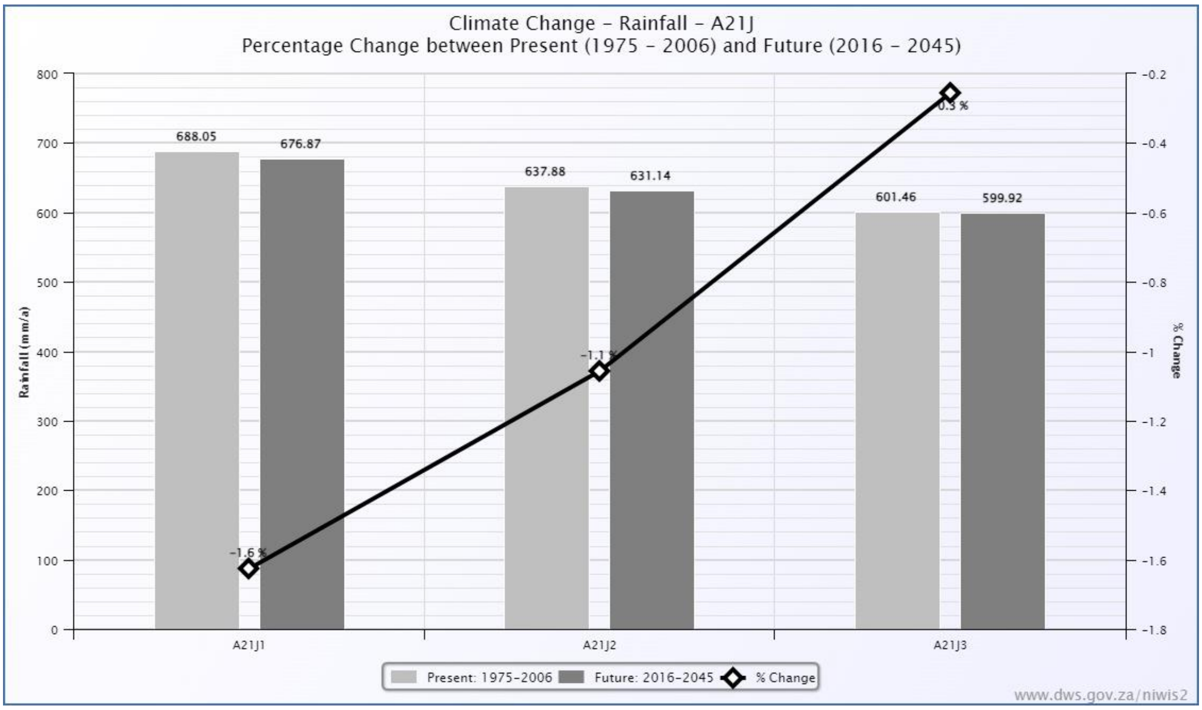

Figure 4-5: MAP for A21J catchment and predicted future change (DWS, 2023)

4.1.4 Storm Rainfall Depths

The storm rainfall depths for the centre position of the project area were extracted from the Design Rainfall Estimation in South Africa software programme (Smithers and Schulze, 2002). The programme uses the six closest rainfall stations to the specified project area. The rainfall stations used for this project area are indicated in Table 4-1. The gridded storm rainfall depths for the contributing catchment at the various return periods and storm durations are indicated in Table 4-2.

Table 4-1: Six Closest rainfall stations to the project area

Station Name	Station No.	Distance (km)	Record (Years)	Latitude	Longitude	MAP (mm)	Altitude (mamsl)
Mamagalieskraal Suid (IRR)	0512602_W	4	63	25°32'S	27°51'E	636	1122
Hartebeespoort-Agrc.	0512545_A	8	83	25°35'S	27°49'E	638	1150
Hartebeespoort (AGR)	0512545_W	8	79	25°35'S	27°49'E	638	1150
de wildt (POL)	0512757_W	9	36	25°37'S	27°56'E	634	1238
Mamogaleskraal	0512481_W	11.4	76	25°31'S	27°47'E	623	1145
Greylingspost	0512787_W	11.5	56	25°38'S	27°57'E	629	1238

Table 4-2: Storm Rainfall Depths for the Catchment

Storm Duration	Return Period / Storm Rainfall Depth (mm)						
min / hr / day	1:2 yr	1:5 yr	1:10 yr	1:20 yr	1:50 yr	1:100 yr	1:200 yr
5 min	9.5	12.9	15.4	17.9	21.4	24.2	27.2
10 min	14.2	19.2	22.9	26.6	31.8	36	40.5
15 min	17.9	24.3	28.9	33.6	40.1	45.4	51
30 min	22.6	30.7	36.5	42.5	50.8	57.5	64.6

Storm Duration	Return Period / Storm Rainfall Depth (mm)						
45 min	26	35.3	42	48.8	58.3	66	74.2
1 hr	28.6	38.9	46.3	53.8	64.3	72.8	81.8
1.5 hr	32.9	44.7	53.1	61.8	73.9	83.6	94
2 hr	36.3	49.2	58.6	68.1	81.5	92.2	103.6
4 hr	42.6	57.9	68.8	80.1	95.7	108.4	121.8
6 hr	46.8	63.6	75.7	88	105.2	119.1	133.8
8 hr	50.1	68	80.9	94.1	112.5	127.3	143.1
10 hr	52.7	71.6	85.2	99.1	118.5	134.1	150.7
12 hr	55	74.7	88.9	103.4	123.6	139.9	157.2
16 hr	58.8	79.9	95	110.5	132.1	149.6	168.1
20 hr	62	84.1	100.1	116.4	139.2	157.6	177.1
24 hr	64.7	87.8	104.5	121.5	145.2	164.4	184.7
1 day	53.8	73	86.9	101	120.8	136.7	153.6
2 day	66.2	89.9	106.9	124.3	148.7	168.3	189.1
3 day	74.8	101.5	120.7	140.4	167.9	190.1	213.5
4 day	81.3	110.4	131.3	152.7	182.6	206.7	232.2
5 day	86.8	117.8	140.1	162.9	194.8	220.6	247.8
6 day	91.5	124.2	147.8	171.8	205.4	232.6	261.3
7 day	95.7	129.9	154.6	179.7	214.9	243.3	273.3

4.1.5 Evaporation

The DWS (2023) National Integrated Water Information System was consulted for potential evaporation rates. The A21J quaternary catchment has an average potential evaporation as well as modelled future changes as presented in Figure 4-6. This data was also compared to that of the Water Resources of South Africa (2012) assessment. This indicated a 1728.93 mm/a evaporation rate for the A21J2 catchment with a projected 10.70% future increase by 2045.

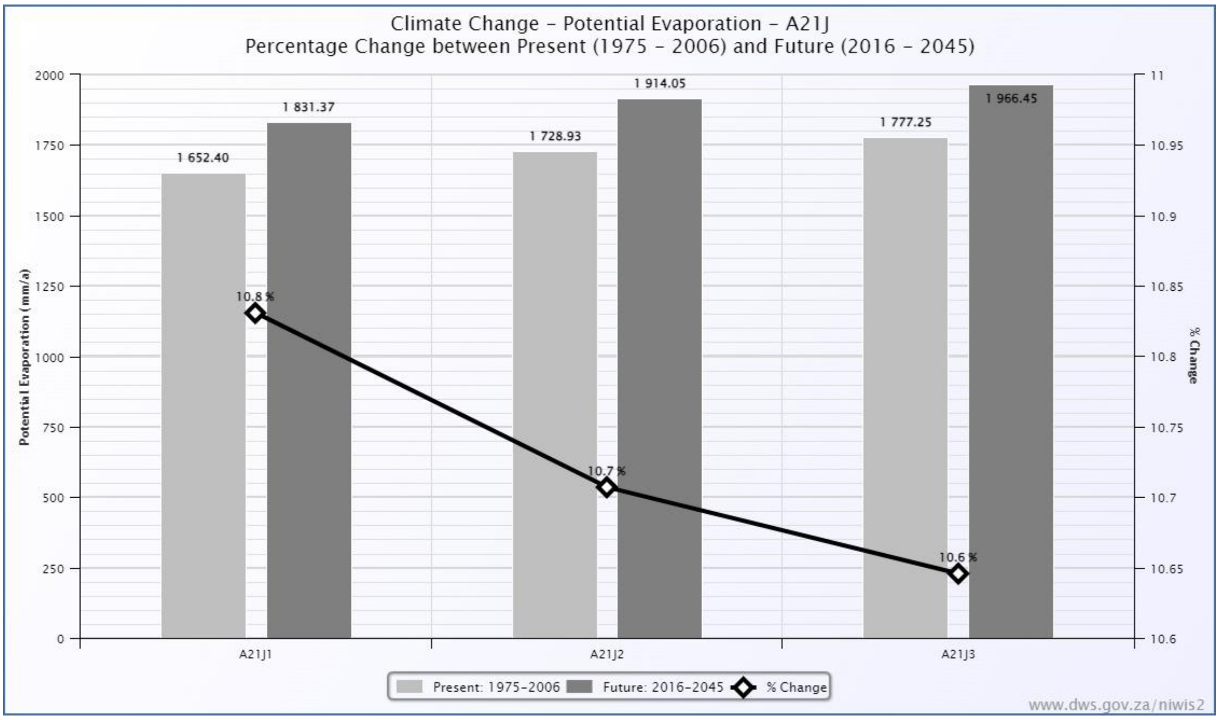

Figure 4-6: Potential Evaporation change for the A21J catchment (DWS, 2023)

4.1.6 Mean Annual Runoff

Mean Annual Runoff (MAR) was considered for the Rosespruit. The reach forms part of the watercourse network which flows through the A21J quaternary catchment. The catchment does however consider more stream networks than just the Rosespruit watercourse, however, assists in providing a compressive image of the drainage and streamflow of the region. Therefore, the streamflow and predicted change for this catchment is represented below in Figure 4-7. Catchments A21J2 has an average streamflow of 112.29 m^3/s for the 31-year period with a projected 17.6% decrease by 2045. The MAR data was compared to that provided in the Water Resources of South Africa (2012) assessment and deemed relevant. The data does however only cover a maximum of 37 years and therefore does not account for the temporal scale required to represent a 1:50 or 1:100-year flood event. Despite this the data does assist in contextualising the systems.

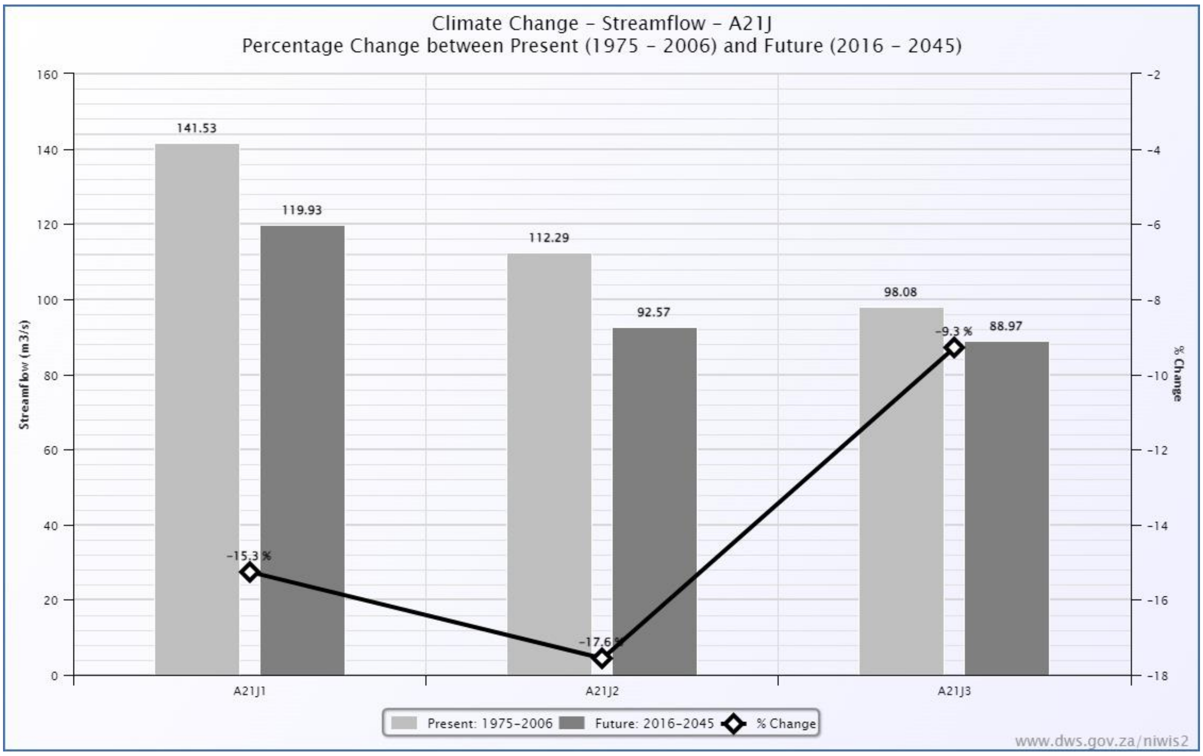

Figure 4-7: Current Streamflow and predicted change for the A21J catchment (DWS, 2023)

4.1.7 Land Cover and Soils

All parameters which affect drainage within the catchment upstream of Vametco were considered. A total of 45 of the 73 land cover classes were derived for the whole catchment (Thompson, 2019). These were then grouped into appropriate classes for simplification as well as according to landuse types required by the drainage utility program for the calculation of peak flows. The dominant land use type in the catchment was derived to be Cultivation and Livestock (47.90%), located throughout the centre of the catchment. The second most dominant land cover type was derived to be Urban/Built up (23.11%), which is concentrated around the periphery of the catchment. Considering the findings of the land cover assessment, the majority of the landcover in the catchment is modified. The landuse types and percent coverage is represented in Table 4-3 and Figure 4-8. The catchment for the project area considered was small and therefore is comprised of a low diversity in geology, land and soil types.

Table 4-3: Catchment land-use by area and percentage

Land Cover Class	Area (km²)	Percentage Cover (%)
Bare	0.18	0.18
Watercourses	1.20	1.19
Mining and Quarries	4.55	4.51
Grassland and Shrubland	8.94	8.86
Forestry, Woodlands and Thickets	14.39	14.26
Urban/Built up	23.32	23.11
Cultivation and Livestock	48.35	47.90
Total	**100.94**	**100**

Soils are a key natural regulator of catchment hydrological response due the capacity that soils have for absorbing, retaining, and releasing water (Schulze, 1989). The soils within the catchment are varied throughout the undulatory elevation. The Soil Conservation Services (SCS) hydrological soil classes of the catchment are presented in Table 4-4 (Schmidt & Schulze. 1987). Classes which are separated by a slash are possible in a South African context and fall somewhere between each listed class on either side of the slash. The SCS hydrological soil classes of the catchment are comprised of either class C soils (11.37%) soils in the north of the catchment and class B/C soil (88.63%) in the remainder of the catchment (Figure 4-9). This represents a silt/sandy clay loam which have moderate/low infiltration rates when thoroughly wetted and consists chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Table 4-4: Soil Conservation Services Hydrologic Soil Class Interpretation (SANRAL, 2013)

Class	Description
Class A	Sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
Class B	Silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
Class C	Soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
Class D	Soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

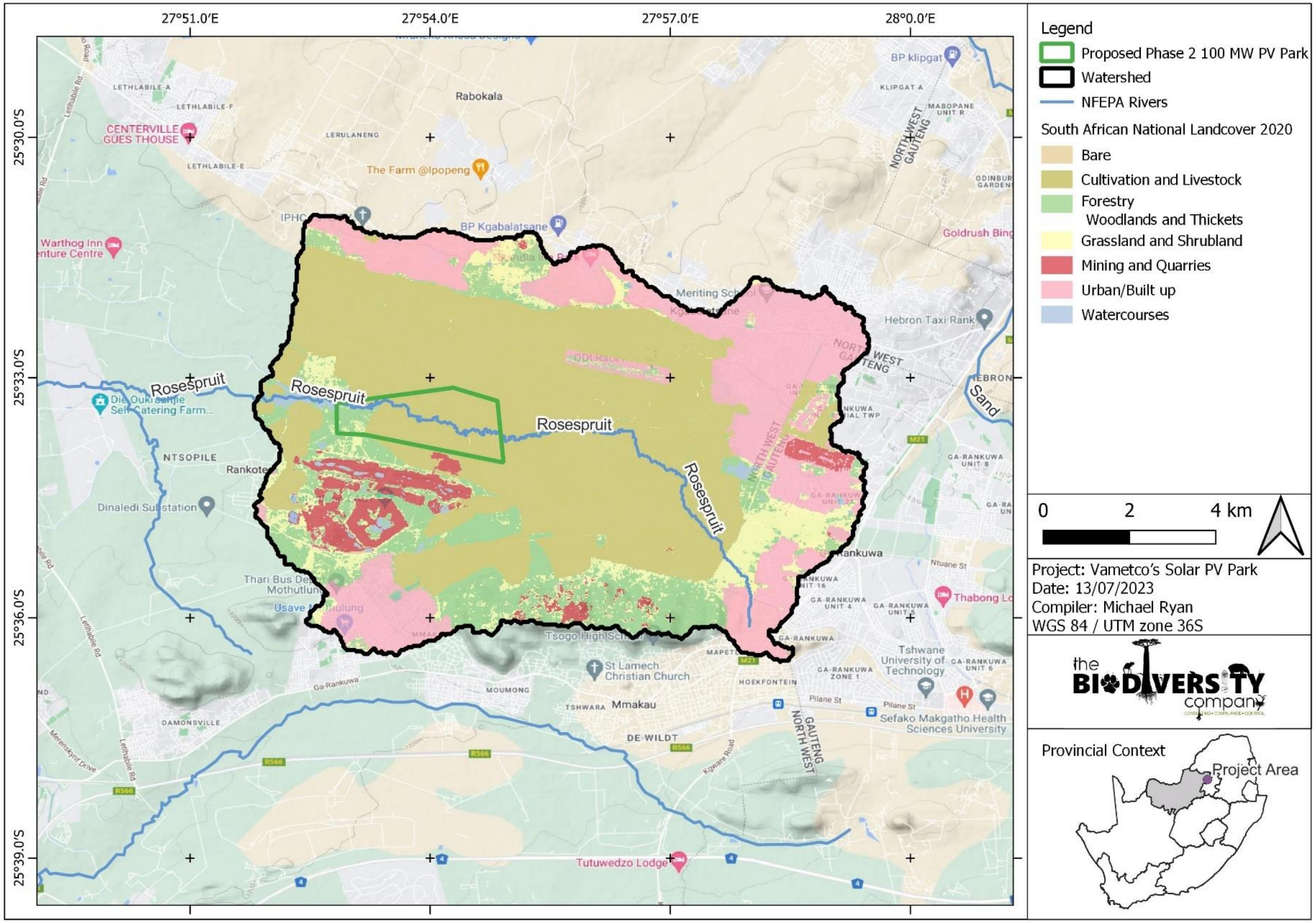

Figure 4-8: Landcover map for the catchment considered in this determination

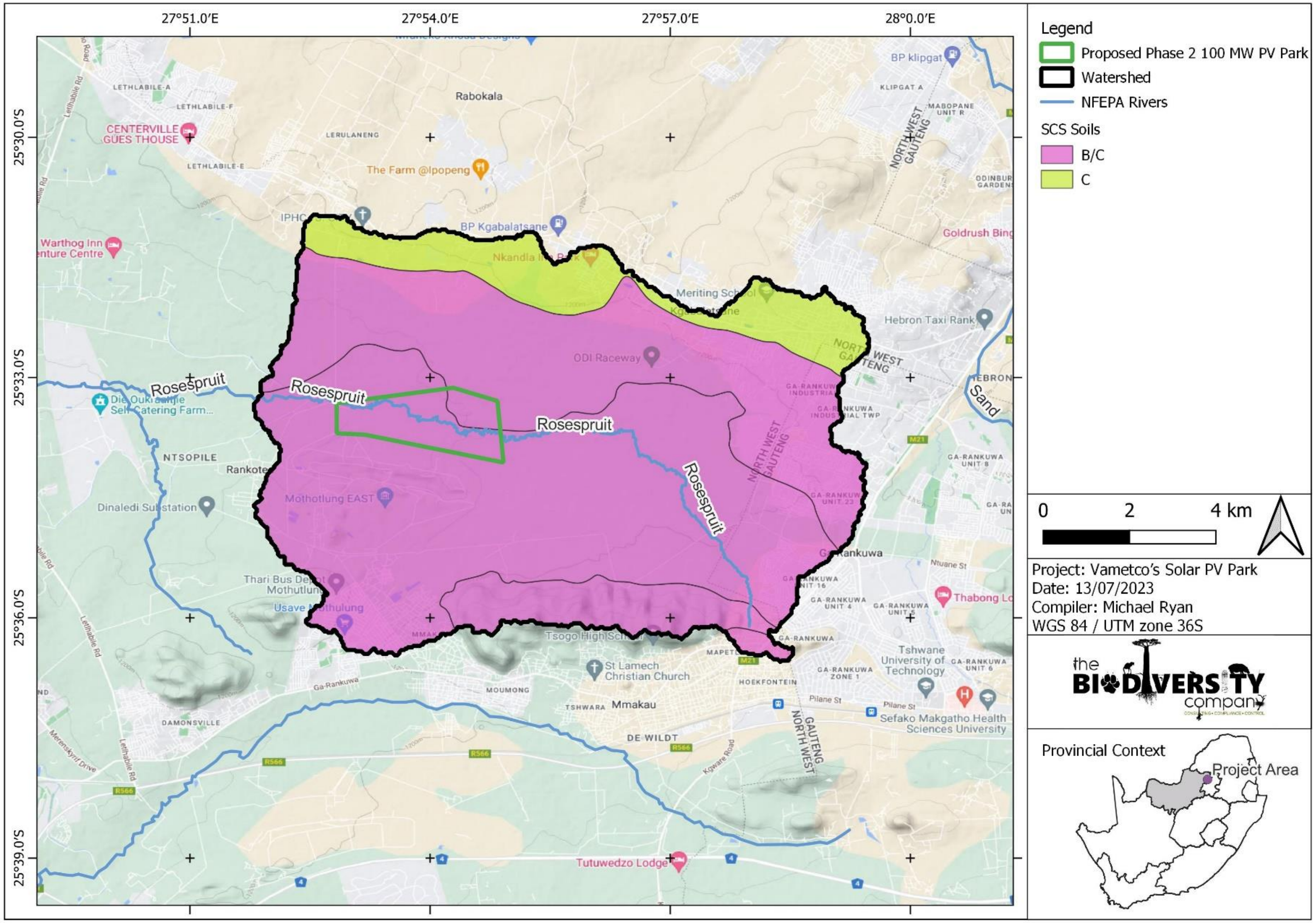

Figure 4-9: SCS soils for the catchment considered in this determination

4.2 River Gauging Stations

An effective method for modelling peak flows is the consideration of all available river gauging stations for observed and verified flows within the watercourse. An assessment of the available data for verified flows in the considered river systems was completed. According to the DWA (2023), the Rosespruit River is an ungauged river system. The closest active gauging station is the Krokodil River @ Krokodilpoort station (A2H048) located along the Crocodile River which incorporates a larger drainage network than is relevant for the project area and is therefore deemed irrelevant. Data from a gauging station could therefore not be be used to calibrate the calculated peak flows.

5 Results

5.1 Mannings roughness

The mannings roughness assessment for natural streams with widths of 30 m were used for the watercourse instream roughness ratings (Chow, 1959). The Rosespruit River which the floodline was modelled for was dry at the time of survey. The system presents largely wetland characteristics with the hydrophilic plan species *Typha capensis* prolific throughout the reach. Site photographs along the reach are presented in Table 5-1. Due to the use of the Rain of Grid Model the landuse layer was added to the HECRAS model with mannings roughness attributed to each individual landuse to effectively model the runoff of rain into channels which eventually reaches the project area. The assigned mannings roughness were sourced from Papaioannou *et al*, (2018).

Table 5-1: Site photos

Site	Upstream	Downstream
River	Rosespruit River	
S1		
GPS	25°33'17.34"S 27°52'49.09"E	

5.2 Peak Flow

The parameters and calculated peak flows using the peak discharge methods are summarised in Table 5-2, with the most appropriate peak flow for the assessment site highlighted in blue (Table 5-3). When determining peak flows, it is pertinent that multiple methods are considered, and the hydrologists discretion is used to consider which is most appropriate. The SDF method was considered first and compared with the other methods due to its versatility as a model (SANRAL, 2013). The SDF model was run first as the SDF model can achieve effective results over variable project settings, allowing for models to be simulated for any catchment size. The SDF methods calculated peak flow was the highest calculated peak flow of the five methods used. The rational and alternative rational models are typically applied to catchments below 15 km^2 (SANRAL, 2013) and therefore considered inappropriate methods for the delineated catchment. The empirical (large catchments) or unit hydrograph methods (15 - 5000km^2) are designed for larger catchments and therefore considered the most appropriate methods for the catchment. Based on this information a conservative approach was taken, the peak flow calculated from the SDF method was used to model the 1 - 50 and 1 - 100 year floodlines.

Table 5-2: Parameters used to calculate Peak Flow

Method	Watershed
MAP (mm)	628
Catchment Area (km^2)	100.94
Longest Watercourse (km)	14.83
H0.10L (mAMSL)	1133
H0.85L (mAMSL)	1186
Height Difference Along 10-85 slope (m)	65
Height difference along equal area slope (m)	65
Distance to catchment centroid (km)	7.3
Number of days per year thunder was heard	50
Veld type region	8
SDF Basin number	1
Kovacs K-region	K4

Table 5-3: Calculated Peak flows for the watershed using the different available methods (m³/s)

Period/Method	Rational	Rational (alternative)	Unit Hydrograph (m³/s)	SDF	Empirical
1:2 Year	82.77	69.37	46.87	22.48	-
1:5 Year	116.52	121.95	74.91	78.96	-
1:10 Year	152.2	165.96	106.15	131.39	90.8
1:20 Year	193.44	213	143.91	190.74	123.23
1:50 Year	257.13	276.64	207.7	279.32	170.79
1:100 Year	323.11	330.23	274.3	353.73	216.19

5.3 Floodlines and Watercourse Extents

The legal definition of the extent of a watercourse is defined in the amendment of the General Authorisation for section 21 (c) and (i) water uses (National Water Act, 1998 (Act No. 36 of1998) - Government Notice 509 (2016)). The extent of the watercourse is defined as:

- A river, spring or natural channel in which water flows regularly or intermittently "within the outer edge of the 1 in 100 year floodline or riparian habitat measured from the middle of the watercourse from both banks"; and
- Wetlands and pans "within 500 m radius from the boundary (temporary zone) of any wetland or pan".

An example of the watercourse extent is provided in Figure 5-1. As a result, all the aspects of a watercourse should be considered to produce a comprehensive total sensitive habitat delineation to indicate the "**No go**" area which is to be protected for the watercourses future health. The aspect considered by this assessment is that of the floodline of a system. According to the buffer guidelines the maximum required buffer should be applied to a system (Macfarlane, *et al*., 2014). The floodline buffer requirements were taken from Ezemvelo (2013), which was determined at 20 m. The modelled 1:50 and 1:100 year floodlines for the Rosespruit reach and its tributary network and associated 20 m buffer within the project area are indicated on Figure 5-2. It should be noted that the Vametco diversion trench could not be detected by the digital elevation model and likely forms an artificially wet area which should be avoided for development.

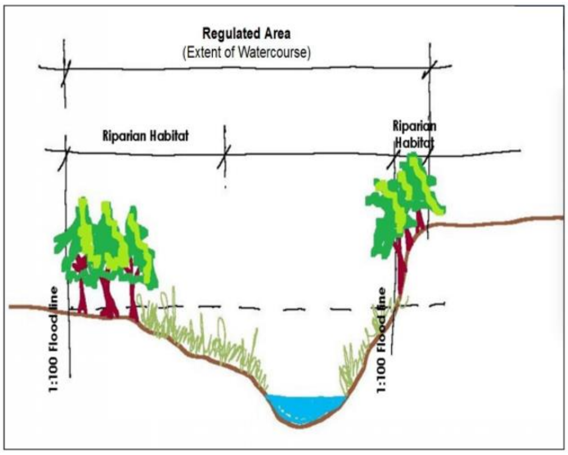

Figure 5-1: The extent of a watercourse (DWA, 2012)

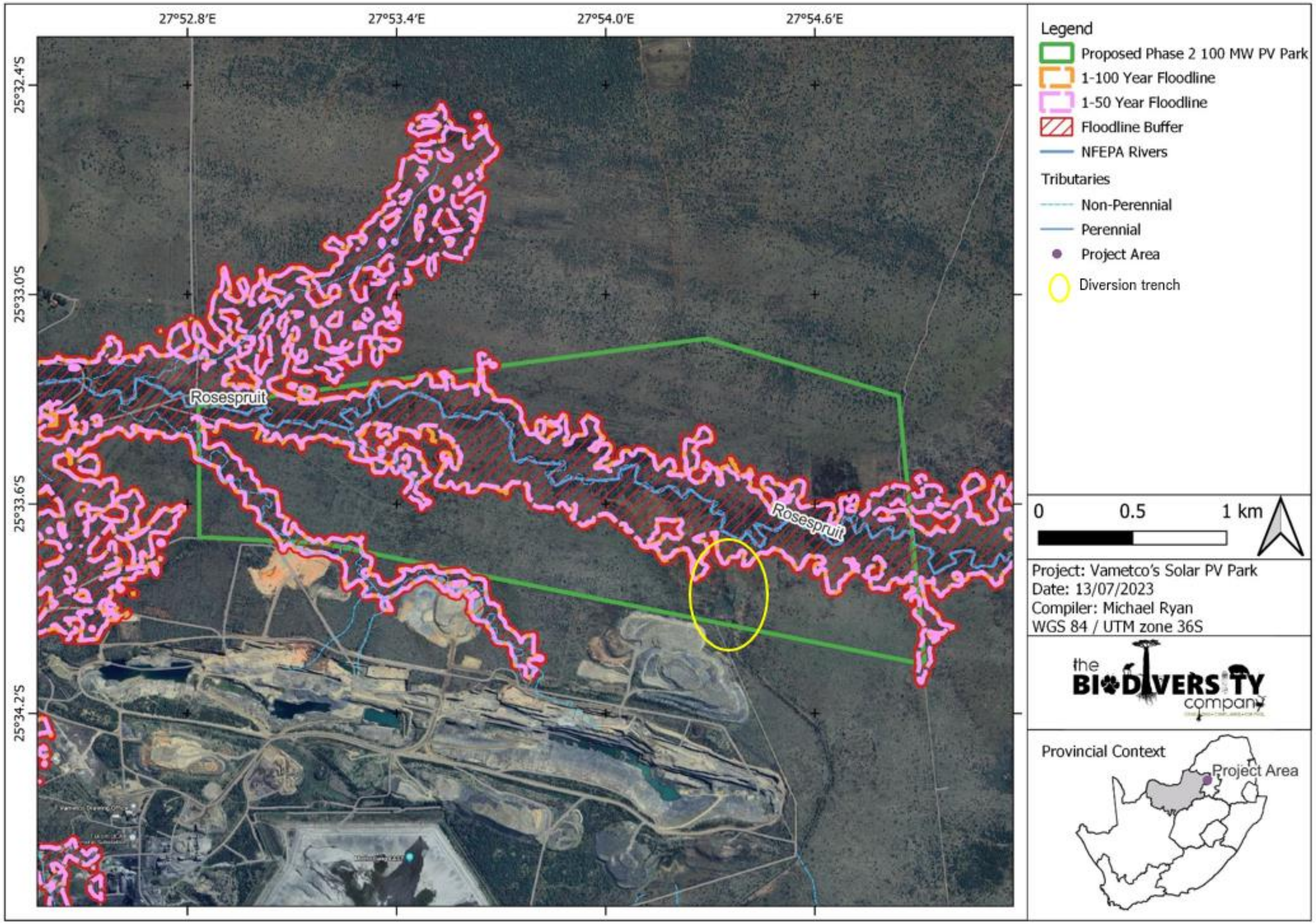

Figure 5-2: Modelled 1-50 and 1-100 year floodlines for the project area

6 Conclusion

The aim of this floodline assessment was to delineate the 1:50 and 1:100 year floodlines for the Rosespruit and associated tributary network associated with the Vametco's Solar facility. The floodlines of the watercourses considered in this assessment were effectively modelled and must be utilised as the watercourse extent for the proposed application. A total sensitivity map/master layout could not be produced due to the lack of accompanying infrastructure layouts. The Vametco Solar facility was found to be within the delineated floodline areas and associated buffers, leaving small portions of the total property extent away from these sensitive hydrological features. Therefore, the developable areas are those areas located outside of the defined watercourse floodline extent and buffers.

Specialist Opinion

It is the opinion of the specialists that due to the footprint of the Vametco's Phase 2 Solar PV Park Project located largely within the defined watercourse extent buffer, with no specific infrastructure layout provided, the project must apply for the appropriate Water Use Authorisation (WUA) with the appropriate risk assessments conducted by a suitable professional.

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