Aquatic Biodiversity Impact Assessment – Riet Fountain Solar Photo-Voltaic (PV) Solar Energy Facility and associated Grid Connection Infrastructure

Pixley ka Seme District Municipality, Northern Cape Province

Report Date: September 2022

CLIENT

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Table of Acronyms

Abbreviation	Definition
CBA	Critical Biodiversity Area
CR	Critically Endangered
DMRE	Department of Mineral Resources and Energy
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EN	Endangered
ESAs	Ecological Support Areas
GN	Government Notices
IHIA	Intermediate Habitat Integrity Assessment
IRP	Integrated Resource Plan
LC	Least Concern
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NT	Near Threatened
NWA	National Water Act
MTS	Main Transmission Substation
ONAs	Other Natural Areas
OHPL	Overhead Power Line
PAs	Protected Areas
PV	Photovoltaic
REIPPP	Renewable Energy Independent Power Producer Procurement
SQR	Sub-quaternary catchment
TBC	The Biodiversity Company
VU	Vulnerable
WMA	Water Management Area

1 Introduction

The modification of land use within a river catchment has the potential to degrade local water resources (Wepener *et al.,* 2005). Altered land use associated with solar developments thus has the potential to negatively impact on local water resources and ecosystem services. To holistically manage water resources in South Africa, the use of standard water quality sampling methods is considered in-effective. Non-point and point source pollutants are dynamic and can fluctuate according to various factors such as rainfall and human error. Aquatic ecology is permanently exposed to the dynamic conditions within waterbodies and can therefore be an effective reflection of the environmental conditions within a management area. In order to effectively manage the potential impacts to watercourses, the establishment of the baseline condition of a watercourse is required. Considering this, the monitoring of aquatic ecology is regarded as an effective tool in water management strategies.

The Biodiversity Company (TBC) was appointed by Savannah Environmental (Pty) Ltd (Savannah) to undertake an aquatic biodiversity assessment for the Pixley Park Renewable Energy project. The Pixley Park Solar Cluster Project comprises of photovoltaic (PV) facilities and associated powerlines, substations and Battery Energy Storage Systems (BESS) facilities.

The Pixley Park Solar Cluster Project will include the construction and operation of four separate PV solar energy facilities and associated infrastructure, located approximately 12 km east of De Aar, in the Northern Cape Province of South Africa.

A single day dry season survey was conducted on the 9th of June 2022, across the entire development footprint hereafter referred to as the "project area". The survey focused on the project footprint and the areas directly adjacent to the project area. Furthermore, identification and description of any sensitive freshwater receptors were recorded across the project area, and how these sensitive receptors may be affected by the proposed development were also investigated.

This assessment was conducted in accordance with the amendments to the Environmental Impact Assessment Regulations. 2014 (GNR 326, 7 April 2017) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). The approach has taken cognisance of the recently published Government Notices (GN) 320 (20 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" (Reporting Criteria). The National Web based Environmental Screening Tool has characterised the aquatic sensitivity of the project area as "Very High" (Figure 1-1) requiring an on-site inspection of the water resources associated with the project area.

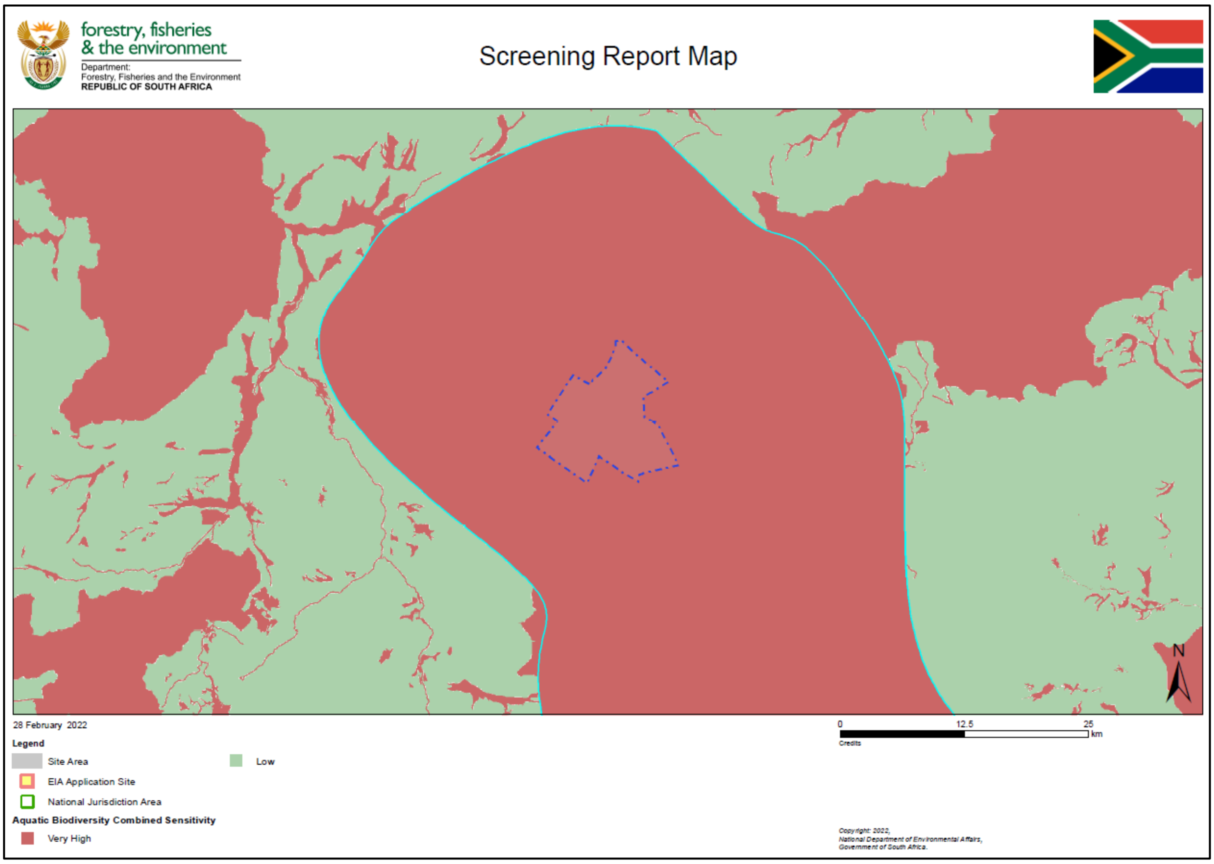

Figure 1-1 Sensitivity for the greater solar cluster project area (4 PV developments) according to the Environmental Screening Tool

Due to the absence of adequate surface water or riverine features directly within the local project footprint, the sampling of biotic responders, and the evaluation and interpretation of the aquatic environment was limited to a literature review at a catchment level from aerial imagery. Additionally, limited surface water was present outside of the project area where *in situ* water quality analysis could be conducted to determine downstream baseline conditions.

The purpose of this specialist assessment is to provide environmental sensitivity information for the environmental authorisation process for the proposed activities associated with the Pixley Park Solar Cluster Project. This report, after taking into consideration the findings and recommendations provided by the specialist herein, 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.

1.1 Project Description

Riet Fountain Solar PV1 (Pty) Ltd is proposing the development of a Photovoltaic (PV) Solar Energy Facility and associated infrastructure on Portion 4 of the Farm Riet Fountain No.6, located approximately 10 km east of De Aar within the Emthanjeni Local Municipality in the Northern Cape Province. The facility will have a contracted capacity of up to 100MW and will be known as Rietfontein Solar PV1. The project is planned as part of a cluster of renewable energy facilities known as Pixley Park, which includes three (3) additional 100 MW Solar PV Facilities (Wagt Solar PV1, Carolus PV1, and Fountain Solar PV1), and grid connection infrastructure connecting the facilities to the existing Hydra Substation. The projects will all connect to the new Vetlaagte Main Transmission Substation (MTS) via the Wag 'n Bietjie MTS.

1.1.1 Photovoltaic Facility

Infrastructure associated with the Solar PV Facility will include the following:

- Solar PV array comprising bifacial PV modules and mounting structures, using single axis tracking technology;
- Inverters and transformers;
- Cabling between the panels;
- Battery Energy Storage System (BESS);
- Laydown areas, construction camps, site offices;
- 12 m wide Access Road and entrance gate to project site and switching station;
- 6 m wide internal distribution roads;
- Operations and Maintenance Building, Site Offices, Ablutions with conservancy tanks, Storage Warehouse, workshop, Guard House;
- Onsite 132 kV IPP Substation, including the HV Step-up transformer, and MV Interconnection building 132 kV Overhead Power Line (OHPL) – 30 m height from the switching station to the Main Transmission Substation (MTS) located on farms Vetlaagte and Riet Fountain, which is to be handed back to Eskom (a separate EA is being applied for in this regard);
- Extension of the 132 kV Busbar at the MTS;
- 132 kV Feeder Bay at the MTS;
- Extension of the 400 kV Busbar at the MTS; and
- Installation of a new 400/132 kV Transformer and bay at the MTS.

A development footprint of approximately 781 ha has been identified within the broader project site (approximately 8 200 ha in extent), by the developer for the development of the Riet Fountain Solar PV1 Facility, which is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes.

It is the developer's intention to bid the proposed project under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme (or similar programme), with the aim of evacuating the generated power into the national grid. This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP), with Rietfontein Solar PV1 set to inject up to 100 MW into the national grid.

1.1.2 Grid Connection Infrastructure

The Grid connection infrastructure will consist of an up to 132 kV Double circuit power line on Portion 4 of the Farm Riet Fountain No.6. The Grid connection infrastructure will include a 132 kV IPP Substation and a powerline with a capacity up to 132 kV which is being assessed within a 300 m wide and between 5.5 km and 11.5 km long corridor connecting to either the new proposed Vetlaagte MTS or the new proposed Wag-'n-Bietjie MTS, which will respectively be located on the farm Vetlaagte (RE/4) or Wagt en Bittje (RE/5).The Vetlaagte MTS will Loop into the Hydra-Perseus 2 or Hydra-Perseus 3 line (400 kV). Substations on either end of the line: Hydra and Perseus. The Wag-'n-Bietjie MTS will loop into the Hydra-Beta 1 line (400 kV). Substations on either end of the line: Hydra and Beta.

The grid connection corridor will consist of:

- Onsite 132 kV IPP Substation including the HV Stepup transformer, MV Interconnection building (footprint up to 100m x 100m located within the 300m wide corridor);
- Onsite 132 kV Eskom switching station – 100 m x 100 m and 30 m height, metering, relay & control buildings, laydown area, ablutions with conservancy tanks and water storage tanks, and access roads which is handed back to Eskom (Separate EA);
- 132 kV Overhead Power Line (OHPL) – 30 m height from the switching station to the Main Transmission Substation (MTS) located on either Vetlaagte (RE/4) or Wag en Bittje (RE/5) farms which will be handed back to Eskom (within 300 m wide corridor and a 31 m wide servitude); and
- Access roads to substation sites (up to 8 m wide) and service tracks (up to 6 m wide) where no existing roads are available. These may be reduced to 6 m and 4 m respectively as permanent roads.

A map illustrating the location and layout design of the proposed Riet Fountain Solar PV1 Facility is presented in Figure 1-2.

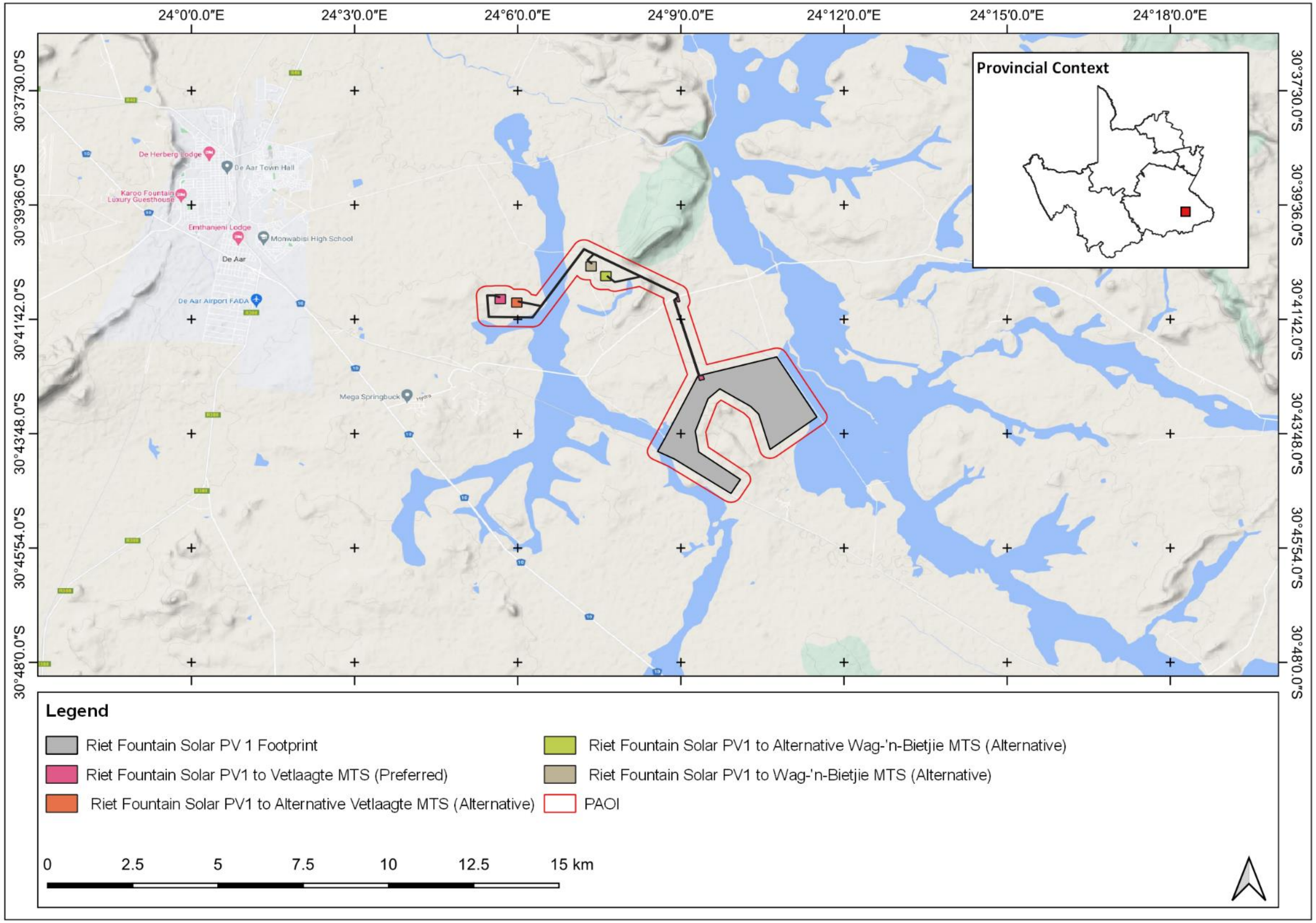

Figure 1-2 Map illustrating the location and layout design of the proposed Riet Fountain Solar PV1 Facility

2 Specialist Details

Report Name	**Freshwater Ecology Impact Assessment – Riet Fountain Solar Photo-Voltaic (PV) Solar Energy Facility and associated Grid Connection Infrastructure: June 2022**
Submitted to	savannah environmental
Report Writer (Aquatic Ecology)	**Dale Kindler**  Dale Kindler is a registered Professional Natural Scientist (Pr. Sci. Nat. 114743) in aquatic science and completed his M. Sc. in Aquatic Health at the University of Johannesburg. He has nine (9) years' experience in conducting Aquatic Specialist Assessments and is SASS 5 Accredited with the Department of Water and Sanitation (DWS). Dale has completed numerous specialist studies locally and internationally, ranging from basic assessments to Environmental Impact Assessments (EIAs) following IFC standards. Dale is contactable at dale@thebiodiversitycompany.com and a curriculum vitae can be supplied on request.
Report Reviewer	**Christian Fry**  Christian Fry has obtained an MSc in Aquatic Health from the University of Johannesburg and is a registered Professional Scientist (Pr. Sci. Nat: 119082). Christian has 9 years of experience conducting basic assessments, biomonitoring and EIAs for various sectors. Christian is contactable at christian@thebiodiversitycompany.com and a curriculum vitae can be supplied on request.
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.

3 Methodologies

3.1 Aquatic Ecology Assessment

In line with the minimum requirements for aquatic biodiversity surveys, a single survey was completed for this assessment. The survey was completed on the 9th of June 2022. The survey period therefore reflects a dry, winter survey.

Due to the absence of adequate surface water or riverine features directly within the local project footprint, the sampling of biotic responders, and the evaluation and interpretation of the aquatic environment was limited to a literature review at a catchment level from aerial imagery. Additionally, limited surface water was present outside of the project area where *in situ* water quality analysis could be conducted to determine downstream baseline conditions.

3.2 Desktop Assessment

The following information sources were considered for the desktop assessment;

- Aerial imagery (Google Earth Pro);
- Contour data (20 m).
- The National Freshwater Ecosystem Priority Areas (Nel *et al*., 2011);
- The South African National Biodiversity Institute (SANBI) datasets;
- The National Biodiversity Assessment wetlands dataset (NBA, 2018); and
- The Desktop Present Ecological Status of watercourses (DWS, 2014).

3.3 Water Quality

Water quality was measured in situ using a handheld calibrated multi-parameter water quality meter. The constituents considered that were measured included: pH, electrical conductivity (µS/cm), temperature (°C) and Dissolved Oxygen (DO) in mg/l.

3.4 Habitat Assessment

Habitat availability and diversity are major attributes for the biota found in a specific ecosystem, and thus knowledge of the quality of habitats is important in an overall assessment of ecosystem health. Habitat assessment can be defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour *et al*. 1996). Both the quality and quantity of available habitat affect the structure and composition of resident biological communities (USEPA, 1998). Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason, habitat evaluation is conducted simultaneously with biological evaluations to facilitate the interpretation of results.

3.4.1 Habitat Integrity and Riparian Delineation

The Intermediate Habitat Integrity Assessment (IHIA) model was used to assess the integrity of the watercourse habitats from a riparian and instream perspective as described in Kleynhans (1996). The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale which are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996).

This model compares current conditions with reference conditions that are expected to have been present. Specification of the reference condition follows an impact-based approach where the intensity and extent of anthropogenic changes within the catchment surrounding a watercourse are used to interpret the impact on the habitat integrity of the downslope freshwater ecosystem (receiving environment). To accomplish this, information on abiotic changes that can potentially influence river habitat integrity are obtained from surveys (in-field observations) in combination with available data sources such as the latest Google Earth satellite imagery. These changes are all related and interpreted in terms of modification of the drivers of the system, namely hydrology, geomorphology and physico-chemical conditions and how these changes would impact on the natural riverine habitats.

The criteria and ratings utilised in the assessment of habitat integrity are presented in Table 3-1 and Table 3-2 respectively. The spatial framework for each IHIA was 5 km up and downstream of the respective sampling points, from the highest elevation to the lowest elevation within the watercourse.

Table 3-1 Criteria used in the assessment of habitat integrity (Kleynhans, 1996)

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of high flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993 in: DWS, 1999). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993 in: DWS, 1999) is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al*., 1992 in DWS, 1999)).
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also, a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon *et al*., 1992). Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 3-2 Descriptions used for the ratings of the various habitat criteria (Kleynhans, 1996)

Impact Category	Description	Score
None	No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1 - 5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6 - 10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11 - 15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16 - 20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21 - 25

The habitat integrity assessment considers the riparian zone and the instream channel of the river. Assessments are made separately for both aspects, but data for the riparian zone are primarily interpreted in terms of the potential impact on the instream component (Table 3-3). The relative weighting (importance value) of criteria remains the same as for the assessment of habitat integrity (DWS, 1999).

Table 3-3 Criteria and weights used for the assessment of instream habitat integrity and riparian habitat integrity (from Kleynhans, 1996)

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
Total	**100**	**Total**	**100**

The negative weights are added for the instream and riparian facets respectively and the total additional negative weight subtracted from the provisionally determined intermediate integrity to arrive at a final intermediate habitat integrity estimate. The eventual total scores for the instream and riparian zone components are then used to place the habitat integrity in a specific intermediate habitat integrity category (DWS, 1999). These categories are indicated in Table 3-4.

Table 3-4 Intermediate habitat integrity categories (From Kleynhans, 1996)

Category	Description	Score (% of Total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0

The riparian delineation was completed according to DWAF (2005). Typical riparian cross sections and structures are provided in Figure 3-1. Indicators such as topography and vegetation were the primary indicators used to define the riparian zone. Elevation data was obtained from topography spatial data was also utilised to support the infield assessment.

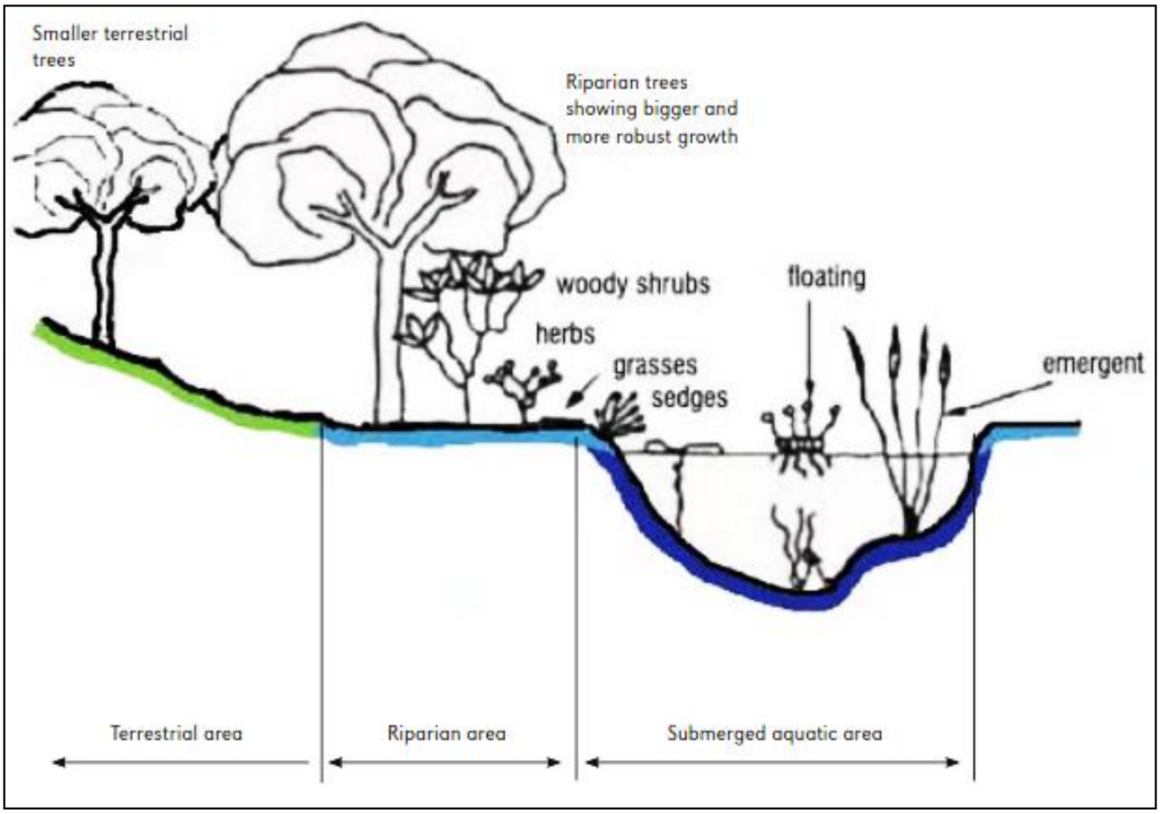

Figure 3-1 Riparian Habitat Delineations (DWAF, 2005)

3.5 Limitations

The following limitations should be noted for the assessment:

- A single season site visit was conducted for this study, which would constitute a dry season survey. As a result, no spatial or temporal trends were assessed for the associated watercourses;
- No baseline biomonitoring data/ report(s) were available for the project area. Therefore, information presents the findings of the single aquatic survey;
- This assessment has only considered aquatic resources both within and downstream Project Area of Influence (PAOI). The PAOI was a 300 m buffer around the proposed development infrastructure;
- Twenty (20) meter contours were used to assist in the delineation of the watercourse features and may cause some discrepancies in areas between sites; and
- No shapefiles for the associated road network were provided for this project, therefore it is assumed that the road footprint will follow the grid and PV infrastructure with watercourse crossings considered likely.

4 Receiving Environment

4.1 Hydrological Setting

The project area is located approximately 10 km east of De Aar, immediately north-east of the hydra substation and approximately 8 km north of the N10 Highway. As presented in Figure 4-1, the project area is located in the Brak River D62D quaternary catchment, within the Orange Water Management Area (WMA 6) (NWA, 2016), and Nama Karoo Ecoregion (Figure 4-3, Kleynhans *et al*., 2005). The main watercourse that drains the project area is the upper reaches of the Brak River [Sub-Quaternary Reaches (SQRs D62D-5391, D62D-5486 and D62D-5332)], a non-perennial river system with an associated low-density network of non-perennial and ephemeral tributaries falling adjacent to and within the project area footprint.

The proposed Riet Fountain PV area has a several unnamed ephemeral/secondary non-perennial tributaries draining a mountainous area into the Brak River and its tributaries. The western tributary network is adjacent to and is overlapped by the western portion of Riet Fountain PV extension area (Figure 4-1). The 132 kV powerline extends from the Riet Fountain PV area in the Brak SQR D62D-5391, across a watershed and into the catchment of a tributary of the Brak River (Brak tributary SQR D62D-5332). The powerline infrastructure traverses a single unnamed ephemeral/secondary non-perennial watercourse draining in a south-westerly direction into the Brak tributary (Figure 4-2). The Brak River then flows in a north westerly direction joining the Orange River approximately 174 km (as the crow flies) downstream of the project area.

The land uses surrounding the project area predominantly includes farming (grazing) activities between natural (open – predominantly mountainous areas) land situated between the aforementioned watercourses. Land use within a catchment influences the ecological integrity of the associated watercourses. Due to the limited land and water use modification within the project related catchment areas, the SQRs were considered largely natural to moderately modified at a desktop level (DWS, 2014). Ephemeral watercourses of the arid regions such as the Karoo are typically dependent on groundwater discharge and are particularly vulnerable to changes in hydrology and are known to be slow to recover from any impacts.

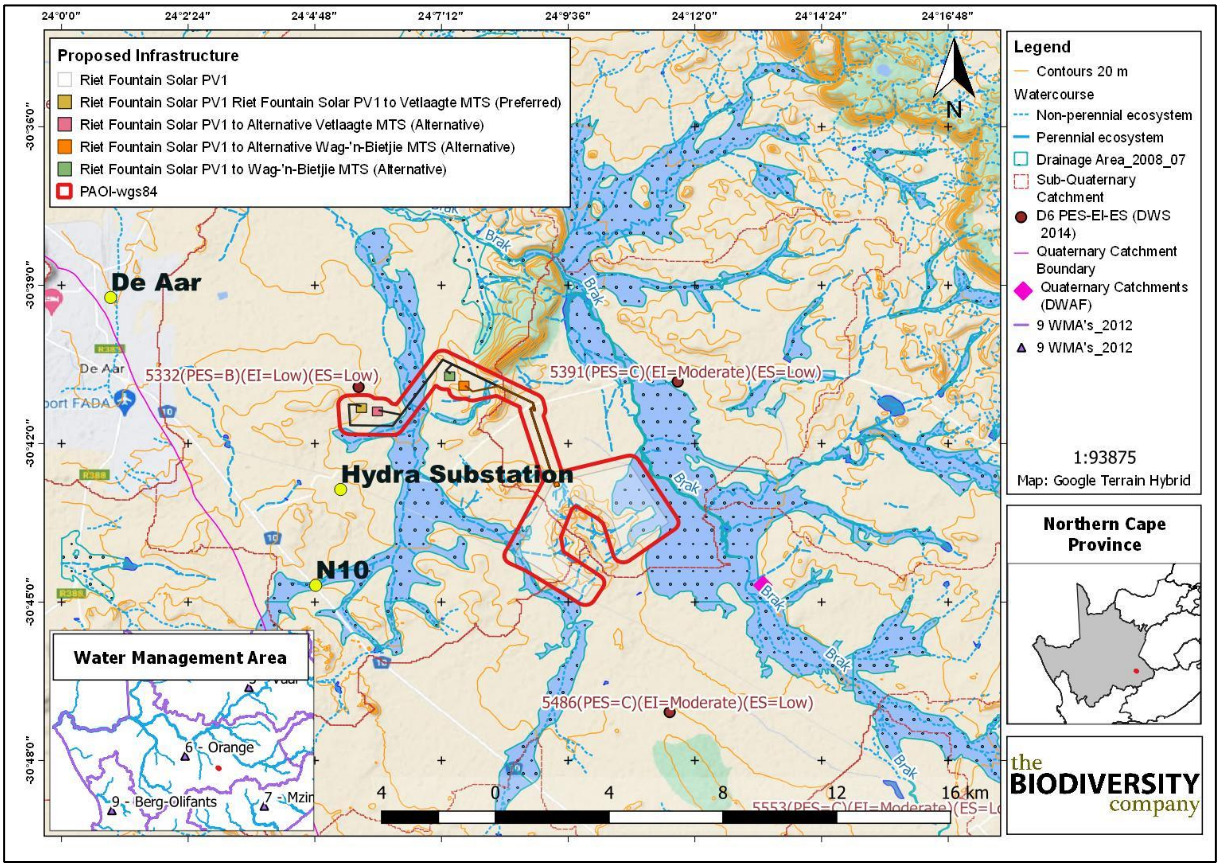

Figure 4-1 Illustration of the watercourses and catchments associated with the project area

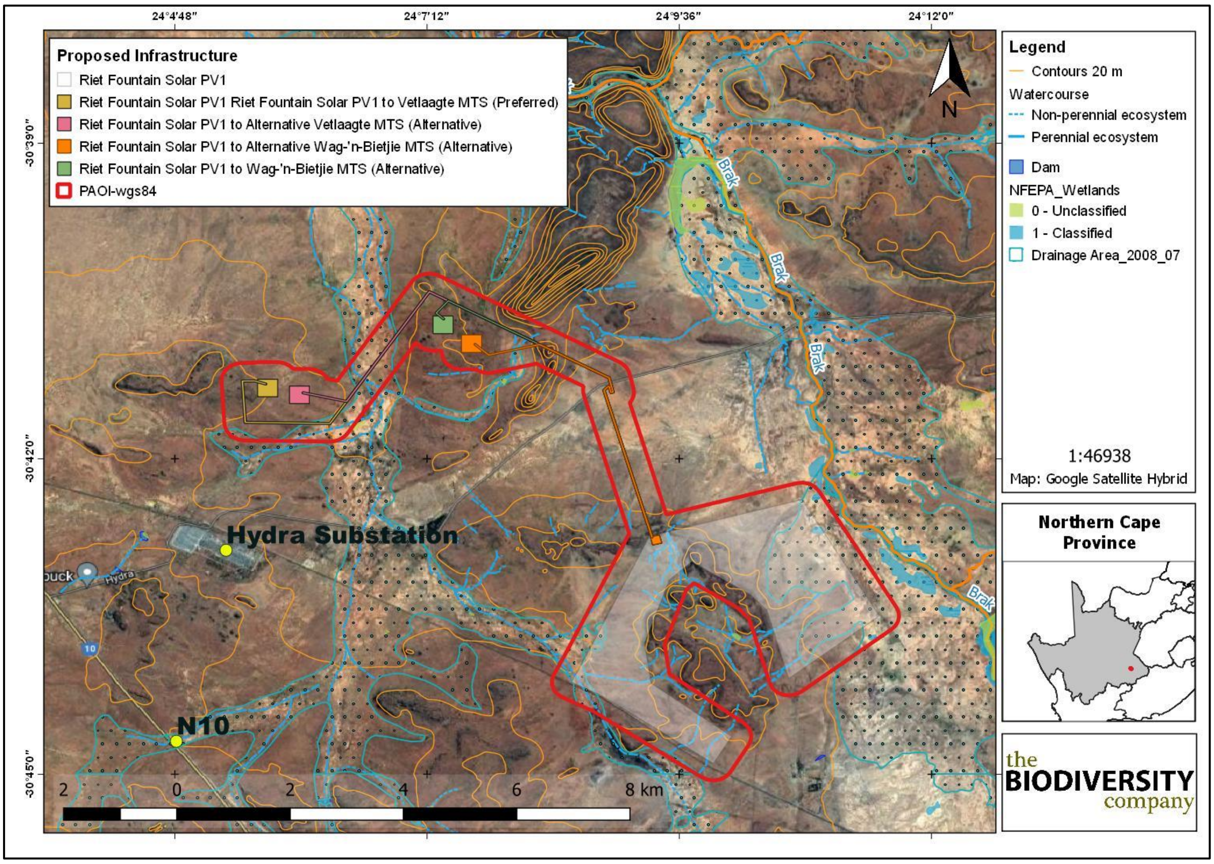

Figure 4-2 Detailed illustration of the local watercourses associated with the project area

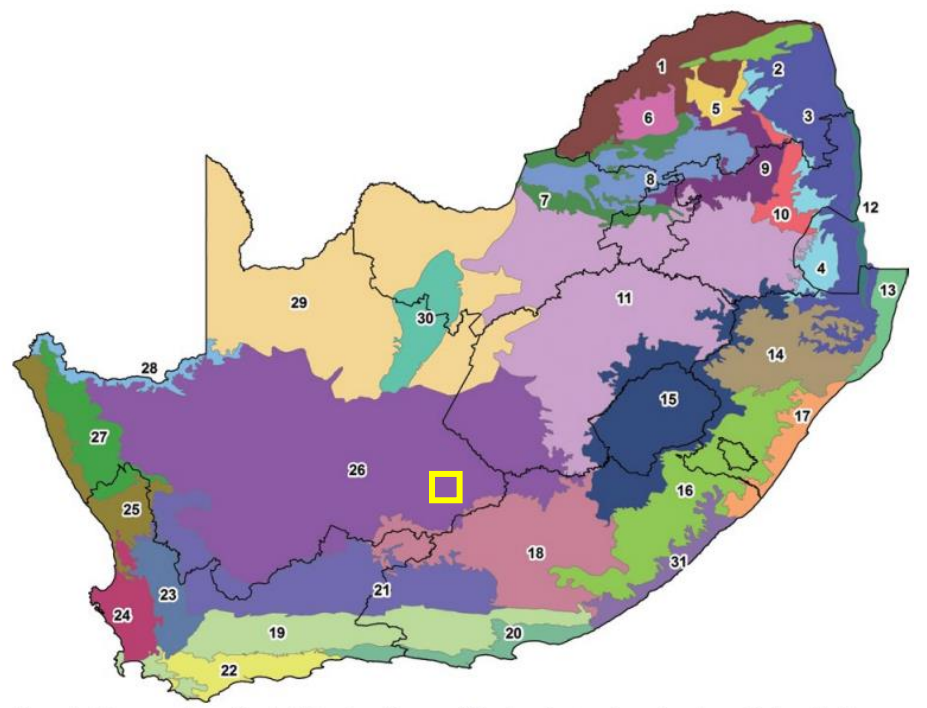

Figure 1.—The ecoregions of South Africa. 1 = Limpopo Plain, 2 = Soutpansberg, 3 = Lowveld, 4 = Northeastern Highlands, 5 = Northern Plateau, 6 = Waterberg, 7 = Western Bankenveld, 8 = Bushveld Basin, 9 = Eastern Bankenveld, 10 = Northern Escarpment Mountains, 11 = Highveld, 12 = Lebombo Uplands, 13 = KwaZulu-Natal Coastal Plain, 14 = Northeastern Uplands, 15 = Eastern Escarpment Mountains, 16 = Southeastern Uplands, 17 = Northeastern Coastal Belt, 18 = Drought Corridor, 19 = Southern Folded Mountains, 20 = Southeastern Coastal Belt, 21 = Great Karoo, 22 = Southern Coastal Belt, 23 = Western Folded Mountains, 24 = Southwestern Coastal Belt, 25 = Western Coastal Belt, 26 = Nama-Karoo, 27 = Namaqua Highlands, 28 = Orange River Gorge, 29 = Southern Kalahari, 30 = Ghaap Plateau, 31 = Eastern Coastal Belt. Black lines represent provincial boundaries.

Figure 4-3 Ecoregions for the project area (yellow square) according to Kleynhans et al. (2005)

4.2 Ecologically Important Landscape Features

The following spatial features describes the general area and associated freshwater resources, this assessment is based on spatial data that are provided by various sources such as the provincial environmental authority and the South African National Biodiversity Institute (SANBI). The desktop analysis and their relevance to this project are listed in Table 4-1.

Table 4-1 Summary of the proposed project to ecologically important landscape features

Desktop Information Considered	Features	Section
SQR	Located in Brak SQR D62D-5391 two Brak tributaries SQR D62D-5332 and D62D-5486	4.9
NFEPA Rivers	Both SQRs form river FEPA features (Upstream management area) within the 500 m regulated area surrounding the project area, while each SQR contains several wetland ecosystem FEPA features.	4.3
Strategic Water Source Areas (SWSA)	Irrelevant – 300 km to the closest SWSA.	-
Ecosystem Threat Status	Relevant – Overlaps with tributaries of the Endangered Brak River ecosystem.	4.5
Ecosystem Protection Level	Relevant – Overlaps mainly with the Poorly Protected Brak River ecosystem.	4.5
Conservation Plan	Relevant – Overlaps with Ecological Support Areas	4.6

4.3 National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach for the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the NWA. This directly applies to the NWA, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al*. 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (Act No.10 of 2004) (NEM:BA), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011).

Figure 4-4 represents freshwater priority areas for the D62D catchment. As presented by the purple square, the Brak (D62D-5391) and two Brak tributaries (D62D-5332 and D62D-5486) river reaches are considered as important upstream management areas as per NFEPAs designation (Nel *et al*., 2011). Upstream management areas are SQR's in which human activities need to be managed to prevent further degradation of downstream river FEPA's while still serving as fish support areas that serve as migration corridors for threatened fish species. These areas need to be managed to maintain water quality for downstream river NFEPA's and water users which includes aquatic and terrestrial biota, and associated freshwater ecoregional areas (Figure 4-3). The Brak (D62D-5391) further contains the following four NFEPA biodiversity features: 1 WetCluster FEPA, Upper Nama Karoo_Channelled valley-bottom wetland, Upper Nama Karoo_Unchannelled valley-bottom wetland, and Upper Nama Karoo_Valleyhead seep, while the Brak tributary (D62D-5332) contains the following four NFEPA biodiversity features: 1 WetCluster FEPA, Upper Nama Karoo_Channelled valley-bottom wetland, Upper Nama Karoo_Depression, and Upper Nama Karoo_Unchannelled valley-bottom wetland.

The Brak tributary (D62D-5486) contains the following four NFEPA biodiversity features: 2 WetCluster FEPAs, Upper Nama Karoo_Channelled valley-bottom wetland, Upper Nama Karoo_Unchannelled valley-bottom wetland and Upper Nama Karoo_Valleyhead seep.

Based on Google Earth imagery and the listed NFEPA biodiversity features, the project area presented channelled valley bottom wetland characteristics, which is typical for the gentle sloped reaches of many river systems. Typically, wetlands offer a host of ecosystems services which includes purification of water quality through phytoremediation by the wetland vegetation. The wetlands are expected to provide cleansing effects from surface runoff associated with the proposed solar development and must be maintained and protected from degradation notably erosion and sedimentation during the proposed project activities.

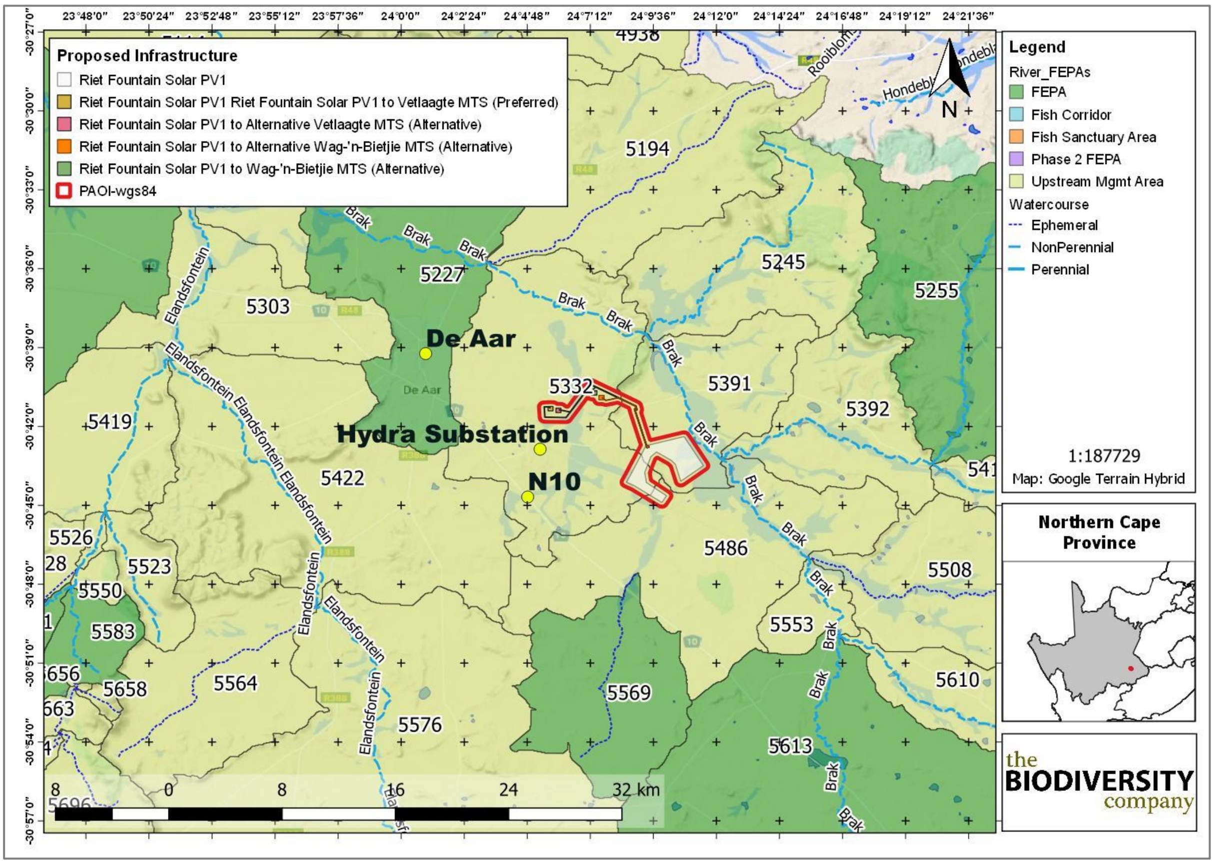

Figure 4-4 NFEPAs for the project area (Nel et al., 2011)

4.4 Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) are areas that supply a disproportionate amount of mean annual runoff to a geographical region of interest. The areas supplying ≥ 50% of South Africa’s water supply (which were represented by areas with a mean annual runoff of ≥ 135 mm/year) represent national Strategic Water Source Areas (SANBI, 2013). According to the SWSAs of South Africa, Lesotho and Swaziland, the project area is not located within the SWSAs. The nearest SWSA is approximately 300 km to the east of the project area. The project area is considered to have a semi-arid (local steppe) climate that receives limited rainfall. This region’s rainfall peaks during autumn months, especially March. The Mean Annual Precipitation (MAP) ranges from 190 to 400 mm with the mean minimum and maximum monthly temperatures for Britstown being -3.6 ℃ and 37.9 ℃ for July and January respectively (also see Figure 4-5 for more information, Mucina & Rutherford, 2006). As illustrated in Figure 4-6, these arid climate systems receive majority of their rainfall during short rainfall events and likely present surface flow for limited time periods while some rainfall events can be considered as immense with resultant flooding.

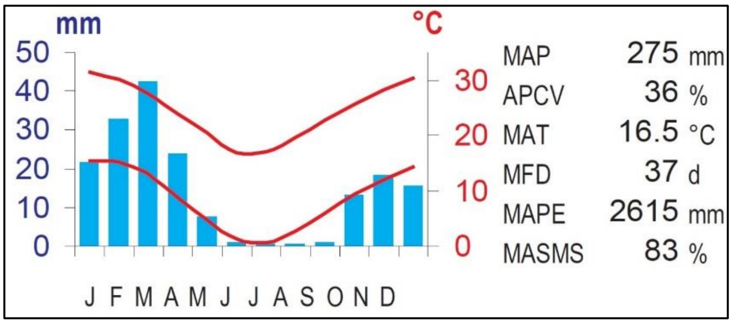

Figure 4-5 Climate for the region (Mucina & Rutherford, 2006)

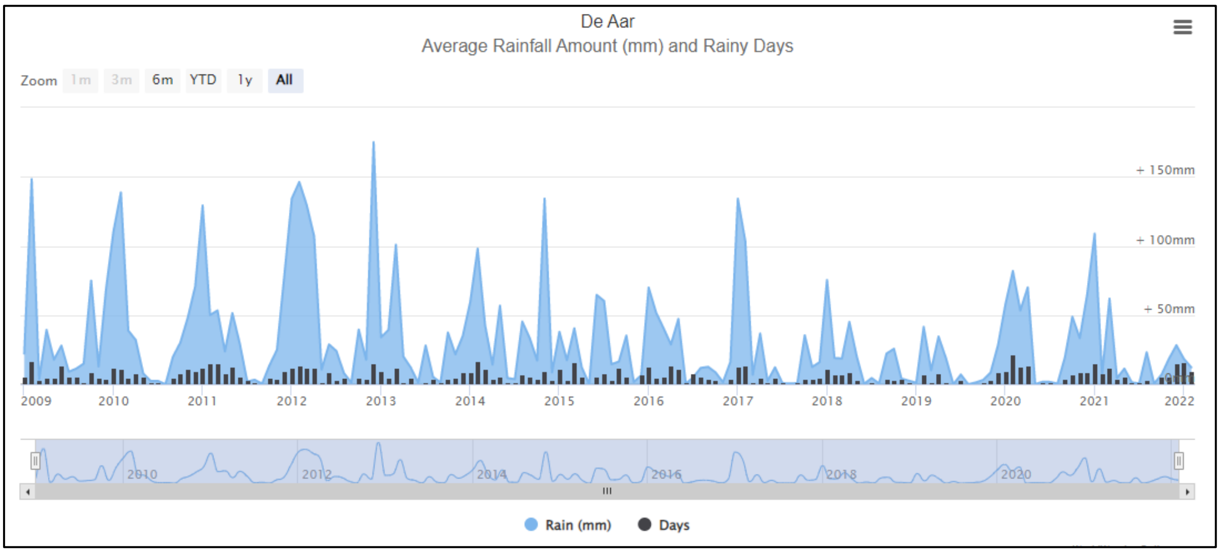

Figure 4-6 Illustration of average precipitation and rainy days (obtained from Worldweatheronline.com)

4.5 South African Inventory of Inland Aquatic Ecosystems

This spatial dataset is part of the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) which was released as part of the National Biodiversity Assessment (NBA) 2018. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. According to the SAIIAE dataset, several wetland areas were identified in the general project area, which included several rivers (Figure 4-7). The wetland units were largely indirectly associated with the project (outside of the 500 m regulated area) warranting no further ecological assessment of the wetland systems for this project, with emphasis rather afforded to the aquatic assessment of the rivers possibly at risk from the proposed project infrastructure.

According to the SAIIAE, the Ecosystem Threat Status (ETS) of aquatic ecosystem types is based on the extent to which each aquatic ecosystem type had been altered from its natural condition. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Least Concern (LC), with CR, EN and VU ecosystem types collectively referred to as 'threatened' (Van Deventer *et al*., 2018; Skowno *et al.,* 2019). Figure 4-7 illustrates that the Brak River has an ecosystem threat status of *EN* and has a *poorly protected* status (Figure 4-8). This highlights the need to limit project related impacts to the watercourses and associated ephemeral drainage network through the implementation of ongoing and adaptive mitigation.

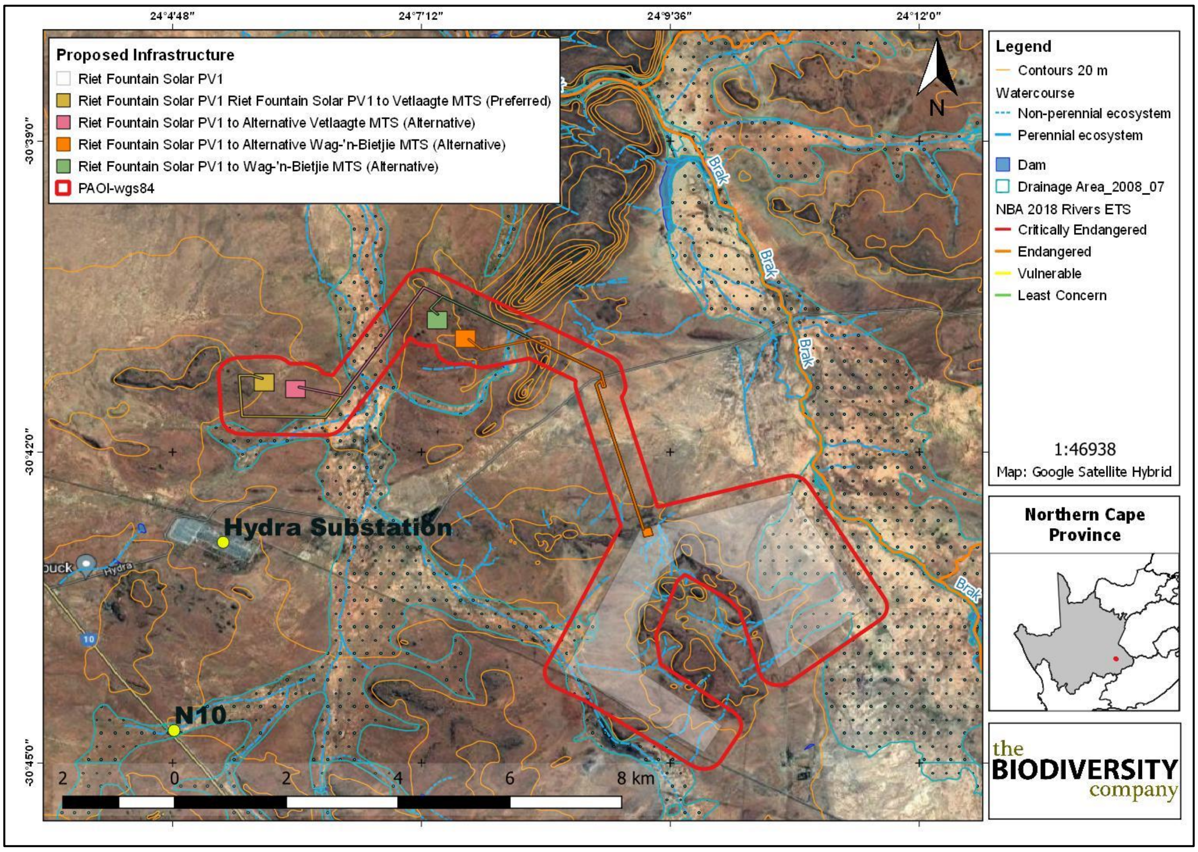

Figure 4-7 Map of the riverine ecological threat status associated with the project area

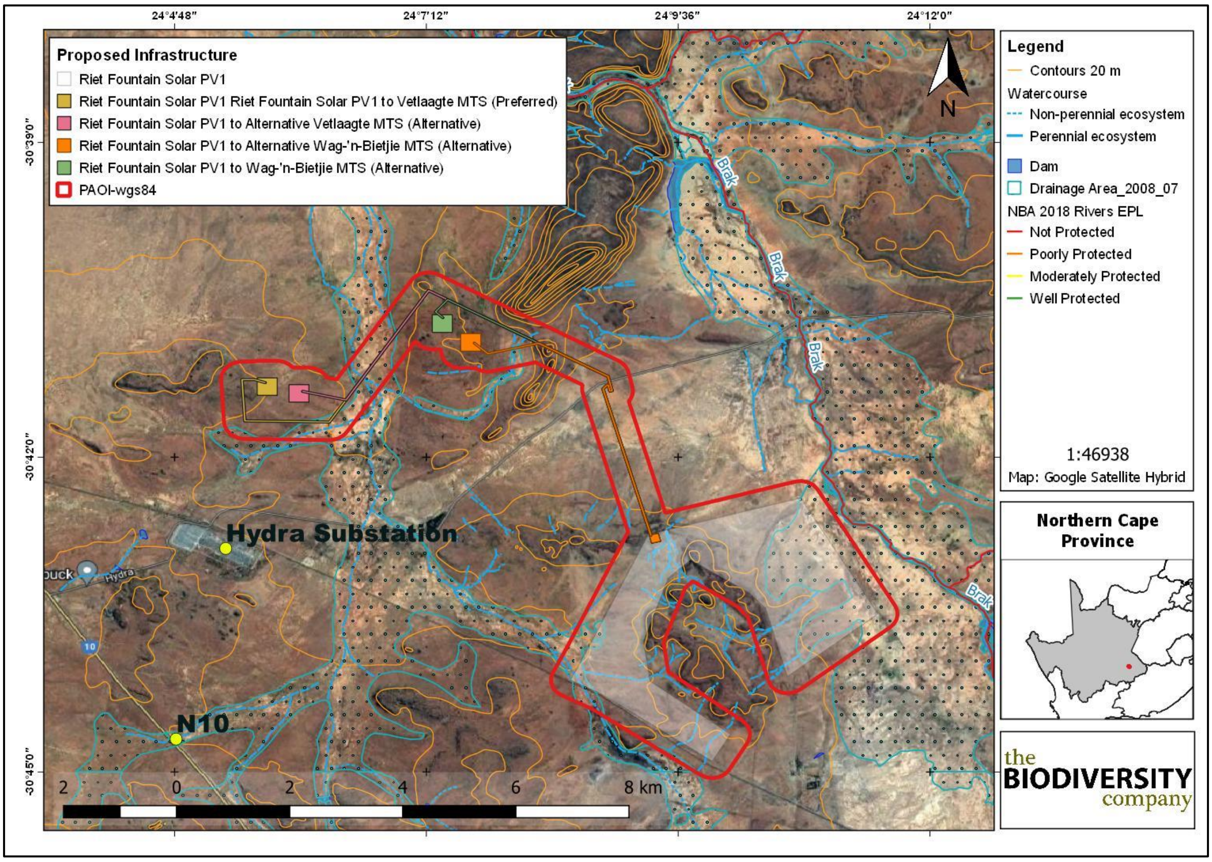

Figure 4-8 Map of the riverine ecological protection level associated with the project area

4.6 Critical Biodiversity Areas and Ecological Support Areas

Northern Cape Critical Biodiversity Areas (CBAs) (SANBI, 2016) - The identification of Critical Biodiversity Areas for the Northern Cape was undertaken using a Systematic Conservation Planning approach. Available data on biodiversity features (incorporating both pattern and process, and covering terrestrial and inland aquatic realms), their condition, current Protected Areas and Conservation Areas, and opportunities and constraints for effective conservation were collated. Priorities from existing plans such as the Namakwa District Biodiversity Plan, the Succulent Karoo Ecosystem Plan, National Estuary Priorities, and the National Freshwater Ecosystem Priority Areas were incorporated. Targets for terrestrial ecosystems were based on established national targets, while targets used for other features were aligned with those used in other provincial planning processes. CBA categories are based on their biodiversity characteristics, spatial configuration and requirement for meeting targets for both biodiversity pattern and ecological processes:

Critical Biodiversity Areas are terrestrial and aquatic areas of the landscape that need to be maintained in a natural or near-natural state to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. Thus, if these areas are not maintained in a natural or near natural state then biodiversity targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity compatible land uses and resource uses (Desmet *et al.,* 2018).

Ecological Support Areas (ESA's) are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of Critical Biodiversity Areas and/or in delivering ecosystem services (SANBI, 2017). Critical Biodiversity Areas and Ecological Support Areas may be terrestrial or aquatic.

Figure 4-9 illustrates that the proposed development overlaps with an Ecological Support Area, while the east portion of the PV1 area overlaps with CBA1 and CBA2 areas. The nature of the development, i.e., a solar cluster and associated infrastructure, will lead to modification of the ESA, CBA1 and CBA2 areas and consequently, the footprint area will be no longer be congruent with the biodiversity targets. The presence of ESA, CBA1 and CBA2 highlights the Brak River as natural areas requiring ecological integrity maintenance.

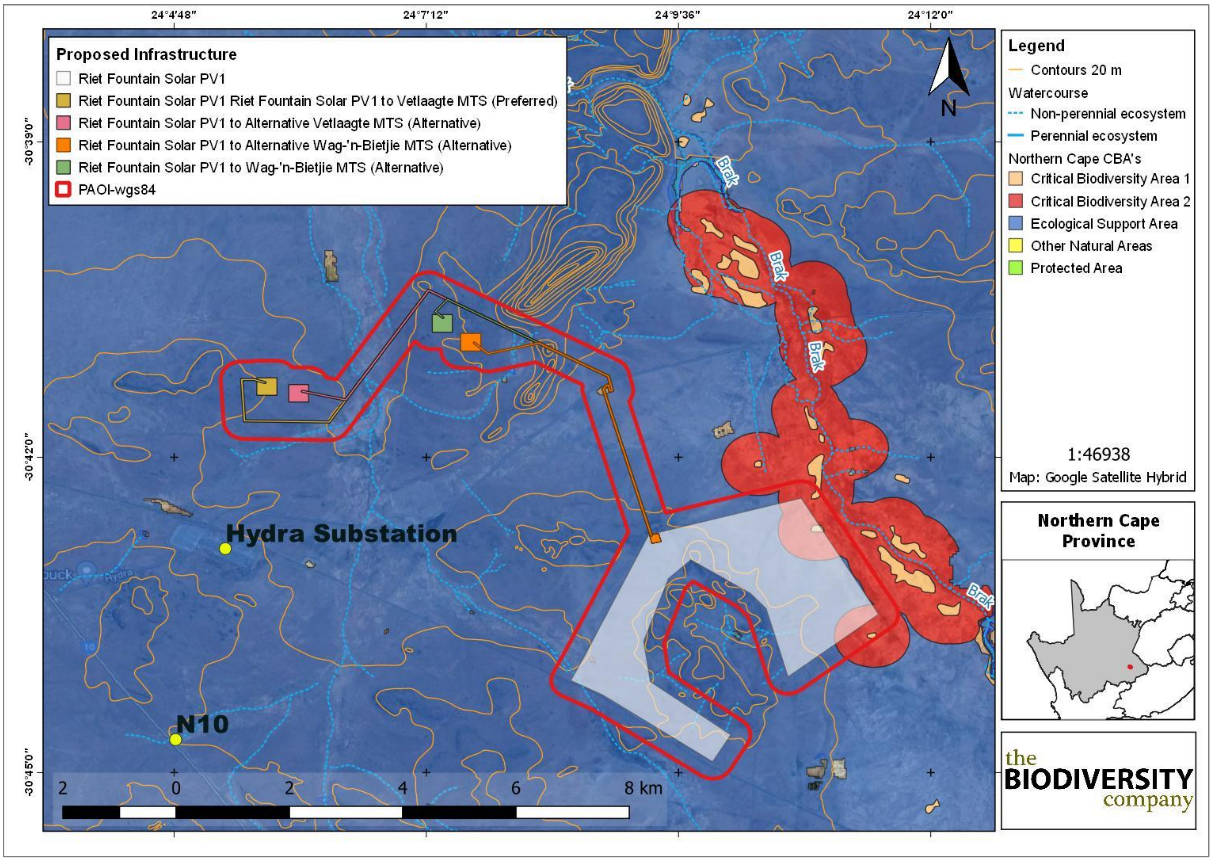

Figure 4-9 Map illustrating the locations of Critical Biodiversity Areas proximate to the proposed project area

4.7 Screening Tool

The National Web based Environmental Screening Tool has characterised the combined aquatic biodiversity sensitivity of the solar cluster project area as "very high"(Table 4-2 and Figure 4-10) required the study of the project area.

Table 4-2 Sensitivity features associated with Aquatic Biodiversity Combined Sensitivity (National Web based Environmental Screening Tool)

Sensitivity	Features	Specialist Verification
Very High	Rivers	Yes, ephemeral ecosystems present in catchment
Very High	Wetlands	Yes, wetland ecosystems present in catchment
Very High	Strategic water source area	Irrelevant – 300 km to the closest SWSA.

The freshwater ecology of the immediate project area and further downstream is sensitive to disturbance from a hydrological and biological perspective, however due to the ephemeral nature of the watercourses, this sensitivity applies more to the watercourses physical characteristics that influence the hydrological and biological aspects in times of surface water presence.

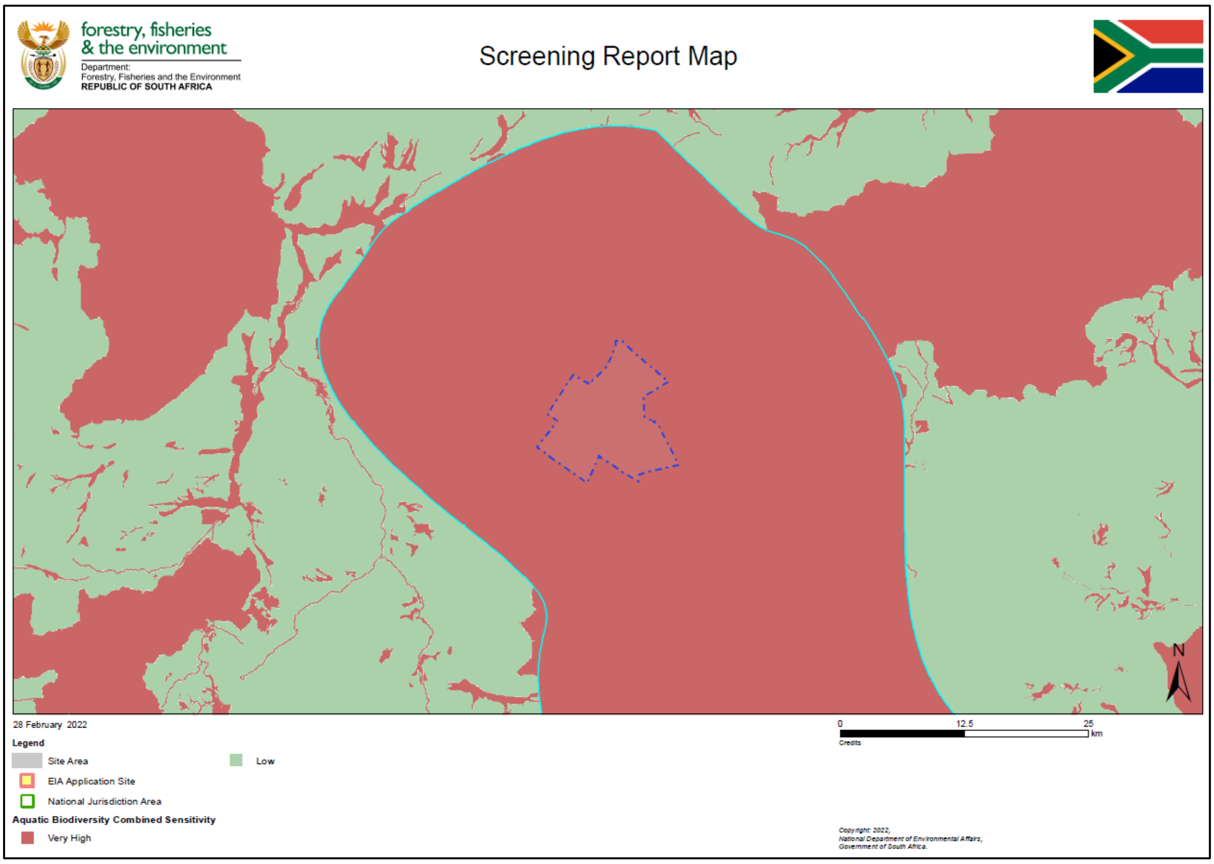

Figure 4-10 Aquatic Biodiversity Combined Sensitivity (National Web based Environmental Screening Tool)

4.8 Resource Water Quality Objectives

The NWA sets out to ensure that water resources are used, managed and controlled in such a way that they benefit all users. In order to achieve this, the Act has prescribed a series of measures such as Resource Water Quality Objectives (RWQOs) to ensure comprehensive protection of water resources so that they can be used sustainably (DWA, 2011).

The Brak River does not have RWQOs specific to this system therefore, the RWQOs for the nearest downstream watercourses serves as the allocated RWQOs to be monitored against. The Brak River drains into the Orange River in close proximity to site OS08 on the Orange River at Prieska (Orange River Quaternary Catchment D72A) (DWAF, 2009). The RWQOs for the watercourses downstream of the project area are presented in Table 4-3 and results from the aquatic assessment were compared to these RWQOs. The Present Ecological Status (PES) of OS08 is moderately modified (class C), while the Recommended Ecological Category (REC) to be maintained is a largely natural (class B). The Ecological Importance and Sensitivity Category for this catchment is rated as Moderate.

Table 4-3 Summary of resources assigned RQOs for the relevant Orange River region (DWAF, 2009)

RWQO site code	Study Unit	Quaternary Catchment	Hydro ID	Electrical Conductivity	Present Ecological State	Management Class	Recommended Ecological Category
Orange River (OS08)	Prieska	D72A	D7H002	550 µS/cm	C	A	B

The project area activities should be aligned with the RWQOs for the Orange WMA in order to limit impacts to local watercourses and their ecological drivers (water quality, flow dynamics and habitat) while maintaining biodiversity goals for the directly associated Brak River catchment and those watercourses downstream of the project area. The stipulated RWQOs should be considered for the Environmental Management Plan (EMP) and monitoring protocols should environmental authorisation be granted for this project.

4.9 Desktop Present Ecological Status of Sub-Quaternary Reach

This section provides desktop information regarding the local project related SQR(s) with regards to the PES including the Ecological Importance, Ecological Sensitivity and anthropogenic impacts within the SQR. The desktop PES information was obtained from DWS (2014) for the three SQRs associated with the project area and the relevant information is presented in Table 4-4.

The desktop PES of the Brak SQR D62D-5391 is moderately modified (class C), and that of the two Brak tributaries SQR D62D-5332 and D62D-5486 is largely natural (class B) respectively. The ecological importance and sensitivity of the two river reaches are rated as moderate and low, respectively. The factors influencing the current desktop PES status for the Brak SQR D62D-5391 includes: Livestock, roads network and crossings infrastructure, and instream weirs. The factors influencing the current PES status for the two Brak tributaries SQR D62D-5332 and D62D-5486 includes: Livestock, roads network and crossings infrastructure, cultivation and instream weirs.

The two major aspects determining the status of the SQRs are water quality and habitat conditions. The physico-chemical (water quality) modifications within the three SQRs have been rated as small with low volumes of return water (effluent) input expected from the agricultural and urban activities (altered land use) present in the catchment areas. Modifications to instream/riparian/wetland habitat continuity, and flow modification were rated to range from small to large within the three SQRs. Additionally, the habitat diversity classes of the SQRs were rated as very low with a low diversity of fish (*Enteromius oraniensis* - Orange River Chubbyhead Barb and *Labeo umbratus* – Moggel) and macroinvertebrate species expected within these systems. Despite this these taxa maintain a moderate sensitivity to altered flows and water quality, highlighting the need for the project to limit impacts to these aspects.

Table 4-4 The desktop information pertaining to the associated Sub Quaternary Reaches

Component/Catchment	Brak (D62D-5391)	Brak tributary (D62D-5332)	Brak tributary (D62D-5486)
Freshwater Ecoregion	Nama Karoo (29)	Nama Karoo (29)	Nama Karoo (29)
Dominant slope class	Lower foothills (class E)	-	-
River flow type/ Seasonality	Non-perennial	Non-perennial	Non-perennial
Present Ecological Status	Moderately Modified (class C)	Largely Natural (class B)	Largely Natural (class B)
Length of SQR Assessed	11.22 km	12.91 km	9.97 km
Ecological Importance Class	Moderate	Low	Moderate
Ecological Sensitivity	Low	Low	Low
Expected Fish Species	2	1	2
Expected Macroinvertebrate Species	4	4	4
RWQOs - Recommended Ecological Category	Largely Natural (class B)		

The current gradient of the considered river reaches in proximity to the project area are found to be a class E geoclass, which places the reaches as lower foothills river reaches (Rountree *et al.,* 2000). Typically, lower foothill reaches are associated with a moderately gentle gradient comprising pools and runs with limited riffles/rapids within a narrow to wide channel. A floodplain is a common associated feature. The instream habitat composition includes mixed alluvial substrates dominated by gravel and sand while some systems are dominated by bedrock. Stones and mud may be present between sand bars due to the flow characteristics associated with the aforementioned gradient.

5 Survey Results

5.1 Aquatic Sampling Points

A single dry season survey was conducted on the 9th of June 2022. This survey was completed in order to support the compliance statement. As the project area presented limited surface water and was characteristic of ephemeral drainage features, a focus on habitat of the site and reach based assessments were conducted. with emphasis placed on the systems within the project area and the downstream receiving environment on the Brak River. The Brak River presented wetland conditions. A total of 8 sampling sites were assessed during the study. Figure 5-1 illustrates the sampling points for the study, and Table 5-1 presents site photographs, Global Positioning System (GPS) coordinates. It should be noted that the sites were not suitable for biological sampling due to either the absence of water or shallow surface waters.

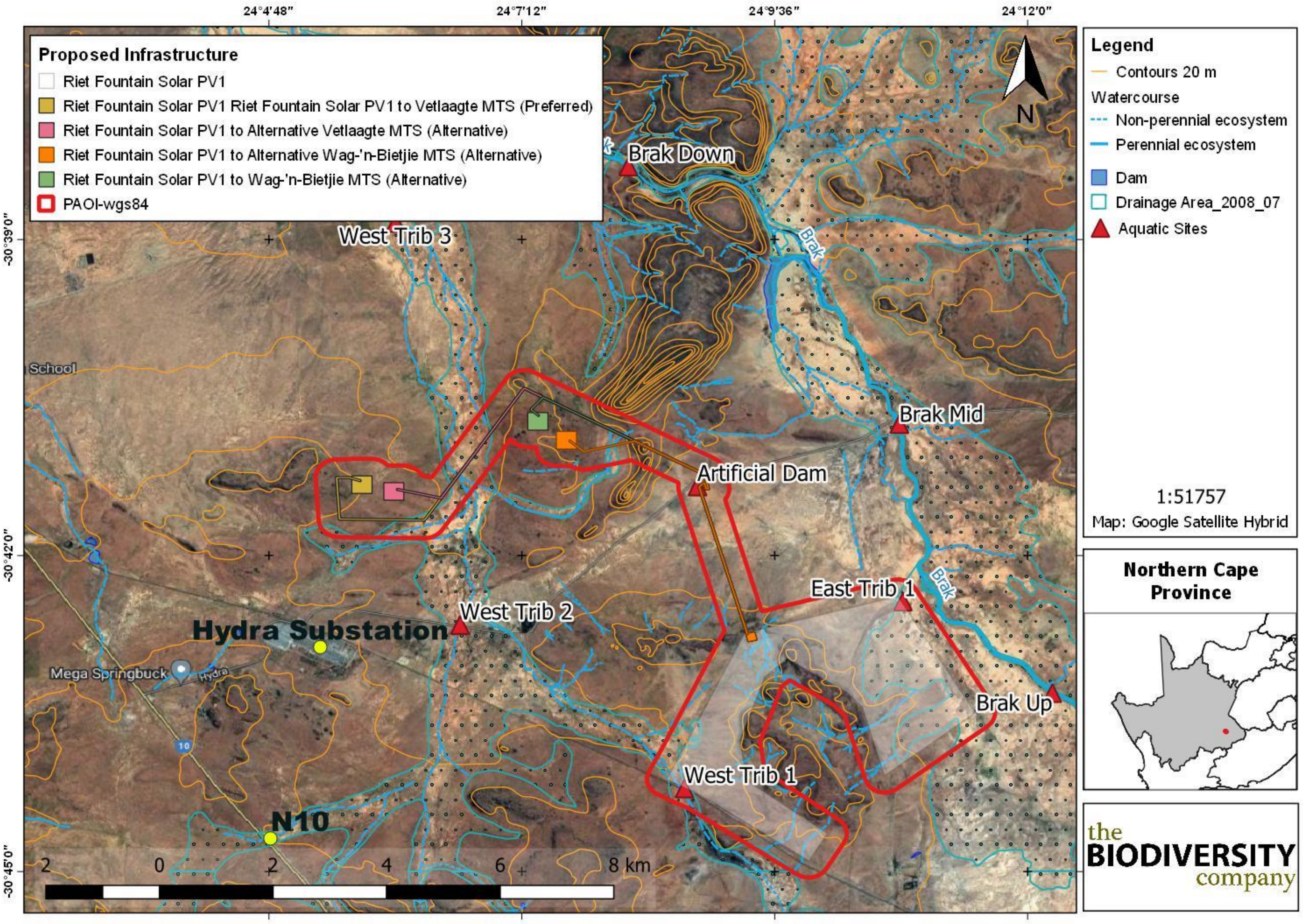

Figure 5-1 Study sampling points

Table 5-1 Sampling site photographs and coordinates (June 2022)

Site	Upstream	Downstream
	Brak River	
Brak Up		
Comments	Upstream Brak River site, upstream and east of proposed infrastructure. The watercourse presented wetland habitat and was dry.	
GPS-coordinates	30°43'18.49"S 24°12'14.13"E	
East Trib 1		
Comments	The site was located on a tributary of the Brak River to the east of proposed PV1 area. The tributary drains the north eastern portion of the PV1 area. The tributary joins the Brak River downstream of Brak Up. The watercourse presented wetland habitat and was dry.	
GPS-coordinates	30°42'26.34"S 24°10'49.02"E	
Brak Mid		
Comments	Midstream Brak River site, midstream and east of proposed infrastructure. The watercourse presented wetland habitat and was dry.	
GPS-coordinates	30°40'42.52"S 24°10'45.43"E	
Brak Down		
Comments	Downstream Brak River site, downstream of proposed infrastructure and downstream of Brak Mid. The site presented wetland habitat. The site was deemed too shallow and unsuitable for standard aquatic sampling methods and was limited to *in situ* water quality analysis only.	
GPS-coordinates	30°38'18.43"S 24° 8'12.64"E	

Site	Upstream	Downstream
	Brak River tributaries	
West Trib 1		
Comments	Located on the major Brak River tributary within the western portion of the project area (Western Tributary). The site serves as an upstream reference site adjacent to the western portion of the PV1 area. This site was presented by a wide drainage area (alluvial floodplain), which was dry at the time of the survey.	
GPS-coordinates	30°44'12.82"S 24° 8'44.55"E	
West Trib 2		
Comments	Located on the Western Tributary within the western portion of the project area and downstream of site West Trib 1. The site assessed the upper portion of the Western Tributary that will be traversed by the proposed linear infrastructure (powerlines and roads). This site was presented by a wide drainage area (alluvial floodplain) with an inconspicuous channel, which was dry at the time of the survey.	
GPS-coordinates	30°42'39.68"S 24° 6'36.75"E	
West Trib 3		
Comments	Located on the Western Tributary in the lower portion of this tributary that will be traversed by the proposed linear infrastructure (powerlines and roads). This site was presented by a wide drainage area (alluvial floodplain) with an inconspicuous channel, which was dry at the time of the survey.	
GPS-coordinates	30°38'50.53"S 24° 6'0.03"E	
Artificial Dam		
Comments	A dam located along a public road with no clear drainage lines. The dam is located adjacent to the BESS area of the PV area. The dam is considered artificial and a result of the presence of the road. The site was dry and considered to have low aquatic ecology importance or sensitivity due to its artificial nature.	
GPS-coordinates	30°41'20.69"S 24° 8'52.01"E	

5.2 *In situ* Water Quality

In situ water quality analysis was conducted during the study at sampling points along the watercourses in the project area catchment which contained water. These results are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms. Results have been compared to limits stipulated in the Target Water Quality Range (TWQR) for aquatic ecosystems (DWAF, 1996) and the RWQOs for the Orange WMA. The results of the June 2022 assessment are presented in Table 5-2.

The water quality presented in the Carolus PV1 aquatics report for site East Trib Dam has been included in this report to present background conditions.

Table 5-2 In situ surface water quality results (June 2022)

Site	pH	Conductivity (µS/cm)	DO (mg/l)	Temperature (°C)
TWQR* RWQOs**	6.5-9*	550**	>5.0 mg/l*	5-30*
West Trib 1	Dry			
West Trib 2	Dry			
West Trib 3	Dry			
Brak Up	Dry			
East Trib 1	Dry			
Brak Mid	Dry			
Artificial Dam	Dry			
East Trib Dam	8.03	282	6.0	9.3
Brak Down	7.68	3 150	7.7	12.3

*TWQR – Target Water Quality Range (DWAF, 2006); **RWQOs - Resource Water Quality Objectives (DWAF, 2009); Levels exceeding guideline levels are indicated in red

Water quality results indicated pH levels within the catchment were alkaline and fell within the TWQR for aquatic biota at both sites which contained surface water. The Dissolved Oxygen (DO) levels at both sites were recorded within the TWQR for aquatic biota and water temperatures fell within expected ranges for the Nama Karoo ecoregion during the winter survey period. The East Trib Dam had acceptable concentrations of dissolved solids as measured in Electrical Conductivity (EC) which fell the RWQOs for the catchment. The EC was however elevated above the RWQOs within the Brak River downstream of the project area at site Brak Down, with a reading of 3 150 µS/cm. This elevated baseline concentration indicates inputs from the natural geology of the area and/or inputs of unknown contaminants from anthropogenic activities within the tributary systems draining the catchment above the site. The elevated EC levels would contribute to adverse conditions limiting the diversity of local aquatic biota in times of surface water presence. It is important to note that background levels may be naturally high and biota in region have potentially adapted to these conditions. Impacts from the alteration of land use within a catchment which includes contaminated runoff from the construction phase of solar developments can contribute to the elevated levels in the downslope watercourses (the receptor).

5.3 Habitat Assessment

Anthropogenic activities drive habitat destruction causing habitat fragmentation and displacement of fauna and flora and possibly direct mortality through altered water quality.

Land clearing destroys local habitat and alters the topography and associated surface hydrology which can lead to the degradation and/or loss of local rivers, streams and drainage lines, or other locally important biological features. The removal of natural vegetation surrounding drainage features is known to reduce the buffering capacity of the watercourses to impacts from adjacent land use activities, notably with a lowered resilience against erosion and water quality impacts. This in turn is likely to reduce aquatic and terrestrial fauna and flora populations and species compositions within the local area and potentially those downstream.

The on-site assessment of the watercourses presented largely dry conditions, with the numerous ephemeral systems presenting no clear banks or riparian features which is typical for watercourses in an arid region (Figure 5-5 and Figure 5-4). Many of the drainage features presented as alluvial fans that have formed in the low laying areas below mountain slopes or gorges due to the flat topography and low water energy that has resulted in the accumulation of alluvial sediment. These areas are broad presenting as wide floodplain-like features which are difficult to observe in-field and are best seen from satellite imagery (Figure 5-3, Figure 5-5 and Figure 5-4). These drainage areas are highlighted in times of good rainfall when the vegetation cover is greatest from inundated soils, with an example from March 2017 imagery highlighting the extent of these areas (Figure 5-2). The areas are prone to flooding during large storm events and may remain saturated for several days to weeks, depending on the permeability of the soils and climate conditions. These areas are important for groundwater recharge.

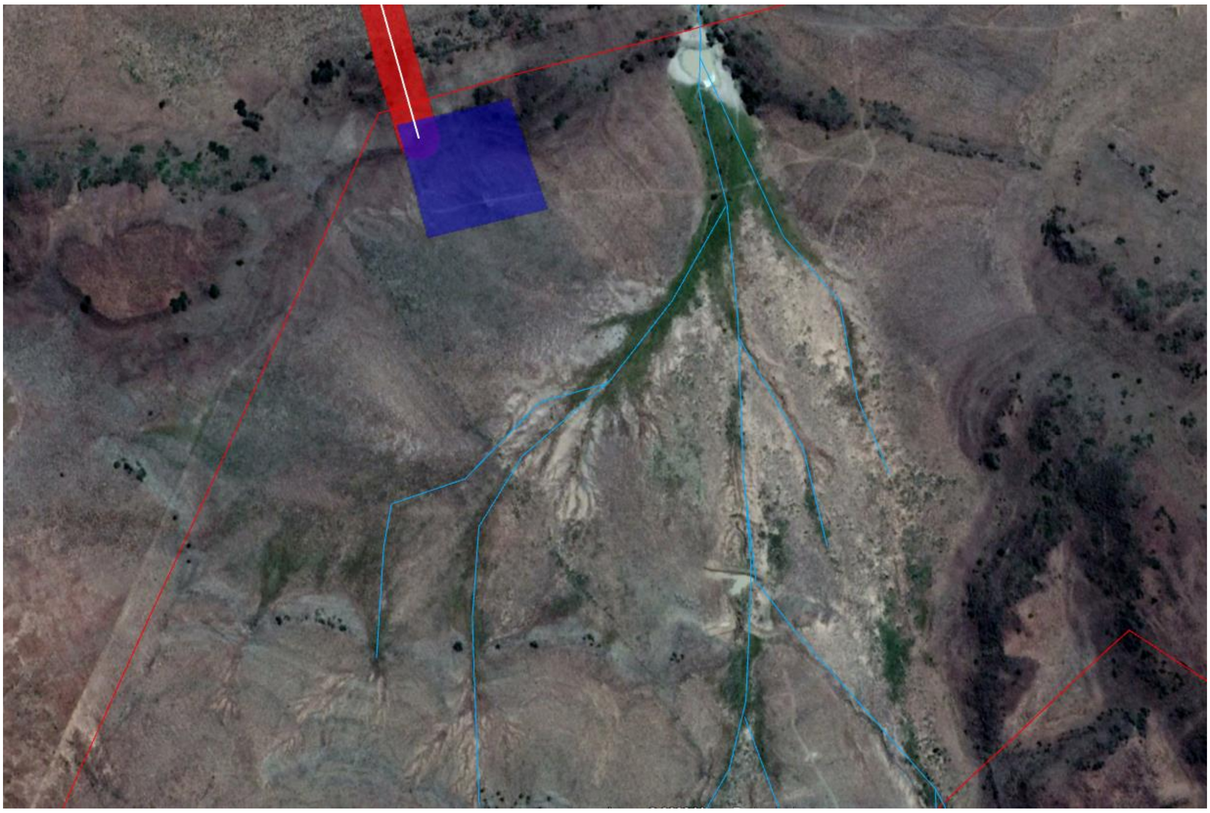

Figure 5-2 Illustration of the alluvial fans (green areas) in wet periods (Google Earth 3/2017)

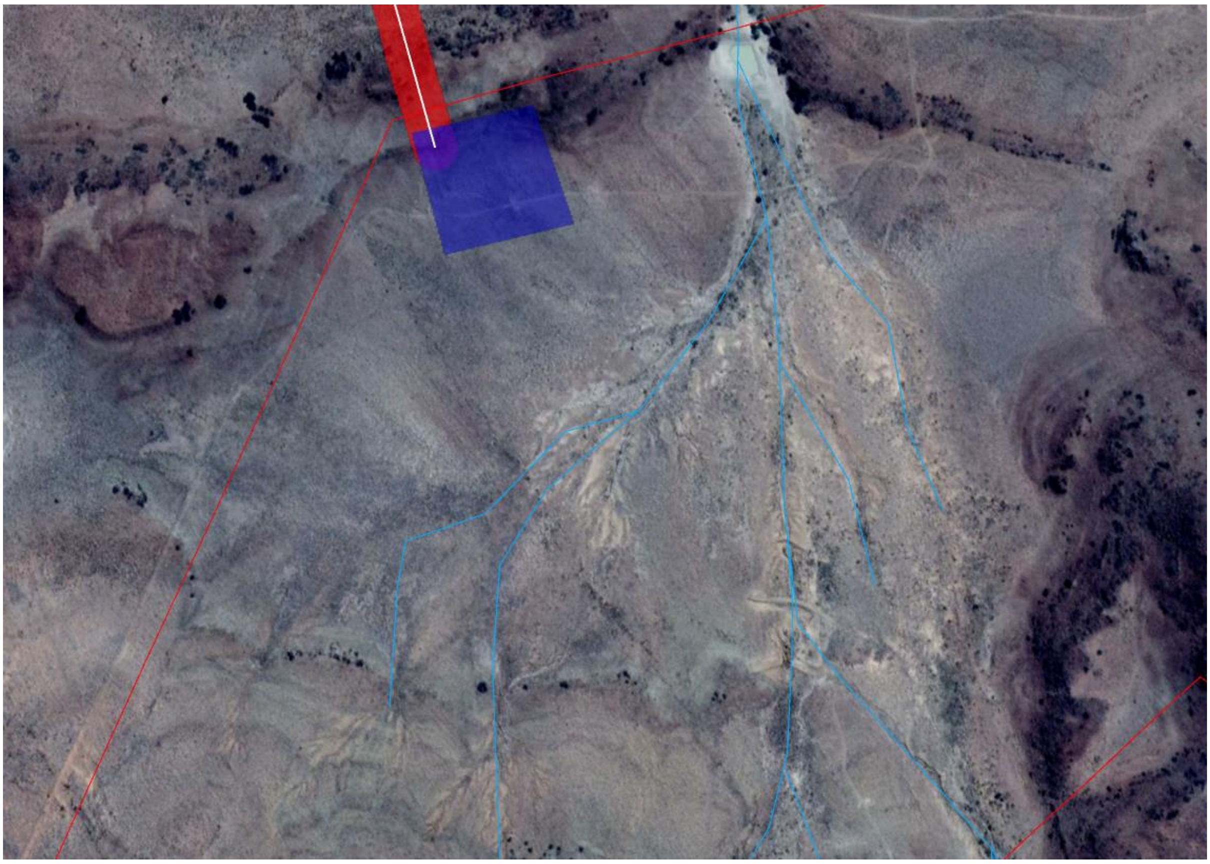

Figure 5-3 Illustration of the alluvial fans in dry periods (Google Earth 4/2020)

This together with the temporary presence of surface water within these watercourses limited the use of the IHIA method. Therefore, the baseline condition of the watercourses is presented through site photos and satellite imagery. Some level of channel habitat modification has taken place through land use activities however the ecosystems and adjacent terrestrial habitat is considered open and largely unmodified. Baseline impacts within the drainage channels and catchment include instream weirs, farm fences, livestock influence and vehicle tracks (formal and non-formal roads) which have altered the hydro-dynamics to some degree. Despite their current level of modification and ephemeral nature, the watercourses are sensitive to further modification as these systems do provide drinking opportunities (in times of rainfall) and habitat for foraging, nesting and refugia for terrestrial biota and avifauna. Therefore, the watercourses in the project area are regarded as sensitive environments in relation to changes in habitat integrity, flow and water quality requiring avoidance from the project related disturbance activities and maintenance of baseline conditions.

Figure 5-4 Illustration of the ephemeral habitat features of the Western tributary (June 2022)

Figure 5-5 Illustration of the catchment condition of the Western tributary (Google Earth)

Figure 5-6 Illustration of existing instream weirs structures and powerline pylons (yellow circles) within the drainage features (Google Earth)

The Brak River is located outside of the development footprint and no direct habitat modifications are expected from the project, therefore this system was not assessed for IHIA.

The proposed project must prevent impacts to water quality and habitat condition in the vicinity of the project footprint to avoid direct impacts to the local drainage systems which are ecologically interconnected with the downstream Brak River.

6 Impact Assessment

6.1 Anticipated Impacts

The findings of this aquatic ecology assessment reveals that under the current layout, the proposed Riet Fountain PV1 development areas is drained by several drainage features draining radially from the mountainous area into the Brak River and its alluvial fan tributary network (Figure 4-2). Additionally, one portion of the 132 kV powerline traverses an ephemeral drainage line in its headwaters, with another portion traversing the associated Brak River ephemeral tributary with wide alluvial floodplain drainage area (Western Tributary). Impacts would therefore be expected directly within the tributary network through the physical loss of smaller drainage features as well as damage to the watercourse habitat, notably where construction disturbance will take place. Impacts have the potential for downstream impacts to the Brak River if left unmitigated.

Impacts include changes to the hydrological regime such as alteration of surface run-off patterns, runoff velocities and/or volumes associated with vegetation clearing, earthworks, levelling, soil stockpiling and the establishment of infrastructure (perimeter fencing, powerline pylons, BESS and substation) and road network. This would include watercourse crossing infrastructure for the powerline maintenance road and potential watercourse crossing infrastructure within the PV1 development area. The presence of solar panels and associated compacted road network increases hard surfaces within the catchment, resulting in an increase in surface runoff during high precipitation events, increasing the erosion potential and may be significant should stormwater management not be catered for. The aforementioned alterations will have a direct result on the sediment movement and drainage characteristics both locally within the influenced tributaries and associated downslope areas such the Brak River. Altered surface run-off patterns, runoff velocities and or volumes above the natural flow regime of the ephemeral drainage lines is expected to cause potentially extensive damage to the bed and banks through erosion and scouring with the associated sedimentation of instream habitat. Powerline pylons constructed within the tributaries and associated marginal zones will result in direct loss or the disturbance of watercourse habitat with associated alteration of hydrology. The same applies to watercourse crossing structures (culverts, or permeable pavers) within drainage areas. In turn, habitat disturbance may degrade habitat quality and result in watercourse and surrounding corridor (Ecological Support Area) fragmentation. A negative shift in the biotic integrity of the tributaries would be expected based on the severity of alterations or losses. It should be taken into account that the Karoo may take decades to rehabilitate due to limited rainfall within the region, therefore rehabilitation may be challenging, highlighting the need to avoid disturbance of these areas.

It is important to highlight that these arid climate systems receive majority of their rainfall during short rainfall events and only present surface flow for limited time periods. Some rainfall events can be considered as massive for the region with resultant flooding expected, notably from increased hardened surfaces in the form of project infrastructure (solar panels, roads, among others). Therefore, careful consideration should be given to the hydrology of these systems with special attention given to stormwater and watercourse crossing designs (likely unnecessary through avoidance mitigation of road network – no road shapefiles available) and resultant discharge velocities from these structures.

These disturbances will be the greatest during the construction phase as the related disturbances could result in direct loss and/or damage, while to a lesser degree in the operation phase (i.e. as and when maintenance occurs). The solar panels and road network will increase surface runoff velocities and is of key concern for the maintenance of baseline watercourse conditions.

6.2 Alternatives considered

No alternatives were provided for the development.

6.3 Loss of Irreplaceable Resources

- ESA, CBA1 and CBA2 areas will be modified.

6.4 Assessment of Impact Significance

The section below and associated tables serve to indicate and summarise the significance of perceived impacts on the aquatic ecology of the project area. Potential impacts were evaluated against the data captured during the desktop and field assessment to identify relevance to the project area. The relevant impacts associated with the proposed construction of the development were then subjected to a prescribed impact assessment methodology which were provided by Savannah Environmental and is presented in Table 6-1.

Table 6-1 Impact assessment methodology

Extent of impact	Rating
Site specific	Very low (1)
Footprint & surrounding areas	Low (2)
Local area	Moderate (3)
Regional	High (4)
Entire habitat unit / Entire system	Very high (5)
Duration of impact	**Rating**
The lifetime of the impact will be of a very short duration (0–1 years)	Very short term (1)
The lifetime of the impact will be of a short duration (2-5 years)	Short term (2)
Medium term (5–15 years)	Moderate term (3)
Long term (> 15 years)	Long term (4)
Permanent	Permanent (5)
Consequence/Magnitude of impact	**Rating**
Small and will have no effect on the environment	None (0)
Minor and will not result in an impact on processes	Minor (2)
Low and will cause a slight impact on processes	Low (4)
Moderate and will result in processes continuing but in a modified way	Moderate (6)
High (processes are altered to the extent that they temporarily cease)	High (8)
Very high and results in complete destruction of patterns and permanent cessation of processes	Very high (10)
Probability of impact	**Rating**
Very improbable (probably will not happen)	Very improbable (1)
Improbable (some possibility, but low likelihood)	Improbable (2)
Probable (distinct possibility)	Probable (3)

Highly probable (most likely)	Highly probable (4)
Definite (impact will occur regardless of any prevention measures)	Definite (5)
Status	**Rating**
Positive	Positive
Negative	Negative
Neutral	Neutral
Reversibility	**Rating**
None	None
Low	Low
Moderate	Moderate
High	High
Irreplaceable loss of resources?	**Rating**
Yes	Yes
No	No
Can impacts be mitigated?	**Rating**
Yes	Yes
No	No
Significance	**Rating**
< 30 points	Low
30-60 points	Medium
> 60 points	High

The assessment of impact significance considers pre-mitigation as well as implemented post-mitigation scenarios. Three phases were considered for the impact assessment:

- Construction Phase;
- Operational Phase; and
- Closure/Rehabilitation Phase.

Mitigation measures must be implemented to negate potential impacts to water resources. The mitigation actions required to lower the risk of the impact are provided in Section 6.6 of this report.

6.4.1 Construction Phase

The following potential main impacts on the ephemeral watercourses and associated biodiversity dependent on these systems (based on the framework above) were considered for the construction phase of the proposed development. This phase refers to the period during construction when the proposed infrastructure is constructed; and is considered to have potentially large direct impacts on aquatic ecosystems, notably where infrastructure intercepts the watercourses. This phase typically involves the removal of indigenous vegetation for infrastructure (laydown yards, powerlines, solar area, BESS, substation, and the associated road network & river crossing structures), landscaping to desired topography, and the establishment of infrastructure. This involves earthworks activities (digging, soil moving and soil stockpiling) and the use of construction chemicals and materials and machinery all of which influence adjacent habitats and includes watercourses. The following construction phase related impacts to aquatic ecology were considered:

- Disturbance/ displacement/ loss of riparian/marginal and instream riverine habitat (Habitat fragmentation) (Table 6-2),
- Contamination of watercourse and biotic community effects (Table 6-3); and
- Alteration of catchment hydrology and associated habitat ecology impacts (Table 6-4).

Table 6-2 Impacts to watercourse habitat and biotic community associated with the construction phase

Impact Nature: Disturbance/ displacement/ loss of riparian, marginal and instream riverine habitat (Habitat fragmentation)		
Destruction, loss and fragmentation of the of habitats, ecosystems and biotic community responses to the alteration of the catchment for solar, grid and associated infrastructure. The drainage network and associated alluvial fan drainage feature within the PV1 area is considered extensive requiring avoidance from solar panels with minimal roads traversing these drainage features.		
	Without mitigation (Impact Rating)	**With mitigation (Impact Rating)**
Extent	Footprint & surrounding areas (2)	Site specific (1)
Duration	Permanent (5)	The lifetime of the impact will be of a short duration (2-5 years) (2)
Magnitude	High (processes are altered to the extent that they temporarily cease) (8)	Low and will cause a slight impact on processes (4)
Probability	Definite (5)	Probable (3)
Significance	**High**	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources?	Yes - ESA, CBA1 and CBA2 areas	No
Can impacts be mitigated?	Yes, although this impact cannot be well mitigated as the loss of vegetation is unavoidable. However, the construction footprint can be realigned to avoid/minimise disturbance to drainage features and associated buffers	
Mitigation:		
See section 6.6 of this report.		
Residual Impacts:		
The loss of currently intact vegetation is an unavoidable consequence of the project and cannot be entirely mitigated. The residual impact following mitigation would however be low for the construction phase with focus on limiting erosion required.		

Table 6-3 Contamination of watercourse and biotic community effects associated with the construction phase

Impact Nature: Pollution of water resources from construction activities		
Pollution stemming from construction activities (spills and leaks from machinery and construction materials, leaching from excavated soils and waste handling) that enters the natural environment and downslope watercourses, with associated impacts to soils, habitat integrity and ecological function which in turn lowers the aquatic and terrestrial biodiversity dependent on the affected ecosystems, notably in times of surface water availability.		
	Without mitigation (Impact Rating)	**With mitigation (Impact Rating)**
Extent	Local area (3)	Site specific (1)
Duration	Moderate term (5–15 years) (3)	Very short term (0–1 years) (1)
Magnitude	Moderate and will result in processes continuing but in a modified way (6)	Minor and will not result in an impact on processes (2)
Probability	Definite (5)	Probable (3)
Significance	**Medium**	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High

Impact Nature: Pollution of water resources from construction activities		
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes, although this impact cannot be well mitigated as some level of pollution is unavoidable, notably where powerline pylons and roads are to be built within drainage areas.	
Mitigation:		
See section 6.6 of this report.		
Residual Impacts:		
Some level of pollution is inevitable due to the nature of the construction activities and cannot be entirely mitigated. The residual impact following mitigation would however be low and of short duration for the construction phase.		

Table 6-4 Impacts to catchment hydrology associated with the proposed construction phase

Impact Nature: Alteration of catchment hydrology and associated habitat ecology impacts from construction activities		
Construction phase activities that result in the reshaping and change in vegetative cover density for solar infrastructure with associated alterations of slope, runoff velocities, infiltration capacity and sediment movement from baseline conditions. This is expected to occur across the catchment, with associated impacts to slope stability, habitat integrity and ecological function. This is especially of concern due to the high erodibility of catchment soils in this arid environment and keys areas would include active working areas (road network, PV area, grid infrastructure, etc) where bare soils are exposed to washaway. This is of special concern in the PV area due to the extent of the alluvial fan and tributary network drainage features.		
	Without mitigation (Impact Rating)	**With mitigation (Impact Rating)**
Extent	Local area (3)	Footprint & surrounding areas (2)
Duration	Permanent (5)	The lifetime of the impact will be of a short duration (2-5 years) (2)
Magnitude	Very high and results in complete destruction of patterns and permanent cessation of processes (10)	Low and will cause a slight impact on processes (4)
Probability	Definite (5)	Probable (3)
Significance	**High**	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	None	Moderate
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes, although this impact cannot be well mitigated as the hydrology alterations are unavoidable and long term. However, the construction footprint can be realigned to avoid watercourses and associated buffers	
Mitigation:		
See section 6.6 of this report.		
Residual Impacts:		
Alteration of the catchment hydrology is inevitable due to the nature of the construction activities and cannot be entirely mitigated. The residual impact following mitigation would however be low and of short duration for the construction phase.		

6.4.2 Operation Phase

The operational phase impacts are related to daily operational and maintenance activities which are anticipated to have indirect impacts on aquatic ecosystems, as well as the deterioration of the adjacent habitats due to the increase in maintenance vehicles across the project footprint. The modification of the catchment drainage will alter watercourse habitats through altered drainage from baseline conditions with increased erosion and sedimentation, especially in exposed/ denuded areas and increased hardened surfaces (solar panels and roads). Stormwater management will therefore be crucial within the proposed operations footprint. This phase typically involves the washing and maintenance of solar panels, and the operation of the road network and river crossing structures for the powerline and PV1 area inspections. The following operational phase related impacts to aquatic ecology were considered:

- Continued fragmentation and degradation of habitats and ecosystems (Table 6-5);
- Contamination of watercourse and biotic community effects (Table 6-6);
- Alteration of catchment hydrology and associated habitat ecology impacts (Table 6-7).

Table 6-5 Impacts to watercourse habitat and biotic community associated with the operational phase

Impact Nature: Continued disturbance/ displacement/ loss of riparian, marginal and instream riverine habitat		
Disturbance created during the construction phase will leave the project area and watercourses vulnerable to erosion (highly erodible catchment) and encroachment by alien vegetation. The operational phase activities will result in the continued destruction, loss and fragmentation of habitats, ecosystems and biotic community responses.		
	Without mitigation (Impact Rating)	**With mitigation (Impact Rating)**
Extent	Footprint & surrounding areas (2)	Site specific (1)
Duration	Long term (> 15 years) (4)	The lifetime of the impact will be of a short duration (2-5 years) (2)
Magnitude	Moderate and will result in processes continuing but in a modified way (6)	Low and will cause a slight impact on processes (4)
Probability	Definite (5)	Probable (3)
Significance	**Medium**	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes, with proper management and avoidance, this impact can be mitigated to a low level.	
Mitigation:		
See section 6.6 of this report.		
Residual Impacts:		
The ESA areas will be lost or degraded by the solar and grid development activities. Despite mitigation, erosion is expected across the project footprint, influencing downslope watercourses and habitat, especially where roads and powerline pylons intercept with watercourses. The residual impact following mitigation would however be low.		

Table 6-6 Contamination of watercourses and negative biotic community impacts associated with the operational phase

Impact Nature: Pollution of water resources from operational activities		
The operation and maintenance of the proposed development will involve the cleaning of the solar panel with chemicals which has the potential to pollute soils (should chemicals be used) and in times of flow will pollute surface runoff from contaminated soils and enter into the downslope watercourses, with associated impacts to habitat integrity and ecological function which in turn lowers the aquatic and terrestrial biodiversity dependent on the affected ecosystems. Further pollution impacts can be expected from hydrocarbons (fuels, oil, etc) from leaking maintenance vehicles which escape into the environment along the road network, entering downslope watercourses during rainfall events, with similar impacts to water quality and ecological functioning.		
	Without mitigation (Impact Rating)	**With mitigation (Impact Rating)**
Extent	Regional (4)	Footprint & surrounding areas (2)
Duration	Long term (> 15 years) (4)	The lifetime of the impact will be of a short duration (2-5 years) (2)
Magnitude	Moderate and will result in processes continuing but in a modified way (6)	Low and will cause a slight impact on processes (4)

Impact Nature: Pollution of water resources from operational activities		
Probability	Definite (5)	Probable (3)
Significance	**High**	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes, although this impact cannot be well mitigated as some level of pollution is unavoidable. Despite this spill kits and other spill prevention measures should be in place	
Mitigation:		
See section 6.6 of this report.		
Residual Impacts:		
Some level of pollution is inevitable due to the nature of the operational activities and cannot be entirely mitigated. The residual impact following mitigation would be Low and of short duration following the implementation of mitigation.		

Table 6-7 Impacts to catchment hydrology associated with the operational phase

Impact Nature: Alteration of catchment hydrology and associated habitat ecology impacts from operational activities		
As a result of the landscaping to new topography and change in vegetative cover type and density below the solar panels, together with increased hardened surfaces from solar panels and road network, new functioning regimes pertaining to surface runoff, infiltration and sediment movement patterns will influence the adjacent natural habitat characteristics. This in turn will potentially influence habitat integrity and ecological functioning, notably from increased return flows (surface runoff), erosion and instream sedimentation impacts. This would be applicable to habitat and watercourse features in proximity to the proposed infrastructure, notably the powerline pylons and downslope areas of the road network and PV area.		
	Without mitigation (Impact Rating)	**With mitigation (Impact Rating)**
Extent	Local area (3)	Site specific (1)
Duration	Long term (> 15 years) (4)	The lifetime of the impact will be of a short duration (2-5 years) (2)
Magnitude	High (processes are altered to the extent that they temporarily cease) (8)	Low and will cause a slight impact on processes (4)
Probability	Definite (5)	Probable (3)
Significance	**High**	**Low**
Status (positive or negative)	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes, although this impact cannot be well mitigated as the hydrology alterations are unavoidable. However, the operational activities need to avoid direct impacts to watercourses and associated buffers (no-go areas), notably erosion.	
Mitigation:		
See section 6.6 of this report.		
Residual Impacts:		
Residual impacts following mitigation are largely related to altered surface runoff and erosion due to altered hydro-dynamics and erodibility of the associated catchment.		

6.4.3 Decommissioning Phase

Solar projects typically operate for approximately thirty and forty years. Following the completion of the economic life of the project or approaching permit expiration, the project owner can apply for a new permit or remove/decommission the facility. The renewal of permits option could involve either operating the same solar panels as the panels can operate past thirty years, albeit at lower efficiency, or “repower” the site by upgrading the facility with more efficient solar technology. Otherwise, the facility can be decommissioned. The solar project permits may define how a solar project is to be decommissioned.

Decommissioning refers to removal of equipment and restoration of the site to near baseline conditions or alternatively the site can be repurposed for other uses, such as agricultural production. Often the solar panels are recycled (glass and aluminium) or sold for off-grid applications or electrification in developing countries. The associated infrastructure (solar and grid, roads and fencing) and foundations are dismantled, and various parts are refurbished, recycled, or landfilled as appropriate. The restoration of the land would involve backfilling of excavations, de-compacting of compacted soils, landscaping to natural conditions, and revegetation of the entire project disturbance footprint.

The impacts for the decommission phase are considered to be similar in significance to the construction phase as the activities are similar and are carried out in reverse order. The impact ratings for this phase would therefore be similar and can be seen in Table 6-2 to Table 6-4.

6.4.4 Cumulative Impacts

The impacts of projects are often assessed by comparing the post-project situation to a pre-existing baseline. Where projects can be considered in isolation this provides a good method of assessing a project’s impact. However, in areas where baselines have already been affected, or where future development will continue to add to the impacts in an area or region, it is appropriate to consider the cumulative effects of development. This is similar to the concept of shifting baselines, which describes how the environmental baseline at a point in time may represent a significant change from the original state of the system. This section describes the potential impacts of the project that are cumulative for freshwater fauna and flora.

Cumulative impacts are assessed in context of the extent of the proposed project area; other solar developments in the area; and general watercourse and habitat loss and transformation resulting from other activities in the region. There are a number of existing renewable energy developments with existing electrical infrastructure and grid connections in the greater De Aar regional area, with additional energy developments proposed.

The expected post-mitigation risk significance for the project in isolation is expected to be low, but in consideration of the larger project area the overall cumulative impact is expected to be medium (Table 6-8). This is expected as the project extends into two quaternary catchment areas. Localised cumulative impacts include the cumulative effects from operations that are close enough (such as nearby farming activities within the area) to potentially cause additive effects on the environment or sensitive receivers. These include disruption of ecological corridors or habitat such as watercourses, impacts to groundwater and surface water quality, and transport of soils and instream habitat smothering impacts.

Table 6-8 Cumulative impacts to aquatic ecosystems associated with the proposed project

Impact Nature: Cumulative loss/ disturbance of habitat and ecological functioning of watercourses in the region
The development of the proposed infrastructure will contribute to cumulative habitat loss within ESA, CBA1 and CBA2 areas, watercourses and adjacent habitat together with the potential for increased contaminants and sediment entering the watercourses.

Impact Nature: Cumulative loss/ disturbance of habitat and ecological functioning of watercourses in the region		
The loss/alteration of habitat lowers the buffering capacity of the catchment to water quality impacts, will have negative impacts on the ecological processes of the associated watercourses in the region.		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project together with the existing and proposed projects in the area**
Extent	Footprint & surrounding areas (2)	Regional (4)
Duration	Long term (4)	Long term (4)
Magnitude	Moderate and will result in processes continuing but in a modified way (6)	High (processes are altered to the extent that they temporarily cease) (8)
Probability	Improbable (2)	Probable (3)
Significance	**Low**	**Medium**
Status (positive or negative)	Negative	Negative
Reversibility	Moderate	None
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes, avoidance of watercourses/drainage network is possible for the project footprint with adherence to buffers.	
Mitigation:		
• Ensure that an adaptive EMP be compiled and effectively implemented considering all mitigation presented in this report as well as the associated terrestrial biodiversity report. • Key focus should be placed on stormwater and erosion prevention strategies. • Further mitigation presented in section 6.6 of this report.		
Residual Impacts:		
Watercourse deterioration over time caused by altered hydro-dynamics, erosion, water quality impacts and alien vegetation infestation and the subsequent loss / deterioration of ecosystem services, despite mitigation. This is a result of the long term duration for the life of the project.		

6.5 Developable and Non-developable Areas

As highlighted in the previous sections, the project area has various ecological characteristics highlighting their sensitivity to degradation. In context of the proposed Riet Fountain Solar PV1 Facility development, the project area was assessed for non-developable areas (areas where no infrastructure or development is to occur – no-go zones) and potentially developable areas (areas more suitable for development) as illustrated in Figure 6-1. The non-developable areas (yellow polygons) were delineated based on the 50 m buffer of the drainage features as they are regarded as Ecological Support Areas and this no-go buffer zone will assist in maintaining faunal (aquatic and terrestrial) diversity, ecosystem functioning and services offered (Macfarlane *et al*, 2009). This buffer width considered the baseline catchment condition, watercourse habitat integrity, the highly erodible nature of the arid environment soils and the wildlife dependence on these systems as per recommendations in Macfarlane *et al*. (2009). Ensuring buffers are intact increases the resilience of a watercourse to future disturbances.

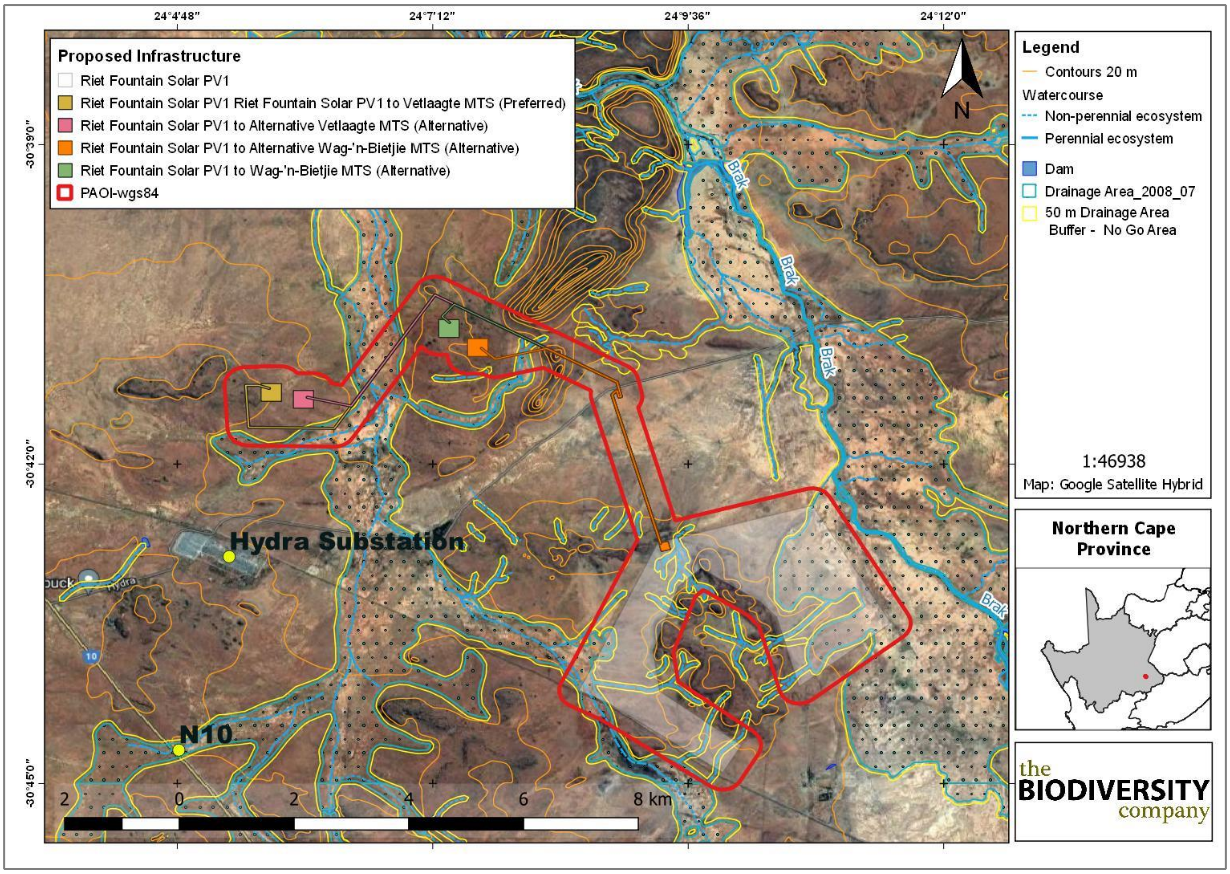

Figure 6-1 Map illustrating the developable and non-developable areas within the proposed development area

The infrastructure of concern to the aquatic features and their associated 50 m buffer is both the drainage network within the PV1 area, and the Western Tributary network whereby the drainage network will be traversed by the proposed PV area and powerline infrastructure and all the associated alternatives in several areas, respectively. The drainage network within the PV1 area is considered extensive negating the use large portions of the proposed PV1 layout for solar panels. The orientation of the powerlines route is in such a manner that the route extends diagonally across (45 degrees) the main stem reach (drainage/flow direction) of the Western Tributary and not perpendicularly (90 degrees) to the drainage/flow direction. This diagonal orientation would result in a greater number of powerline pylons located directly within the sensitive watercourse features and buffer area than if the route were redesigned perpendicular to the drainage channel. This perpendicular orientation would result in far less pylons within the drainage area. Additional avoidance measures include limiting pylons from being built within or near drainage features by having the powerlines span watercourse features, notably the smaller systems. Additionally, the associated road network should follow avoidance mitigation and be aligned to avoid all drainage features, and where crossings are absolutely necessary for wet season crossings, the road should be constructed of permeable in key areas of wetness or steep slopes to prevent erosion or habitat destruction during use. This avoidance strategy through changes of project infrastructure design will limit the amount of habitat being impacted for the construction and operation of the solar development (Figure 6-2).

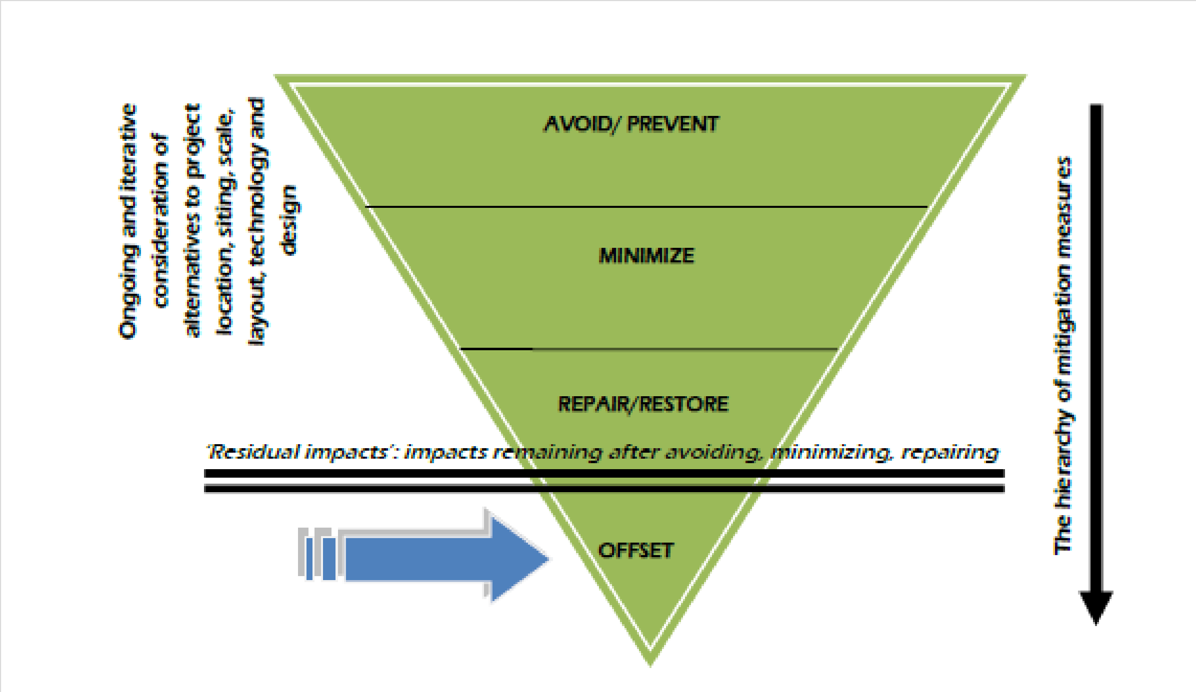

Figure 6-2 Schematic diagram illustrating the mitigation hierarchy indicating where residual impacts are considered. Source: (DFFE, 2021)

6.6 Mitigation

In light of the expected impacts from proposed activities the following mitigation measures have been proposed to lower the intensity of the impacts on the ecological integrity of the catchment and its downslope watercourses.

6.6.1 Powerlines and Roads (Grid Connection Infrastructure)

The proposed powerline construction is regarded as a low risk to the watercourse should construction occur outside of the delineated sensitive drainage features as the disturbance footprint area is limited to the pylon base. However, the increase in traffic along the associated road servitude is likely to increase erosion of channels and banks along drainage lines and watercourse areas. Should pylon placement be within the watercourse areas impacts would be expected. The powerlines pose low risks to the watercourse network during the operational phase should the pylons be constructed outside of the delineated drainage network by spanning overhead of these drainage areas.

The following powerline and road mitigation measures are provided:

- The recommended buffer zones must be strictly adhered to during the construction phase of the project, with exception of the activities and structures required to traverse the watercourse. Any supporting aspects and activities not required to be within the buffer area must adhere to the buffer zone;
- The pylons must be constructed outside of the delineated drainage network by spanning overhead of these sensitive areas. This avoidance measure limits pylons from being built within or near drainage features, notably the active channel;

- The realignment of the powerlines within the Western Tributary to a perpendicular orientation would result in a lower number of powerline pylons located directly within the Western Tributary and buffer area;
- Areas where construction is to take place must be clearly demarcated. Any areas not demarcated must be completely avoided;
- Landscape and re-vegetate all cleared areas as soon as possible to limit erosion potential;
- Install sedimentation/erosion protection measures prior to construction in the form of several rows of sand bags, silt traps and fences, this is particularly important in the access roads leading to the watercourse and around active working areas for pylons foundations;
- Energy dissipation, such as stone berms or blocks must be strategically placed along the road margins for the entire road network as surface runoff leaves the roads and enters the surrounding environment with the potential for severe erosion. The steeper the slope of the road, the more regular the berms should be spaced and can be as close as one meter apart where necessary;

Figure 6-3 Example of road margin erosion prevention

- The road margins should be hydroseeded with vigorous growing indigenous grasses that are drought tolerant to lower erosion of these key areas;
- The section of roads which will traverse the lowest lying areas/potentially wet areas or steeper slopes will be subjected to traffic from vehicles for inspections and maintenance on site with the potential for damage to habitat and erosion and thus require permeable paving. The permeable paving provides a stable platform to carry the loads of service vehicles whilst the vegetation growing through the permeable pavers compliments the surrounding vegetation, preventing erosion in these key areas;

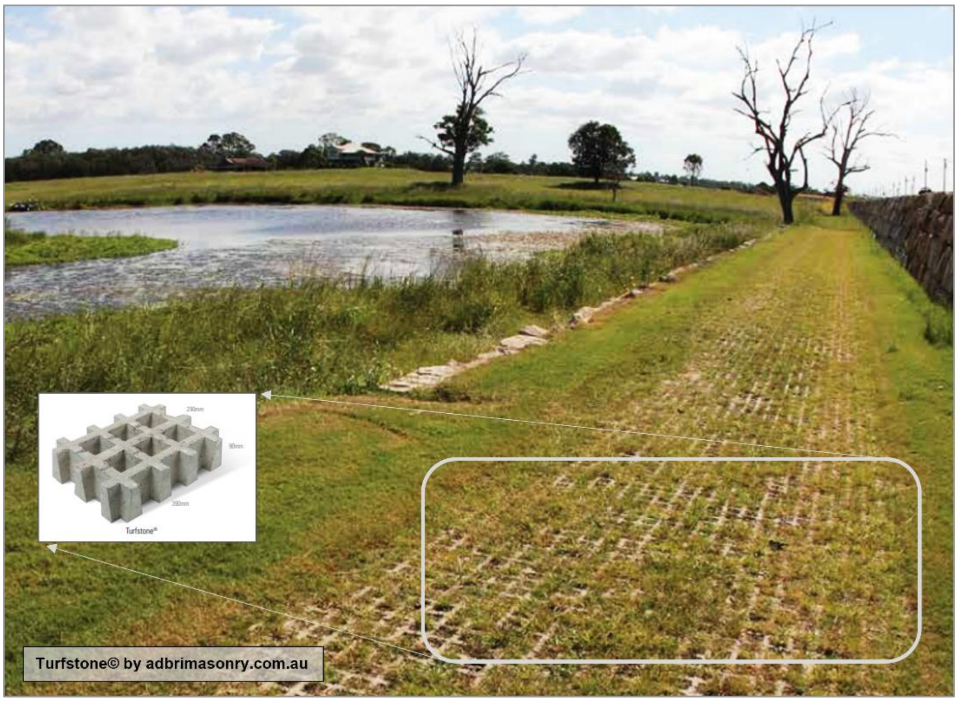

Figure 6-4 Example of permeable paving for roads and habitat maintenance

- An inspection of the pylons, road network and surrounding influenced areas must be completed within 1 month following the end of construction activities and within a week after the first rainfall event. Thereafter, routine monitoring should take place for the life of the project. Should erosion be developing this must be immediately addressed through appropriate and adaptive measures.

6.6.2 Solar Panels (Photovoltaic Facility)

The proposed PV1 construction is regarded as a low risk to the drainage network should construction occur outside of the delineated sensitive drainage features as the proposed footprint area extends across several drainage areas which constitute alluvial fans, dams and drainage lines. However, the increase in hardened surfaces from the high volume of solar panels and the associated road servitude is likely to increase erosion of the drainage features. It is assumed that the solar panels will be constructed on stilts and the use of stilts will lower the impacts to ground and surface waterflows. However, the volume of solar panels constructed in the footprint will influence the hydro-dynamics of the drainage network.

The following solar panel mitigation measures are provided:

- The recommended buffer zones must be strictly adhered to during the construction phase of the project, with exception of the activities and structures required to traverse the watercourse (where considered critical and necessary). Any supporting aspects and activities not required to be within the buffer area must adhere to the buffer zone;
- The solar panels and associated road network must be constructed outside of the delineated drainage network to avoid impacts these sensitive areas;
- The project must ensure that the minimum number of necessary roads traverse the delineated low lying drainage areas in the PV1 area to ensure hydrological connectivity maintenance;
    - The number of roads should be restricted to single road per drainage line/area;

- The section of roads which will traverse the lowest lying areas/potentially wet areas (drainage feature) require permeable paving as discussed in the powerline and roads mitigation section;

- A qualified Hydrologist with experience in arid areas must develop a suitable and adaptive Stormwater management plan to ensure no erosion takes place and that clean water reports back to the Brak system;
    - The panels should be fitted with stormwater gutters to control the runoff in an ecologically sensitive manner to prevent erosion;
    - Stormwater runoff from the panels should enter the drainage system through diffuse channels fitted with flow attention / energy dissipation structures in the form of green infrastructure;
    - Stormwater runoff and runoff from cleaning the panels would be increased, increasing erosion in the surrounding areas;
    - The cleaning of the solar panel must avoid using chemicals as this will pollute soils, and in times of flow will pollute surface runoff from contaminated soils.
- Solar panels must be mounted on pile driven or screw foundations, such as post support spikes, rather than heavy foundations, such as trench-fill or mass concrete foundations, to reduce the negative effects on natural soil functioning, such as its filtering and buffering characteristics, while maintaining habitats for both fossorial and epigeic biodiversity (Bennun *et al,* 2021). If concrete foundations are used that would increase the impact of the project as there would be direct impacts to soil permeability and characteristics, thereby influencing inhabitant fauna;
- Indigenous vegetation must be maintained under the solar panels to ensure biodiversity is maintained and to prevent soil erosion (Beatty *et al,* 2017; Sinha *et al*, 2018). This vegetation cover will maintain surface roughness which will assist in maintaining hydrological connectivity through infiltration and subsurface interflow. The photographs below are sourced from these documents;

- The vegetation type to be maintained under the solar panels should be low-growing grasses which reduce the potential impact of fire as shorter grass would lower the intensity of fires. Sheep-grazing should be introduced to assist in maintaining the vegetation to reduce fire risk (Vaverková *et al.,* 2022); and
- Environmental Control Officer (ECO) to provide supervision and oversight of vegetation clearing activities.

6.6.3 General Mitigation Measures

The following general mitigation measures are provided:

- Construction activities must take place during the low flow period (as much as possible). In addition to this, basic stormwater structures such as berms must be designed and implemented prior to and throughout the duration of the construction activities;
- The water resources outside of the specific project site area must be avoided;
- Where possible, the construction of any watercourse crossings (if needed) must take place from the existing areas of disturbance and not from within the drainage lines/areas;
- Prevent uncontrolled access of vehicles through the watercourse that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;
- Laydown yards, camps and storage areas must be beyond the watercourse and associated buffer areas.
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the drainage systems;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- All chemicals and toxicants to be used for the construction must be stored outside the watercourses and in a bunded area;
- Appropriately contain any generator diesel storage tanks, machinery spills (e.g. accidental spills of hydrocarbons oils, diesel etc.) or construction materials on site (e.g. concrete) in such a way as to prevent them leaking and entering the environment;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- Mixing of concrete must under no circumstances take place within the drainage systems. Scrape the area where mixing and storage of sand and concrete occurred to clean once finished;
- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. These should not be placed near any watercourse or in buffer zones. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- All removed soil and material must not be stockpiled within the watercourses. Stockpiling should take place outside of drainage systems. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds or sand bags;

- All active working areas (road network, PV area, grid infrastructure, etc) where bare soils are exposed must be protected against erosion through adequate erosion prevention measures to prevent exposed soils washing into adjacent habitat and watercourses;
- Erosion and sedimentation into the drainage lines must be minimised through the land scaping to gentle gradients and the re-vegetation of any disturbed areas;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses that are drought tolerant) to protect the exposed soil;
- Landscape and re-vegetate all cleared areas as soon as possible to limit erosion potential associated with steep slopes and bare/exposed soils.
- The access road and associated road margins, and silt traps must be inspected on a monthly basis for signs of erosion. When erosion is observed, the area should be rehabilitated within 7 days. In addition, inspections following a >50 mm/ 24 hr rainfall event must occur within 7 days of the event;
- No dumping of construction material on-site may take place;
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported;
- Make sure all excess consumables and building materials / rubble are removed from site and deposited at an appropriate waste facility; and
- The decommissioning of solar developments and associated costs can be substantial and are the responsibility of the project owner and not for the landowners or local municipality (if separate entities). These costs should include the salvage value projections to ensure this phase caters appropriately for the restoration costs of the land to baseline conditions.

6.7 Recommendations

The following recommendations are provided for the project and are considered key aspects for environmental authorisation:

- A competent ECO must oversee the respective phases of the project, with watercourse areas as a priority to limit the listed impacts on the watercourses. The ECO must be supplied with a copy of this report and the other specialist study reports conducted for this project to familiarise themselves with the mitigation and recommendations prior to construction;
- A qualified Hydrologist with experience in arid areas must develop a suitable and adaptive Stormwater management plan to ensure no erosion takes place and that clean water reports back to the Brak system;
- The project must ensure that the minimum number of necessary roads traverse the delineated low lying drainage areas in the PV1 area to ensure hydrological connectivity maintenance;
- An adaptive rehabilitation plan needs to be implemented from the onset of the project. The key focus should be placed on stormwater and erosion prevention strategies;

- Stormwater runoff should enter the drainage system through diffuse channels fitted with flow attenuation / energy dissipation structures;
- Therefore, an infrastructure monitoring and service plan must be compiled and implemented during the operational phase. This will include the monitoring the road reserve route, all stormwater discharge points, energy dissipation structures, and stability of watercourse habitat in the project footprint. This service plan should be adaptive based on on-site conditions;
- A Rehabilitation Plan must be written for the development area and ensured that it be adhered to for all stages of the project life; and
- This report must consider the associated TBC terrestrial biodiversity report and associated mitigation and recommendations.

7 Conclusions

Desktop information associated with the proposed Riet Fountain Solar PV1 and associated grid infrastructure development indicates that the indirectly affected downstream Brak River system and directly associated ephemeral tributaries within the project area have sensitivity to modification. These systems serve as ESA's, CBAs and important NFEPA upstream management areas. The desktop PES of the Brak SQR D62D-5391 is moderately modified (class C), and that of the two Brak tributaries SQR D62D-5332 and D62D-5486 is largely natural (class B) respectively. with an associated ecological importance and sensitivity of moderate and low, respectively. The Recommended Ecological Category (REC) to be maintained is a class B which can be achieved through the responsible management of the tributary network and associated catchment.

The June 2022 dry season survey found limited surface water within the ephemeral drainage features. Surface water was present in the Brak River and in a tributary to the northeast of project area with limited water quality impacts recorded. The electrical conductivity was however elevated above the RWQOs within the Brak River downstream of the project area at site Brak Down, indicating likely catchment influence and/or high background levels. No water was present in the Western Tributary system.

The assessed watercourses presented flat alluvial floodplain habitat features with no clear banks or riparian features which is typical for watercourses in an arid region. These ecosystems and adjacent terrestrial habitat was dominated by open natural land and largely unmodified, with some influence from land use activities within their catchment. Despite their current level of modification and ephemeral nature, the watercourses are sensitive to further modification as these systems do provide drinking opportunities (in times of rainfall), and provide connectivity and habitat for foraging, nesting and refugia for terrestrial biota and avifauna. During periods of flow, they are likely to only support a low diversity of macroinvertebrates for a short period of time. Therefore, the watercourses in the project area are regarded as sensitive environments in relation to changes in habitat integrity, flow and water quality requiring avoidance from the project related disturbance activities and maintenance of baseline conditions.

The aquatic features presented in this report require a buffer of 50 m and are to be treated as a no-go zone and avoided as far as is feasible. Ensuring that aquatic features and buffers are intact increases the resilience of a watercourse to future disturbances. These buffers would ensure adequate ecological integrity maintenance from the adjacent proposed solar facilities.

Impact statement

An impact statement is required as per the NEMA regulations with regards to the proposed development. As a result of the ephemeral nature of the watercourses and susceptibility to erosion, the construction and operation phase activities would influence the hydrology, water quality and soil movement within the affected watercourses, notably where the proposed powerline infrastructure and all alternatives traverse these aquatic features and their associated 50 m buffer. Provided the powerline route be designed so that the fewer pylons are required within the no-go zones (where feasible), and the PV1 area avoid the extensive non-developable drainage network, the project will present low rated residual impacts to the watercourses. It is the specialist's opinion and supported by survey findings, the specialist agrees with the "Very High" aquatic theme sensitivity as per the National Web based

Environmental Screening Tool. The project infrastructure does pose risk to the watercourses and it is the specialist's opinion that following the implementation of avoidance mitigation, recommendations and remedial measures, the risks can be lowered. Therefore, authorisation of the proposed development can be carefully considered by the authorities.

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9 Appendix A Specialist declarations

Declaration of Report Writer

I, **Dale Kindler**, declare that:

- I act as the 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 expertise in conducting the specialist report relevant to this application, 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 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;
- 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.

Dale Kindler

Aquatic Ecologist

The Biodiversity Company

July 2022

Declaration of Report Reviewer

I, **Christian Fry**, declare that:

- I act as the 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 expertise in conducting the specialist report relevant to this application, 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 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;
- 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.

Christian Fry

Aquatic Ecologist

The Biodiversity Company

July 2022