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GEELSTERT SOLAR FACILITY 1 NEAR AGGENEYS, NORTHERN CAPE PROVINCE

FRESHWATER RESOURCE STUDY AND ASSESSMENT

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Authors: Gerhard Botha

PROPOSED DEVELOPMENT OF THE GEELSTERT 1 SOLAR FACILITY NEAR AGGENEYS, NORTHERN CAPE PROVINCE

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Authors: Mr. Gerhard Botha

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Prepared for: Savannah Environmental (Pty) Ltd.
First Floor, Block 2, 5 Woodlands Drive Office Park, Cnr Woodlands Drive & Western Service Road,
Woodmead
2191
Cell: 082 734 5113
Email: reuben@savannhsa.com

Prepared by Nkurenkuru Ecology and Biodiversity
3 Jock Meiring Street
Park West
Bloemfontein
9301
Cell: 083 412 1705
Email: gabotha11@gmail com

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I. DECLARATION OF CONSULTANTS INDEPENDENCE

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- have and will not have any vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 326) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offense in terms of regulation 48 of GN No. R. 326.

REPORT AUTHORS

Gerhard Botha *Pr.Sci.Nat* 400502/14 (Botanical and Ecological Science)

Field of expertise: Fauna & flora, terrestrial biodiversity, wetland ecology, aquatic and wetland, aquatic biomonitoring, and wetland habitat evaluations. BSc (Hons) Zoology and Botany, MSc Botany (Phytosociology) from 2011 to present.

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PROPOSED CONSTRUCTION OF THE GEELSTERT 1 SOLAR PV FACILITY, NORTHERN CAPE PROVINCE

FRESHWATER RESOURCE STUDY AND ASSESSMENT

1. INTRODUCTION

Applicant

Geelstert Solar Facility 1 (Pty) Ltd.

Project

The project will be known as Geelstert 1.

Proposed Activity

Geelstert Solar Facility 1 (Pty) Ltd is proposing the development of a commercial solar PV facility and associated infrastructure, known as Geelstert 1, on a site located approximately 11km south-east of Aggeneys (Figure 1) within the Khâi-Ma Local Municipality and the Namakwa District Municipality in the Northern Cape Province.

A potential development area (located within the study area and affected property, Remaining Extent of the Farm Bloemhoek 61) with an extent of ~578ha has been identified by Geelstert Solar Facility 1 (Pty) Ltd as a technically suitable site for the development of a solar PV facility with a contracted capacity of up to 125MW. The development footprint (~245ha) of Geelstert 1 will be located within the development area. The study area is located within Focus Area 8 of the Renewable Energy Development Zones (REDZ), which is known as the Springbok REDZ. Due to the location of the study area within a REDZ, a Basic Assessment (BA) process will be undertaken in accordance with GN R114 as formally gazetted on 16 February 2018.

The development area of Geelstert 1 is proposed to accommodate the following infrastructure, which will enable the solar PV facility to generate a contracted capacity of up to 125MW (Figure 2):

» Bifacial or monofacial PV panels, mounted on fixed-tilt or tracking mounting structures with a maximum height of 3.5m;
» Centralised inverter stations or string inverters;

- A temporary laydown area;
- Cabling between the panels, to be laid underground where practical;
- An on-site facility substation stepping up from 22kV or 33kV to 132kV or 220kV, with an extent of up to 1ha to facilitate the connection between the solar PV facility and the grid connection solution;
- An access road to the development with a maximum width of 8m;
- Internal access roads within the PV panel array area with a maximum width of 5m;
- Operation and Maintenance buildings including a gate house and security building, control centre, offices, warehouses, a workshop and visitors centre.

It is the Developer's intention to bid the solar PV facility under the Department of Mineral Resources and Energy's (DMRE) Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). Ultimately, the project is intended to be part of the renewable energy projects portfolio for South Africa, as contemplated in the Integrated Resources Plan (IRP).

A separate Basic Assessment process will be undertaken for the Geelstert Grid Connection to connect Geelstert 1 to the Aggeneis Main Transmission Substation (MTS).

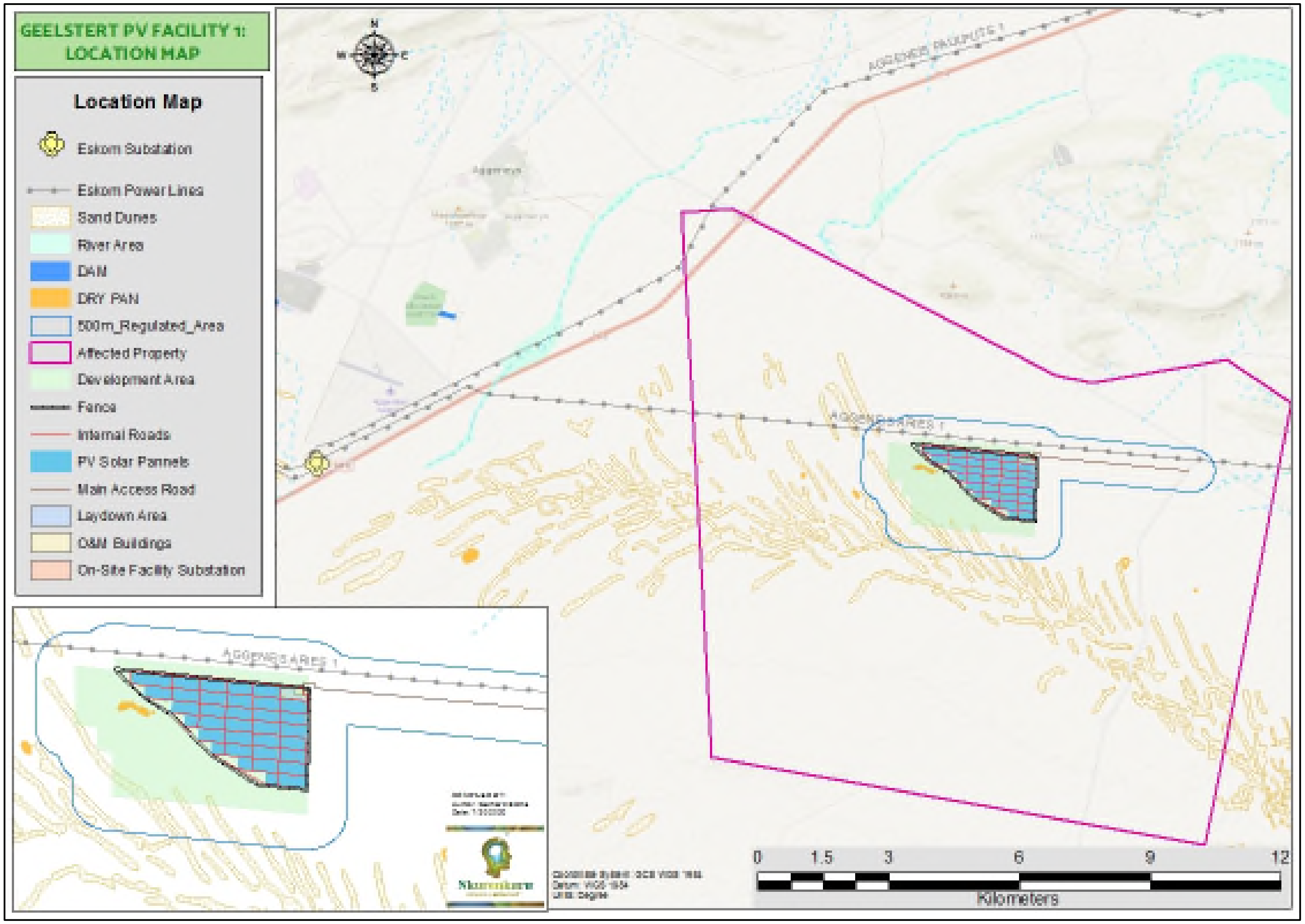

Figure 1: Location map of the proposed Geelstert 1 solar PV facility.

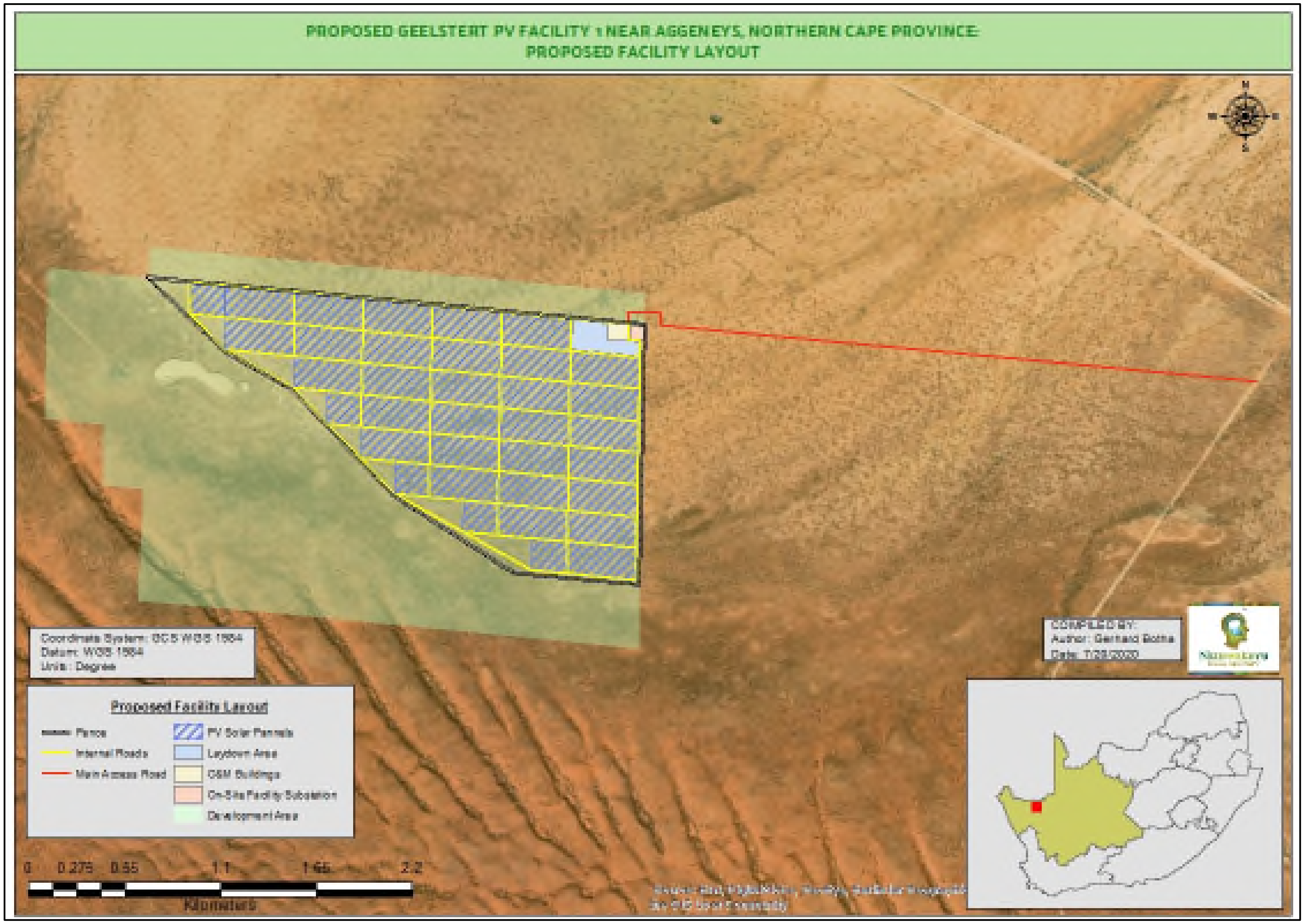

Figure 2: Proposed layout of the Geelstert 1 solar PV facility.

Terms of reference

The primary objective of the specialist wetland assessment was to provide information to guide the proposed Solar PV development with respect to the potential impacts on the affected freshwater ecosystems within the project site. The focus of this study was solely on the specific Hydrogeomorphic Units (HGMs), within a radius of 500m of the proposed development area footprint and which may be impacted by the proposed development.

The focus of the work involved the undertaking of a specialist assessment of freshwater resource features, which included the following tasks:

- Desktop identification and delineation of potential freshwater resource areas affected by the proposed development, or occurring within a 500m radius of the proposed development area using available imagery, contour information and spatial datasets in a Geographical Information System (GIS);
- Undertaking a rapid water resource screening and risk assessment to determine which desktop delineated/mapped watercourses/wetlands are likely to be measurably affected by the proposed activities. This was used to flag watercourses/wetlands for further infield assessments as well as identify those watercourses/wetlands that will be unaffected and will not require further assessment (i.e. wetlands/rivers within adjacent catchments, upstream or some distance downstream of the predicted impact zone);
- Site-based (detailed in-field) delineation of the outer wetland boundary of wetland/watercourse areas within the project focal area and which were flagged during the desktop screening/risk assessment;
- Classification of wetlands and riparian areas and assessment of conservation significance based on available data sets;
- Description of the biophysical characteristics of the delineated freshwater habitats based on onsite observations and sampling (i.e. hydrology, soils, vegetation, existing impacts etc.);
- Baseline functional assessment of wetland habitats based on field investigations, involving the:
  - PES (Present Ecological State/Condition) of the delineated wetland units;
  - EIS (Ecological Importance and Sensitivity) of the delineated wetland units;
  - Direct and indirect ecosystem services (functions) importance of the delineated wetland units only.
- Impact assessment and identification of mitigation measures to reduce the significance of potential aquatic impacts for both the construction and operational phases of the project. For this section the same methodology and layout approach within the Basic Assessment Report was followed in order to maintain uniformity and coherence between the two reports.
- Compilation of a specialist wetland assessment report detailing the methodology and findings of the assessment, together with relevant maps and GIS information.

Conditions of this report

Findings, recommendations, and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements, or conclusions drawn from or based on this report must clearly cite or refer to this report. Whenever such recommendations, statements or conclusions form part of the main Basic Assessment Report relating to the current investigation, this report must be included in its entirety.

Relevant legislation

The link between ecological integrity of freshwater resources and their continued provision of valuable ecosystem goods and services to burgeoning populations is well-recognised, both globally and nationally (Rivers-Moore et al., 2007). In response to the importance of freshwater aquatic resources, protection of wetlands and rivers has been campaigned at national and international levels. A strong legislative framework which backs up South Africa's obligations to numerous international conservation agreements creates the necessary enabling legal framework for the protection of freshwater resources in the country. Relevant environmental legislation pertaining to the protection and use of aquatic ecosystems (i.e. wetlands and rivers) in South Africa has been summarized below.

South African Constitution 108 of 1996

» Section 24 of Chapter 2 of the Bill of Rights No. 108 of 1996 states that everyone has the right to:
  (a) to an environment that is not harmful to their health or well-being; and
  (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that—
    (i) prevent pollution and ecological degradation;
    (i) promote conservation; and
    (ii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

National Environmental Management Act 107 of 1998

» Wetlands and other watercourses defined in the NWA are also protected in the National Environmental Management Act (Act 107 of 1998), (NEMA). The act lists several activities that require authorisation before they can be implemented. NEMA lists various activities that require authorisation when located within 32 m or less from the edge of a wetland or other watercourse type.

National Water Act (Act No. 36 of 1998)

According to the National Water Act (Act No. 36 of 1998), a water resource is defined as: "a watercourse, surface water, estuary, or aquifer. A watercourse in turn refers to

(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse. Reference to a watercourse includes, where relevant, its bed and banks."

A wetland is defined as: "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances support or would support vegetation typically adapted to life in saturated soil.

Chapter 4 of the Act deals with the regulation of the use of water and the requirements for controlled activities, general authorisations, and licenses. In general, a water use must be licensed unless: it is listed in Schedule 1 of the Act as an existing lawful water use, or is permissible under a general authorisation, or if a responsible authority waives the need for a license.

According to the Department of Water and Sanitation (DWS), any activity that falls within the temporary zone of a wetland or the 1:100 year floodline (whichever is greater) qualifies as a Section 21 water use activity (depending on the use) and will thus require either a general authorization or Water Use License (WUL). According to the NWA, an application for a WUL should be submitted to the DWS if any of the above activities are to be undertaken.

Section 21 of the National Water Act (NWA Act No. 36 of 1998) covers the following activities, which might be applicable to the proposed project. According to Section 21 of the NWA and in relation to the river ecosystem, the following activity is considered a use, and therefore requires a water use license:

21 (c) impeding or diverting the flow of water in a watercourse;
21 (i) altering the bed, banks, course or characteristics of a watercourse;

In terms of Section 22 (1), a person may only undertake the abovementioned water uses if it is appropriately authorised:

22(1) A person may only use water
(a) without a licence
(i) if that water use is permissible under Schedule 1;
(ii) if that water use is permissible as a continuation of an existing lawful use; or

(iii) if that water use is permissible in terms of a general authorisation issued under section 39;

(b) if the water use is authorised by a licence under this Act; or

(c) if the responsible authority has dispensed with a licence requirement under subsection (3).

Other pieces of legislation that may also be of some relevance to freshwater resources include:

- » The National Forests Act No. 84 of 1998;
- » The Natural Heritage Resources Act No. 25 of 1999;
- » The National Environmental Management: Protected Areas Act No. 57 of 2003;
- » Minerals and Petroleum Resources Development Act No. 28 of 2002;

2. METHODOLOGY

Assessment Approach and Philosophy

The delineation and classification of freshwater resources were conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009). These methods are contained in the attached Appendix 1, which also includes wetland definitions, wetland conservation importance, and Present Ecological State (PES) assessment methods used in this report.

In addition to these guidelines, the general approach to freshwater habitat assessment was furthermore based on the proposed framework for wetland assessment as proposed within the Water Research Commission's (WRC) report titled: "Development of a decision-support framework for wetland assessment in South Africa and a Decision-Support Protocol for the rapid assessment of wetland ecological condition" (Ollis *et.* al., 2014). A schematic illustration of the proposed decision-support framework for wetland assessment in South Africa is provided in Figure 3 below.

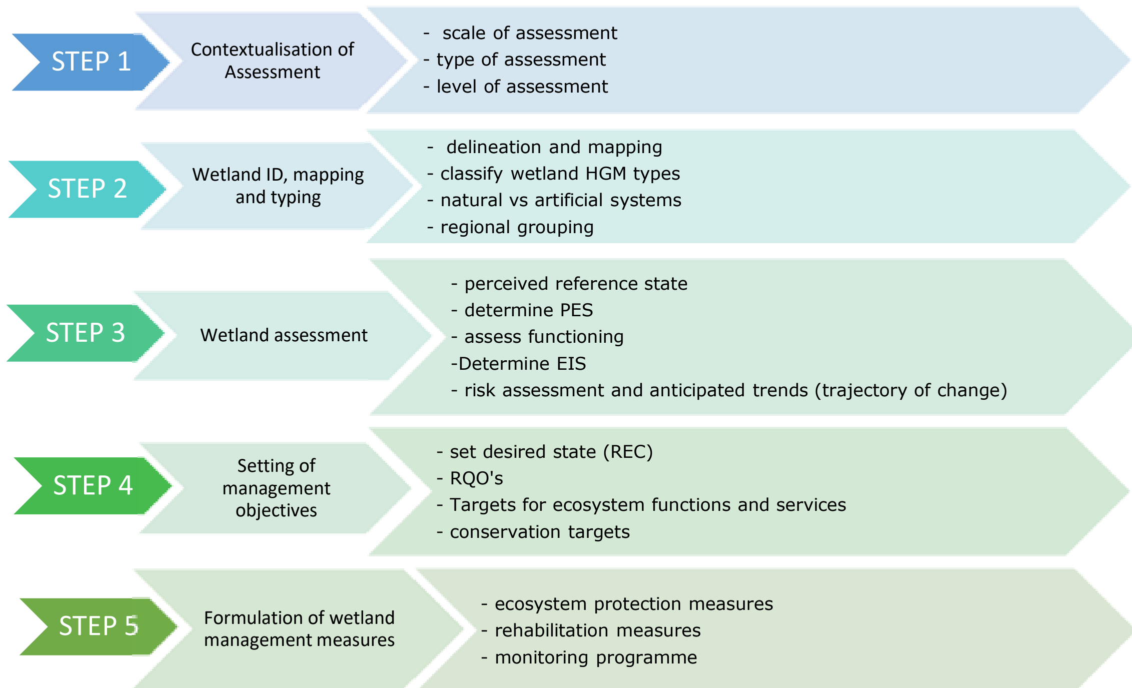

Figure 3: Proposed decision support framework for wetland assessment in South Africa (after Ollis et al., 2014)

Data scouring and review

Data sources from the literature and GIS spatial information were consulted and used where necessary in the study and include the following (also refer to Table 1):

Vegetation:

» Vegetation types and their conservation status were extracted from the South African National Vegetation Map (Mucina and Rutherford 2006) as well as the National List of Threatened Ecosystems (2011), where relevant.

» Critical Biodiversity Areas for the site and surroundings were extracted (CBA Map for Northern Cape Province obtained from http://bgis.sanbi.org/fsp/project.asp).

» The IUCN conservation status of the species in the list was also extracted from the database and is based on the Threatened Species Programme, Red List of South African Plants (Version 2017.1).

Ecosystem:

» Freshwater and wetland information were extracted from the National Freshwater Ecosystem Priority Areas assessment, NFEPA (Nel et al. 2011). This includes rivers, wetlands, and catchments defined under the study.

» Important catchments and protected areas expansion areas were extracted from the National Protected Areas Expansion Strategy 2008 (NPAES).
» Critical Biodiversity Areas were extracted from the Northern Cape Conservation Plan (Oosthuysen & Holness, 2016), available from the SANBI BGIS web portal.

Table 1: Information and data coverages used to inform the freshwater resource assessment.

	Data/Coverage Type	Relevance	Source
Biophysical Context	**Colour Aerial Photography**	Desktop mapping of habitat/ecological features as well as drainage network.	National Geo-Spatial Information (NGI)
	Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
	1:50 000 Relief Line (20m Elevation Contours GIS Coverage)	Desktop mapping of terrain and habitat features as well as drainage network.	Surveyor General
	1:50 000 River Line (GIS Coverage)	Highlight potential on-site and local rivers and wetlands and map local drainage network.	CSIR (2011)
	South African Vegetation Map (GIS Coverage)	Classify vegetation types and determination of reference primary vegetation	Mucina & Rutherford (2006, 2018)
	NFEPA: river and wetland inventories (GIS Coverage)	Highlight potential on-site and local rivers and wetlands	CSIR (2011)
	NBA2018 National Wetland Map 5 (GIS Coverage)	Highlight potential on-site and local rivers and wetlands	NBA (2018)
	DWA Eco-regions (GIS Coverage)	Understand the regional biophysical context in which water resources within the study area occur.	DWA (2005)
Conservation and Distribution Context	**NFEPA: River, wetland and estuarine FEPAs** (GIS Coverage)	Shows location of national aquatic ecosystems conservation priorities	CSIR (2011)
	National Biodiversity Assessment – Threatened Ecosystems (GIS Coverage)	Determination of national threat status of local vegetation types	SANBI (2011)
	Critical Biodiversity Areas of the Northern Cape (GIS Coverage)	Determination of provincial terrestrial/freshwater conservation priorities and biodiversity buffers	SANBI (2016)

Data scouring and review

The desktop delineation of all freshwater resources within 500m of the proposed development / activities was undertaken by analysing available 20m contour lines and colour aerial photography supplemented by Google Earth™ imagery where more up to date imagery was needed. Digitization and mapping were undertaken using QGIS 3.8.2 and ArcMap 10.4.1 GIS software. All of the mapped freshwater resources were then broadly subdivided into distinct resource units (i.e. classified as ephemeral channels and drainage lines, washes and ephemeral rivers and wetlands). This was undertaken based on aerial photographic analysis and professional experience in working in the region. Please note that the desktop map was updated as part of the finalisation of the assessment to include the detailed delineation of the units occurring within the study area.

'Impact Potential' Screening Assessment

Following the desktop identification and mapping exercise, watercourses were assigned preliminary 'likelihood of impact' ratings based on the likelihood that activities associated with the proposed development will result in measurable direct or indirect changes to the mapped watercourse units within 500m of the proposed development. The 'impact potential' ratings were refined following the completion of the field work (fieldwork was conducted from the 21st to 22nd of July 2020). Each watercourse unit was ascribed a qualitative 'impact potential' rating according to the ratings and descriptions provided in Table 2, below.

Table 2: Preliminary risk ratings for the mapped wetland units including rationale.

Likelihood of Impact Rating	Description of Rating Guidelines
High	These resources are likely to require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: » resources located within the footprint of the proposed development activity and will definitely be impacted by the project; and/or » resources located within 15m upstream and/or upslope of the proposed development activity and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or » resources located within 15m or downslope of the development and trigger requirements for Environmental Authorisation according to the NEMA: EIA regulations; and/or » resources located downstream within the following parameters: • within 15m downstream of a low risk development; • within 50m downstream of a moderate risk development; and/or • within 100m downstream of a high risk development e.g. mining large industrial land uses
Moderate	These resources may require impact assessment and a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: » resources located within 32m but greater than 15m upstream, upslope or downslope of the proposed development; and/or » resources located within a range at which they are likely to incur indirect impacts associated with the development (such as water pollution, sedimentation and erosion) based on development land use intensity and development area. » This is generally resources located downstream within the following parameters: • within 32m downstream of a low risk development; • within 100m downstream of a moderate risk development; and/or • within 500m downstream of a high-risk development (note that the extent of the affected area downstream could be greater than 500m for high risk developments or

	developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Low	These resources are unlikely to require impact assessment or Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: » resources located a distance upstream, upslope or downslope (>32m) of the proposed development and which are unlikely to be impacted by the development project; and/or » resources located downstream but well beyond the range at which they are likely to incur impacts associated with the development (such as water pollution, sedimentation and erosion). This is generally resources located downstream within the following parameters: • greater than 32m downstream of a low risk development; • greater than 100m downstream of a moderate risk development; and/or • greater than 500m downstream of a high risk development (note that the extent of the affected area downstream could be greater than 500m for high risk developments or developments that have extensive water quality and flow impacts e.g. dams / abstraction and treatment plants);
Very Low	These resources will not require impact assessment or a Water Use License in terms of Section 21 (c) & (i) of the National Water Act for the following reasons: » resources located within another adjacent sub-catchment and which will not be impacted by the development in any way, shape or form.

Baseline Freshwater Resource Assessment

The methods of data collection, analysis and assessment employed as part of the baseline freshwater habitat assessment are briefly discussed in this section. The assessments undertaken as part of this study are listed in Table 3 below along with the relevant published guidelines and assessment tools / methods / protocols utilised. A more comprehensive description of the methods listed below is included in Appendix 1.

Table 3: Summary of methods used in the assessment of delineated freshwater resources.

Method/Technique	Reference for Methods / Tools Used
Freshwater Resource Delineation	A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005).
Freshwater Resource Classification	National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2013).
Freshwater Resource Condition/PES	Wetland Index of Habitat Integrity (DWAF, 2007).
Freshwater Ecological Importance and Sensitivity (EIS)	EIS (Ecological Importance and Sensitivity) assessment tool (DWAF 1999c; Rountree & Malan, 2013).
Buffers for rivers and watercourses	Presently there are no prescribed aquatic buffers for the Northern Cape and for this project, thus the Eastern Cape buffer guidelines will be applied for rivers and watercourses as they are becoming more widely accepted.
Buffers for wetlands	Buffer zone tool for the determination of Aquatic Impact Buffers and additional Setback Requirements for wetland ecosystems (Macfarlane *et al.* 2014).

Assumptions and Limitations

General Assumptions and Limitations

- This report deals exclusively within a defined area as well as downstream freshwater/aquatic resources that may potentially be impacted and which fall within the Regulated Areas (500 m) as defined by DWS.
- All relevant project information provided by the applicant and engineering design team to the specialist was correct and valid at the time that it was provided.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the NC Province at the time of the assessment.

Sampling Limitations and Assumptions

- While disturbance and transformation of habitats can lead to shifts in the type and extent of ecosystems, it is important to note that the current extent and classification are reported on here.
- The delineation of the outer boundary of riparian areas is based on several indicators, including topography (macro-channel features), the presence of alluvial deposition and vegetation indicators. The boundaries mapped in this specialist report, therefore, represent the approximate boundary of riparian habitat as evaluated by an assessor familiar and well-practiced in the delineation technique.
- The accuracy of the delineation is based solely on the recording of the relevant onsite indicators using a GPS. GPS accuracy will, therefore, influence the accuracy of the mapped sampling points and therefore resource boundaries and an error of 3 – 5m can be expected. All soil/vegetation/terrain sampling points were recorded using a Garmin etrex Touch 35 Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- Any freshwater resources that fall outside of the affected catchment (but still within the 500m DWS regulated area) and are not at risk of being impacted by the specific activity were not delineated or assessed. Such features were flagged during a baseline desktop assessment before the site visit.
- Sampling by its nature means that generally not all aspects of ecosystems can be assessed and identified.
- While every care is taken to ensure that the data presented are qualitatively adequate, inevitably conditions are never such that this is 100% possible. The nature of the vegetation, seasonality, human intervention etc. limit the veracity of the material presented.
- No water sampling and analysis was undertaken.
- The vegetation information provided is based on onsite/ infield observations and not formal vegetation plots. As such, the species list provided only gives an indication of the dominant and/or indicator wetland/riparian species and thus only provides a general indication of the composition of the vegetation communities.

- No faunal sampling and/or faunal searches were conducted and the assessment was purely wetland and riverine habitat based.
- Probably the most significant potential limitation associated with such a sampling approach is the narrow temporal window of sampling.
  - Ideally, a site should be visited several times, during different seasons to ensure that the full complement of plant and animal species present is captured.
  - However, this is rarely possible due to time and cost constraints and therefore, the representation of the species sampled at the time of the site visit should be critically evaluated.
  - The site was sampled outside of the wet season.
  - The footprint was covered in detail with the result that the results are considered highly reliable and it is unlikely that there are any significant species or features present that were not recorded.

Baseline Assessment – Limitations and Assumptions

- All assessment tools utilised within this study were applied only to the resources and habitats located within the development footprint as well as the 500m DWS "regulated area" around the footprint area, and which are at risk of being impacted by the proposed development. Any resource located outside of the DWS "regulated area" and which is not a risk of being impacted was not assessed.
- It should be noted that the most appropriate assessment tools were selected for the analysis of the specific features and resources that may potentially be impacted by the proposed development. The selection was based on the assessment practitioner's knowledge and experience of these tools and their attributes and shortcomings.
- Furthermore, it should be noted that these assessment techniques and tools are currently the most appropriate available tools and techniques to undertake assessments of freshwater resources, they are however rapid assessment tools that rely on qualitative information and expert judgment. While these tools have been subjected to peer review processes, the methodology for these tools is ever-evolving and will likely be further refined in the near future. For the purposes of this assessment, the assessments were undertaken at rapid levels with somewhat limited field verification. It, therefore, provides an indication of the PES of the portions of the affected systems rather than providing a definitive measure.
- The PES, EIS and functional assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects.
- The impact descriptions and assessment are based on the author's understanding of the proposed development based on the site visit and information provided.

» Evaluation of the significance of impacts with mitigation takes into account mitigation measures provided in this report and standard mitigation measures to be included in the Environmental Management Programme (EMPr).

3. CONSERVATION AND FUNCTIONAL IMPORTANCE OF AQUATIC ECOSYSTEMS

Water affects every activity and aspiration of human society and sustains all ecosystems. "Freshwater ecosystems" refer to all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters, and estuaries (Driver *et al*., 2011). South Africa's freshwater ecosystems are diverse, ranging from sub-tropical in the north-eastern part of the country, to semi-arid and arid in the interior, to the cool and temperate rivers of the fynbos. Wetlands and rivers form a fascinating and essential part of our natural heritage and are often referred to as the "kidneys" and "arteries" of our living landscapes and this is particularly true in semi-arid countries such as South Africa (Nel *et al.*, 2013). Rivers and their associated riparian zones are vital for supplying freshwater (South Africa's most scarce natural resource) and are important in providing additional biophysical, social, cultural, economic, and aesthetic services (Nel *et al*., 2013).

The health of our rivers and wetlands is measured by the diversity and health of the species we share these resources with. Healthy river ecosystems can increase resilience to the impacts of climate change, by allowing ecosystems and species to adapt as naturally as possible to the changes and by buffering human settlements and activities from the impacts of extreme weather events (Nel *et al.*, 2013). Freshwater ecosystems are likely to be particularly hard hit by rising temperatures and shifting rainfall patterns, and yet healthy, intact freshwater ecosystems are vital for maintaining resilience to climate change and mitigating its impact on human wellbeing by helping to maintain a consistent supply of water and for reducing flood risk and mitigating the impact of flash floods. We, therefore, need to be mindful of the fact that without the integrity of our natural river systems, there will be no sustained long-term economic growth or life (DEA *et al*., 2013).

Freshwater ecosystems, including rivers and wetlands, are also particularly vulnerable to anthropogenic or human activities, which can often lead to irreversible damage or longer-term, gradual/cumulative changes to freshwater resources and associated aquatic ecosystems. Since channelled systems such as rivers, streams, and drainage lines are generally located at the lowest point in the landscape; they are often the "receivers" of wastes, sediment, and pollutants transported via surface water runoff as well as subsurface water movement (Driver *et al.,* 2011). This combined with the strong connectivity of freshwater ecosystems means that they are highly susceptible to upstream, downstream, and upland impacts, including changes to water quality and quantity as well as changes to aquatic habitat & biota (Driver *et al.,* 2011).

South Africa's freshwater ecosystems have been mapped and classified into National Freshwater Ecosystem Priority Areas (NFEPAs). This work shows that 60% of our river ecosystems are threatened and 23% are critically endangered. The situation for wetlands is even worse: 65% of our wetland types are threatened, and 48% are critically endangered (Driver *et al.*, 2011). Recent studies reveal that less than one-third of South Africa's main rivers are considered to be in an ecologically 'natural' state, with the principal threat to freshwater systems being human activities, including river regulation, followed by catchment transformation (Rivers-Moore & Goodman, 2009). South Africa's freshwater fauna also display high levels of threat: at least one-third of freshwater fish indigenous to South Africa are reported as threatened, and a recent southern African study on the conservation status of major freshwater-dependent taxonomic groups (fishes, molluscs, dragonflies, crabs, and vascular plants) reported far higher levels of threat in South Africa than in the rest of the region (Darwall *et al*., 2009).

Clearly, urgent attention is required to ensure that representative natural examples of the different ecosystems that make up the natural heritage of this country for current and future generations to come. The degradation of South African rivers and wetlands is a concern now recognized by Government as requiring urgent action and the protection of freshwater resources, including rivers and wetlands, is considered fundamental to the sustainable management of South Africa's water resources in the context of the reconstruction and development of the country.

4. STUDY AREA

Regional/Local Biophysical Setting

The project is located on Remaining extent of the farm Blomhoek 61, situated approximately 11km south-east of Aggeneys (Figure 1) within the Khâi-Ma Local Municipality and the Namakwa District Municipality in the Northern Cape Province. Geelstert 1 will have a generating capacity of 125MW and will cover an area of up to approximately 245ha.

Land use within the project site is mostly for farming. Farming practices consist of cattle farming with some "free" roaming game. Due to the aridity of the area large tracts of land are still fairly natural. Infrastructure are mostly in the form of kraals, water points, boreholes and small dwellings.

Prominent anthropogenic features (natural and unnatural) within the region include the Ghamsberg Mine to the north, Black Mountain Mine to the north west, and the town of Aggeneys to the north west. The project site lies just south east of the N14 Route that links Springbok to Aggeneys and Pofadder. An existing 400kV power lines lies just north of the project site (Figure 1). Apart from these anthropogenic features, vast areas of landscape are still mostly natural (very poorly developed) and predominantly used for livestock farming. Fences, occasional tracks and kraals tend to be the main anthropogenic features within these areas.

The study site occurs within the Quaternary Catchment D82C (Lower Orange Water Management Area), which is drained by relative short, endorheic, ephemeral watercourses (Figure 4).

The proposed development area is situated within the Northern Cape Pan Veld Geomorphic Province (Partridge *et al.,* 2010). The main feature of this province, which straddles the uplifted Griqualand–Transvaal axis, is the frequency of pans (some of vast size e.g., Verneukpan and Grootvloer) that are remnants of earlier (Cretaceous) drainage systems (De Wit, 1993). Each pan has its own endoreic drainage network. These pans can be regarded as discontinuous groundwater windows, in which the substantial excess of evaporation over precipitation under the prevailing hot, dry climate, leads to rapid concentration of dissolved solids within each discrete basin. Some of the pans are linked by now defunct palaeo-valleys which, under the more humid conditions of the Miocene, contained substantial rivers. The Koa Valley traversing the central portion of the farm property (proposed development site located just north of this palaeo-valley) are such a relict feature. These drainage systems were disrupted both by progressive aridification and by uplift along the Griqualand–Transvaal axis, causing the dismembering of several drainage features (Partridge & Maud, 2000).

Four main drainage systems traverse this geographic province; from east to west these are the Boesak, Vis/Hartbees and Brak rivers. The rivers in the extreme northwest (e.g., the Brak) are, however, characterised by narrower valley cross-sectional profiles and slightly steeper slopes than the rivers of the east. Furthermore, these rivers of the extreme northwest are characterised by convex longitudinal profiles and linear BFCs (Macro-reach Best Fit Curves: aggregading alluvial river systems where there is no significant lateral input of water or sediment), so that their sediment storage surrogate descriptors become BV[1] (a sediment storage surrogate descriptor indicative of low sediment storage capability). The Brak River in fact follows the Koa valley, the course of which was disrupted by uplift along the Griqualand–Transvaal axis which crosses it at right angles.

A summary of the biophysical features and the setting of the project site and surroundings are summarised in Table 4 below (also refer to Appendix 2 for a more detailed description of the biophysical setting).

Table 4: Summary of the biophysical setting of the projects site as well as the surroundings

[1] BV Sediment storage surrogate descriptor (Partridge *et. al*., 2010): Valley Width = Broad (3647m>w>2343) and Slope = Very Steep (0.0057<s). The storage class for BV is very low.

<table>
<tr><th>Biophysical Aspect</th><th colspan="6">Desktop Biophysical Details</th><th>Source</th></tr>
<tr><td colspan="8">Physiography (for affected property)</td></tr>
<tr><td>Av. Elevation a.m.s.l</td><td colspan="6">848m</td><td>Google Earth & ArcGis</td></tr>
<tr><td>Max. Elevation a.m.s.l</td><td colspan="6">1055m</td><td>Google Earth & ArcGis</td></tr>
<tr><td>Min. Elevation a.m.s.l</td><td colspan="6">811m</td><td>Google Earth & ArcGis</td></tr>
<tr><td>Av. slope</td><td colspan="6">0.7%</td><td>Google Earth & ArcGis</td></tr>
<tr><td>Maximum slope</td><td colspan="6">7.9%</td><td>Google Earth & ArcGis</td></tr>
<tr><td>Landscape Description</td><td colspan="6">The general topography of the affected property is relatively flat, with the exception of isolated outcrops and inselbergs. The affected property is situated at the foot of the Ghaamsberg Mountain/Inselberg. The affected property has a slight concave shape with the higher lying areas located to the south and north. The central region of the property can be described as a lower-lying trough (Koa Pallaeo-valley) filled with aeolain sand, forming low, parallel running dune structures (north west to south east direction). This sand sheet thins out to the north and south, becoming coarser and gravellier. Most of the freshwater features are located north of the dune system, with most of the ephemeral channels and drainage lines running in a north to south direction from the Ghaamsberg Mountain. Most of these ephemeral channels, washes and drainage lines are diffuse, endorheic systems. Small, endorheic, depression wetlands are also a prominent feature of the landscape, although only five such features are located within the surveyed development area.</td><td>Google Earth & Mucina and Rutherford, 2006</td></tr>
<tr><td>Land Type Classification</td><td colspan="2">Af26</td><td colspan="2">Af21</td><td colspan="2">Ag26</td><td>ARC</td></tr>
<tr><td rowspan="2">Terrain Type</td><td colspan="2">Symbol</td><td colspan="4">Description</td><td rowspan="2">ARC</td></tr>
<tr><td colspan="2">B2</td><td colspan="4">Rolling or broken plains or plateaus with some relief.</td></tr>
<tr><td>Geomorphic Province</td><td colspan="6">Northern Cape Pan Veld</td><td>Partridge et al., 2010</td></tr>
<tr><td>Geology and Soils</td><td colspan="6">Unconsolidated superficial sediments of Late Caenozoic age; including Quaternary to Recent sands and gravels of probable braided fluvial or sheet wash origin, as well as a veneer of downwasted surface gravels and colluval deposits. The fluvial and colluvial sediments are locally overlain by unconsolidated aeolain sands of the Gordonia Formation. Linear sand dunes, trending north west to south east, characterise the Koa River-palaeovalley.</td><td>ARC & SA Geological Dataset</td></tr>
<tr><td>Prominent Soil Forms</td><td colspan="6">Hutton, Mispah, Fernwood, Clovely, Dundee, exposed rock</td><td>ARC</td></tr>
<tr><td colspan="8">Climate</td></tr>
<tr><td>Mean annual temperature</td><td colspan="6">18.6°C</td><td>Climate-data.org</td></tr>
<tr><td>Warmest Month & Av. Temp.</td><td colspan="6">January: 25.6°C</td><td>Climate-data.org</td></tr>
<tr><td>Coldest Month & Av. Temp.</td><td colspan="6">July: 10.7°C</td><td>Climate-data.org</td></tr>
<tr><td>Rainfall Seasonality</td><td colspan="6">Late Summer (Highest in March)</td><td>DWAF, 2007</td></tr>
<tr><td>Annual precipitation</td><td colspan="6">78 mm – 110 mm</td><td>Schulze, 1997</td></tr>
<tr><td>Mean annual runoff</td><td colspan="6">0.3 mm</td><td>Schulze, 1997</td></tr>
<tr><td>Mean annual evaporation (S-Pan)</td><td colspan="6">2200-2600 mm</td><td>Schulze, 1997</td></tr>
<tr><td colspan="8">Surface Hydrology (for proposed development area)</td></tr>
<tr><td>DWA Ecoregions</td><td colspan="3">Level 1</td><td colspan="3">Level 2</td><td>DWA, 2005</td></tr>
</table>

	Nama Karoo	26.02	
Wetland vegetation group	Nama Karoo Bushmanland		CSIR, 2011
Water management area	Lower Orange WMA (14)		DWA
Quaternary catchment	Name (Symbol)	Extent (km^2)	DWA
	D82C	5246	
Sub Quaternary Catchments	Name (Symbol)	Extent (km^2)	DWA
	3958	1241	
Vegetation Overview (for affected property)			
Biome	Nama Karoo Biome (Bushmanland Bioregion) & Azonal Vegetation (Inland Saline Vegetation Bioregion)		Mucina & Rutherford, 2018
Vegetation Types (Figure 4)	Bushmanland Bioregion: Bushmanland Sandy Grassland, Bushmanland Arid Grassland Inland Saline Vegetation Bioregion: Bushmanland Vloere		Mucina & Rutherford, 2018

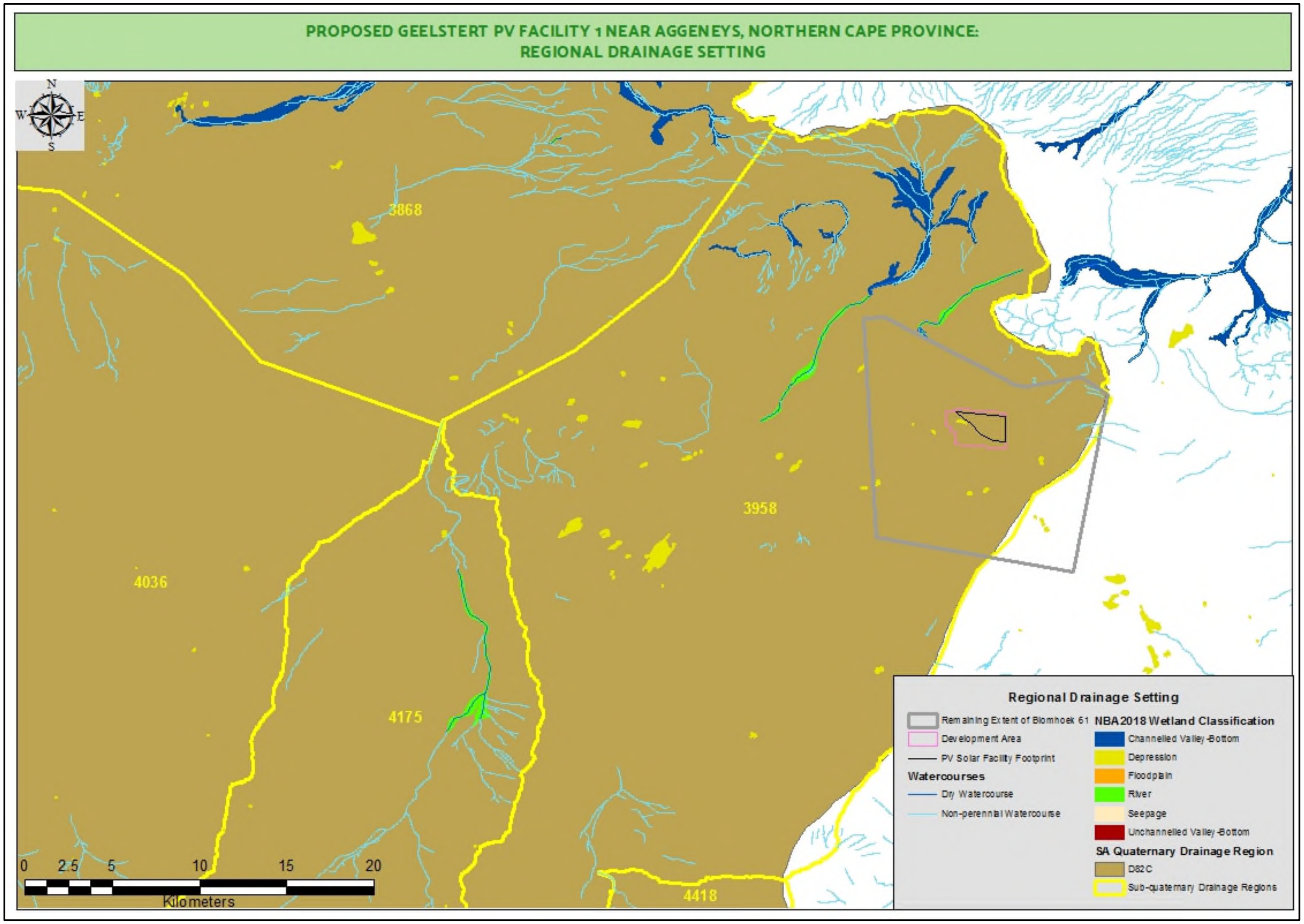

Figure 4: Regional drainage setting associated with the proposed Geelstert 1 development.

Conservation Planning / Context

Understanding the conservation context and importance of the study area and surroundings is important to inform decision making regarding the management of the aquatic resources in the area. In this regard, national, provincial, and regional conservation planning information available was used to obtain an overview of the study site (Table 5). (Also refer to Appendix 2 for a more detailed description of the conservation planning context.)

Table 5: Summary of the conservation context details for the study area.

Conservation Planning Dataset		Relevant Conservation Feature	Location in Relationship to Project Site	Conservation Planning Status
NATIONAL LEVEL	National Freshwater Ecosystem Priority Area	Unnamed River (FEPA ID: 3935)	Located well away from the development site (~8 km north-west)	Non-FEPA River
		Wetlands	Natural depression wetlands, mostly small in size within the development site	Non-FEPA Wetlands
		Wetland Vegetation: • Nama Karoo Bushmanland - Depressions	Intact wetland areas within the development site.	Least Concern
	Vegetation Types	Bushmanland Sandy Grassland	A small portion of the development site, south-western portion, falls within this vegetation type	Least Concern
		Bushmanland Arid Grassland	The bulk of the development site is situated within this vegetation type	Least Concern
		Bushmanland Vloere	Small isolated patch located within the development area, however, located outside of the PV solar Facility's footprint	Least Concern
	Threatened Ecosystems	Not Classified	Ecosystems of Study Area	Least Concern
PROVINCIAL AND REGIONAL LEVEL	[2]NCBSP: Critical Biodiversity Areas	Critical Biodiversity Area 2 (Sand dunes with natural vegetation associated with the Koa Valley)	Small portion of the development site, to the south west, falls within this CBA2 However, the proposed development footprint falls outside of this CBA2 area.	CBA 2
		Ecological Support Area Natural areas fringing Koa Valley.	Majority of the development site falls within this ESA.	ESA

National Level of Conservation Priorities (Threatened Ecosystems)

2 The identified CBA2 and ESA within the proposed development site, as well affected farm property, are associated with terrestrial features and subsequently these provincial conservation areas and the potential impact the development will have on these areas will be dealt within, in detail, within the terrestrial ecological study and assessment.

According to Mucina and Rutherford (2018), the impacted vegetation types are classified as Least Threatened and are furthermore not listed within the Threatened Ecosystem List (NEMA:BA). The Bushmanland Vloere vegetation type represents the vegetation associated with inland saline habitats (depression of pan wetlands). Only one such vegetation type has been identified within VegMap (2018). This site was confirmed, during the site visit, as a depression wetland and was consistent with the description provided by Mucina & Rutherford (2006) for the Bushmanland Vloere vegetation type. However, during the site visit, additional depression wetlands were identified within the development area (but outside of the project footprint), and which were also consistent with the classification of Bushmanland Vloere.

National Freshwater Ecosystem Priority Areas (2011)

A review of the NFEPA coverage for the study area (Figure 5) revealed that no FEPAs were present within the affected property. The most prominent drainage feature within the sub-quaternary catchment is an endorheic, ephemeral watercourse located approximately 8km north west of the development area. This ephemeral watercourse drains in a north west direction and is classified as a Lowland River (according to geomorphological zonation) with a V1 and/or V2 valley form. According to DWAFs 1999 Present Ecological State for mainstream rivers this watercourse was classified as largely natural (Class B) (Kleynhans, 2000). This watercourse is classified as a non-prioritised freshwater resource (Non-FEPA) and furthermore falls within a non-prioritised sub-quaternary catchment in terms of the NFEPA project. A number of small wetlands (all depression wetlands) were mapped on the affected property (two wetlands within the development area and none within the proposed project footprint), however these have not been identified as wetland FEPAs (Figure 5).

Critical Biodiversity Areas and Broad Scale Ecological Processes

The identified CBA2 and ESA within the proposed development site, as well as the affected farm property, are associated with terrestrial features. Therefore, these provincial conservation areas and the potential impact the development will have on these areas will be dealt with, in detail, within the terrestrial ecological study and assessment.

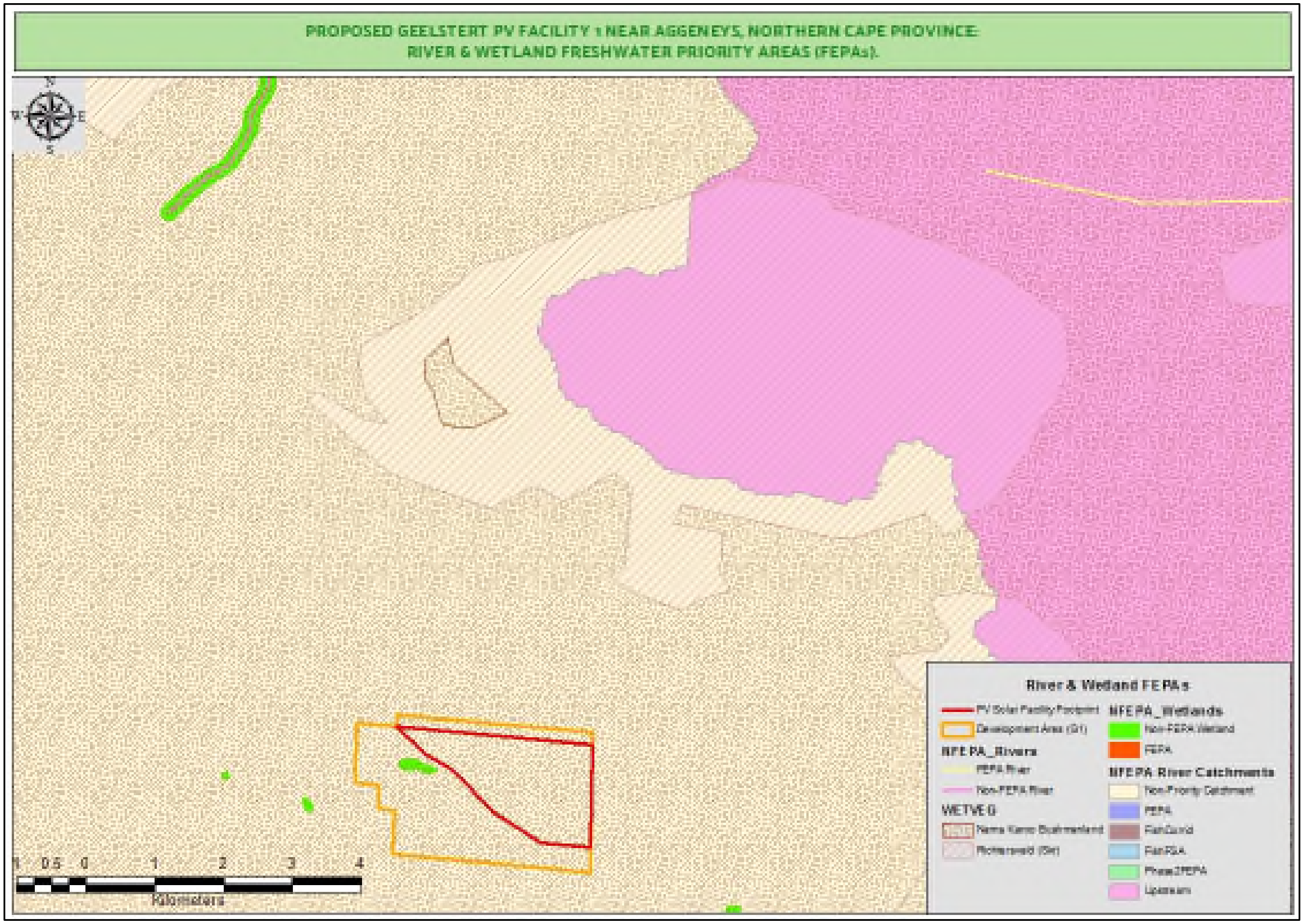

Figure 5: Map showing surrounding river and wetland Freshwater Priority Areas (FEPAs).

5. FINDINGS OF THE SURFACE WATER RESOURCE BASELINE ASSESSMENT

Desktop Mapping and Wetland/Watercourse Risk Screening

Water resources (wetland and watercourses) within a radius of 500m around the proposed Development Area were mapped and classified at a desktop level followed by a desktop rating of risk associated with the proposed activities. This was undertaken to guide field assessments and inform water use identification for the proposed project. Several water resources were identified and rated; these include wetland features in the form of endorheic depression wetlands and ephemeral streams/washes that fall within the 500m regulated area.

The main risks associated with the construction and operations of the proposed activities are:

» Potential direct/indirect physical modification/destruction of wetlands within the vicinity of the footprint of Geelstert 1.
» Potential direct/indirect physical loss and/or modification of watercourses within the vicinity of the footprint of Geelstert 1, both planned and accidental;
» Potential direct/indirect physical alteration of flow characteristics of watercourses within the vicinity of the footprint of Geelstert 1 and associated erosion and sedimentation impacts;
» Alteration of catchment surface water processes / hydrological inputs and associated erosion and sedimentation impacts; and
» Surface runoff contamination and local watercourse water quality deterioration.

The risk ratings for each of the mapped water resources are presented in Table 6 and Figure 6 below. The proposed activities pose a potential high risk to a few depression wetlands (five wetlands) located between 30 and 75m west of the facility footprint. The larger ephemeral streams/washes located to the west (>800m from the proposed facility Footprint) are at very low risk of being impacted by the proposed development due to the distance from the development and the fact that the proposed development is located largely outside of the catchment of these watercourses.

Note: The risk ratings provided relates to the likelihood that a water resources unit may be measurably negatively affected to inform the legal processes. Thus, this is essentially risk screening, **not a risk assessment and risk ratings are not a representation of impact intensity/magnitude of the change.**

Table 6: Preliminary risk ratings for the mapped wetland units including rationale.

Risk Class	Water Resource Number	Water Resource	Rationale
High	W1	Depression Wetland	These depression wetlands have very small catchment areas. The development footprint slightly extends into the outer most peripheries of the catchment areas. Direct impacts may include a change in the quantity and quality of water input from the PV solar facility.
	W2	Depression Wetland	
	W3	Depression Wetland	
	W4	Depression Wetland	
	W5	Depression Wetland	
Very Low	S1	Ephemeral River/Wash	These water resource units are either located in separate micro-catchments or some distance downslope or downstream of the proposed development. Risk from secondary impacts are low and measurable impacts on these water resources are unlikely.
	S2	Ephemeral River/Wash	
	S3	Ephemeral River/Wash	

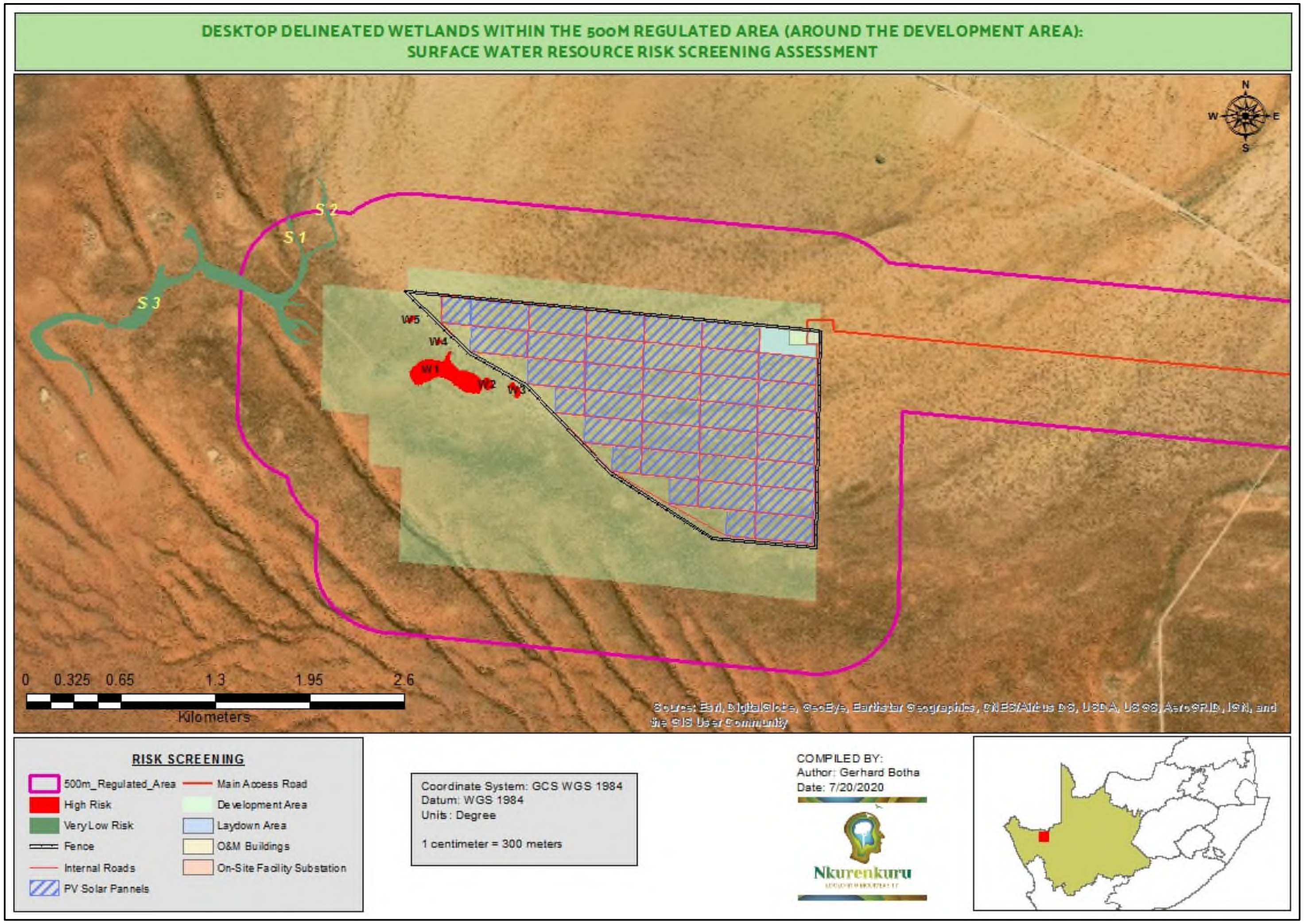

Figure 6: Desktop delineated wetlands and watercourses within 500m of the proposed development area with risk screening ratings.

Baseline Assessment Results

The baseline habitat assessment, informed by on-site data collection, focused primarily on wetland units rated as being at **Moderate to High risk** of being impacted by the proposed activities. This section sets out the findings of the baseline assessment of those water resources units and includes:

- Delineation, Classification & Habitat Descriptions;
- Present Ecological State (PES) Assessment;
- Ecological Importance and Sensitivity (EIS) Assessment;

The on-site / in-field assessment of the wetland indicators was conducted by Gerhard Botha from Nkurenkuru Biodiversity and Ecology on the 21st and 22nd of June 2020.

Ultimately, it was found that there are five wetland features with a high risk of being impacted which required further assessment (included below).

Wetland Classification, Delineation and Description

A. Wetland Delineation

The water body delineation and classification were conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (2009).

For the DWS definitions of different hydrological features refer to Appendix 1.

Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of five (5) wetland units. Wetland ecosystems are the dominant drainage features in this landscape and comprised of ephemeral depressions (endorheic) hydrogeomorphic (HGM) units. Depression wetlands, also known as pans, form within shallowed-out basins within the flatter landscape areas and are generally closed systems that are inward draining (endorheic). All five depression wetlands are located outside of the proposed PV solar facility footprint, but are still in relatively close proximity to the facility footprint (between 30 and 75 m from the facility's boundary). As mentioned earlier, these wetlands have relatively small catchments of which the proposed facility footprint slightly encroach upon. All five wetlands share similar geomorphological characteristics and range in size from 798m^2 to 70 174m^2. The shapes of the depression wetlands also vary from oval to kidney shape.

Such ephemeral depression wetlands make up the majority of the lentic (non-flowing) systems of the greater landscape. These depression wetlands are endorheic, i.e. isolated from other surface water ecosystems, usually with inflowing surface water but no outflow. There is generally little or no direct connection with groundwater, and these pans tend to be fed by unchanneled overland flow and interflow following rainfall events. Interflow is the lateral movement of water, usually derived from precipitation, that occurs in the upper part of the unsaturated zone between the ground surface and the water table. This water generally enters directly into a wetland or other aquatic ecosystem, without having occurred first as surface runoff, or it returns to the surface at some point down-slope from its point of infiltration.

Endorheic pans are the most common wetland type in arid and semi-arid environments (Allan *et al.*, 1995), and are generally thought to form as a result of the synergy of a number of factors and processes, including low rainfall, sparse vegetation, flat to gently sloping topography, disrupted drainage, geology (e.g. dolerite sills and dykes) grazing and deflation. The Bushmanland endorheic pans, or "vloere" as they are called locally, are one of the most extensive salt pan systems in South Africa (Mucina *et al.*, 2006). They appear to be concentrated around the relict channels of the ancient Tertiary Orange River catchment (Mucina *et al.*, 2006). These pans are highly variable in size and form.

Inundation periods can last from a few days to months to a year. Similarly, the frequency is highly variable, from once a year or less (some pans in the Northern Cape are inundated once every few decades) to several inundations per year. The flat, central portion of these pans tends to be devoid of vegetation, with a typical zonation of plants occurring around the margins. They tend to be filled with clayey, finer sediments, with a high salt content, due to salt-bearing substrates and mineral-rich groundwater.

B. Wetland Terrain and Soils

The soil properties of all five wetlands were largely similar. Typically, an Orthic A horizon overlies a loose, friable, sandy to grainy-sandy, "faded" E horizon. In some, isolated localities, this E horizon was overlying a Neocutanic B horizon, however the presence of this horizon was relatively scarce within these depressions. The dominant soil form of these depression wetlands is Fernwood, although Vilafontes were also recorded (where a Neucutanic B horizon underlies the E horizon).

Typically, the orthic A horizons of the centre portions of these wetland areas comprise of light reddish brown to almost pink soil which transition into soils with slightly darker hues and chromas (light brown to reddish yellow to red along the peripheries of the depression wetlands). According to the Munsell Soil Chart (Munsell Soil Chart, 2009) the hue, chroma and value of the Orthic A horizons varied, from the interior to the outer periphery, from 2.5YR//4 to 7.5YR/6/4 to 7.5YR/6/8 to 2.5YR/5/8. In some areas these top horizons may contain a low amount of silt. Underlying the Orthic A horizon are, as mentioned a paler, structureless E horizon. Soils within this horizon have undergone iron reduction with lateral flow through this horizon and have resulted in the lighter, somewhat bleached colouring. Some soil profiles yielded E horizons with discernible mottling or streaking with a higher chroma than that of the matrix, and is the result of periodic saturation with water. Most of the soil samples taken indicated a pink E horizon (7.5YR/8/4 or 7/4).

From the reduced soil characteristic, it is clear that these depression wetlands experience occasional saturation and are regarded as ephemeral systems that are likely only saturated for short periods of time following sufficient rainfall events, and may remain dry for extended periods of time (several years).

Site Photos	
 **Photo 1**: W1 (depression wetland) in the background. Note the absence of vegetation within the wetland and the shrubby vegetation along the periphery.	 **Photo 2:** W4 (depression wetland). The central portion is mostly devoid of vegetation apart from a few shrubs.
 **Photo 3:** Some mottling with in the E horizon.	 **Photo 4:** Typical example of Fernwood Soil Form.
 **Photo 5:** Vilafontes soil form.	 **Photo 6:** W2 (depression wetland). The central portion is mostly devoid of vegetation apart from a few shrubs.

C. Wetland Vegetation

Vegetation composition was fairly similar for all depression wetlands and comprised of a central portion that is largely devoid of vegetation (Wetland 1 is totally devoid) apart from a few scattered shrubs and graminoids, mostly *Lycium cinereum* and *Stipagrostis ciliata*. The sparse core of the wetlands is likely due to the highly saline properties of the soils, creating a "toxic" environment for most species. The outer fringes of the depression wetlands can be classified as species poor, open shrublands, dominated by *Lycium* *cinereum*. Other species that are regularly encountered along the peripheries of the depressions include; *Rhigozum trichotomum, S. ciliata, S. uniplumis, Aptosimum spp. (A. albomarginatum, Monechma genistifolium, Hermannia spinosa, Melolobium candicans, Grielum humifusum, Arctotheca calendula, Crassothona* spp. and *Arctotis depressa*. Wetland 4 also contained a single species of *Parkinsonia africana* which along with *Boscia foetida* and *B. albitrunca* are the the only indigenous tree species found within the region. These species are not considered as hydrophytic (obligate and facultative wetland species), which are typical of wetlands, however, the lack of such hydrophytic species can be expected as a result of the harsh, dry climate, and sporadic rainfall.

<table>
<tr><th colspan="2">Site Photos</th></tr>
<tr><td>
Photo 7: W1 (depression wetland). The core of this wetland is totally devoid of vegetation.</td><td>
Photo 8: W4 (depression wetland). The core of this wetland comprises a few shrubs (*L. cinereum*).</td></tr>
<tr><td>
Photo 9: Periphery of W3 comprising of a higher density of shrubs.</td><td>
Photo 10: *Parkinsonia africana* recorded at the edge of W4.</td></tr>
</table>

D. Present Ecological State

The ephemeral depression wetlands have been assessed based on the three wetland driving processes (responsible for wetland formation and maintenance); Hydrology, Geomorphology and Water Quality as well as Vegetation Alteration which, although not port of the wetland driving processes, provides an indication of the intensity of human land use activities. The integration of these ratings indicated two groups of wetlands according to their overall Present Ecological Ratings (PES). Wetlands 3, 4 and 5 have been assessed to be Class A (Natural), whilst Wetlands 1 and 2 have been assessed as Class B (Largely Natural).

Wetlands 3, 4 and 5 have been minimally impacted and are still in a natural state. The vegetation has been slightly impacted through grazing. The geomorphology and hydrological character have remained unimpacted. However, flood peak may have slightly changed due to a reduction in catchment roughage leading to increase inputs (volume and intensity) and a reduction in water retention with the areas of the catchment. However, this impact is very small within the catchments of these wetlands.

Wetlands 1 and 2 have been exposed to some form of disturbance, however, these impacts are still relatively limited. The hydrological character of these wetlands has been somewhat altered due to a reduction in roughage within their catchments. The alterations of the vegetation within the catchment area are due to historical and current grazing activities and have been excessively exacerbated by the severe drought conditions experienced within the region. The impacts of this reduction in surface roughage are an increase in flood peaks and alteration of flows in the catchment. The geomorphology of these two wetlands has also been slightly impacted through trampling and soil disturbance: Small embankments have been created, especially within Wetland 1 in order to accumulate the water within a specified area of the wetland, probably in an attempt to decrease the surface area exposed to evaporation.

Site Photos	
 **Photo 11**: W1 (depression wetland). Trampled livestock footpath.	 **Photo 12:** W3 (depression wetland).Trampled livestock footpaths.
 **Photo 13:** Small embankment created within W1.	 **Photo 14:** A reduction in surface roughage (vegetation) within the catchments of most wetlands.

E. Wetland Ecosystem Services

Depression wetlands capture runoff due to their inward draining nature, reducing the volume of surface water that would either simply disappear into the soil or exit the area via drainage and stream channels. This collection and retention of water, following rainfall events plays an important role in the maintenance of biodiversity and the creation of special niche habitats. These wetlands for example provide valuable seasonal water and food sources for migrating fauna as well as local fauna and avifauna such as the endemic Red Lark (*Calendulauda burra).* Furthermore, invertebrates such as small crustaceans (e.g. Tadpole Shrimp – *Triops spp*.), brachiopods and dipterans are restricted to these depression wetlands and hatch as these depressions fill up, in turn providing a valuable food source for various fauna.

Furthermore, temporary to ephemeral wet pans provide the opportunity for the precipitation of minerals including phosphate minerals because of the concentrating effects of evaporation. Additionally, nitrogen recycling is also an important function of these wetlands.

F. Wetland Ecological Importance and Sensitivity (EIS)

"Ecological importance of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred.": Kleynhans (1999)

Following the Ecological Importance and Sensitivity (EIS) assessment, based on Primary Determinants (Indigenous wetland species and wetland habitats) and Modifying Determinants (Protected status and Ecological Integrity), it was found that the wetlands can be divided into two groups namely:

» Those wetlands (W1, W2 & W3) which are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. As such these three depression wetlands have been assessed to be Class B (High Ecological Importance and Sensitivity).
» W4 and 5 are considered to be ecologically important and sensitive on a more local scale. The biodiversity of these wetlands is not as sensitive to flow and habitat modifications. As such these two depression wetlands have been assessed to be Class C (Moderate Ecological Importance and Sensitivity).

From the assessment it appears that the Ecological Importance and Sensitivity is affected by the size of the features as well as the association (linkage) with other wetlands. W2 and W3 are located in close proximity to the large W1 depression with W2 somewhat connected to W1.

A summary of the EI&S are provided below in Tables 7 and 8:

Table 7: EI&S Score sheet for determining the ecological importance and sensitivity for depression wetlands W1, W2 & W3.

Score Guideline: Very high = 4; High = 3, Moderate = 2; Marginal/Low = 1; None = 0

Confidence Rating: Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1

DETERMINANT		IMPORTANCE SCORES (0-4) AND RATINGS		Reason
		Score	Confidence	
PRIMARY DETERMINANTS	Rare & Endangered Species	3	3	Red lark (*Calendulauda burra*), vulnerable and regional endemic, is likely to utilize these wetlands during times of saturation.
	Populations of Unique Species	3	4	No unique populations of aquatic fauna and flora were identified within the wetlands. However, invertebrates like branchiopods, crustaceans, and

				dipterans hatch out during wet periods and along with algae are an important food source for a variety of avifaunal and faunal species including water birds. Subsequently, unique populations can be expected to be present after sufficient rainfall.
	Species/taxon Richness	1	4	Low species/taxon richness
	Diversity of Habitat Types or Features	1	5	The diversity of habitat types is limited to bare areas devoid of vegetation as well as communities of graminoid and scrubland vegetation fringing and inside some of the core of the wetlands.
	Migration route/breeding and feeding site for wetland species	3	4	The wetlands are likely to be important migration route/breeding and feeding sites for invertebrates and the waterfowl after rainfall events. The wetlands are also likely to be a potential feeding site for the Red Lark.
	Sensitivity to Changes in the Natural Hydrological Regime	3	4	The ephemeral nature of the wetlands mean that the wetlands will be fairly sensitive to further reductions and changes in the natural hydrological regime. The graminoid species that make up the wetlands are likely to transition to more terrestrial and drought resistant species with over grazing and reduction of water supply.
	Sensitivity to Water Quality Changes	2	4	The wetlands act as sediment sinks and therefore are typically associated with high sediment loads given the minimal vegetation cover and harsh dry climate. This is evidenced in the alluvial deposits in the wetlands. The wetlands are known to be sodic and will have a good buffering capacity.
	Flood Storage, Energy Dissipation & Particulate/Element Removal	3	5	One of the main potential functions of the wetlands is the ability to perform a functional role in terms of sediment trapping, erosion control and particulate removal. In this regard, the wetlands are

				significant in terms of the role the wetlands perform in the greater landscape.
MODIFYING DETERMINANTS	Protected Status	2	5	ESA according to the Northern Cape Conservation Plan, 2017
	Ecological Integrity	2	5	The overall PES of the wetlands was assessed to be Class B systems (Largely Natural with few modifications)
TOTAL		24	43	
MEDIAN		2		
OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE		**B** **High**		

Table 8: EI&S Score sheet for determining the ecological importance and sensitivity for depression wetlands W4, & W5.

DETERMINANT		**IMPORTANCE SCORES (0-4) AND RATINGS**		**Reason**
		Score	**Confidence**	
PRIMARY DETERMINANTS	Rare & Endangered Species	2	3	Red lark (*Calendulauda burra*), vulnerable and regional endemic, is likely to utilize these wetlands during times of saturation.
	Populations of Unique Species	1	4	No unique populations of aquatic fauna and flora were identified within the wetlands. However, invertebrates like branchiopods, crustaceans, and dipterans hatch out during wet periods and along with algae are an important food source for a variety of faunal species including water birds
	Species/taxon Richness	1	4	Low species/taxon richness
	Diversity of Habitat Types or Features	1	5	The diversity of habitat types is limited to bare areas devoid of vegetation, as well as communities of graminoid and shrubland vegetation fringing and some inside the core of the wetlands.
	Migration route/breeding and feeding site for wetland species	2	4	The wetlands are likely to be of moderate importance as a migration route/breeding and feeding site. As some invertebrates may provide a valuable food source for the waterfowl after rainfall events.
	Sensitivity to Changes in the Natural Hydrological Regime	2	5	The ephemeral nature of the wetlands means that the

				wetlands will be fairly sensitive to further reductions and changes in the natural hydrological regime. The graminoid species that make up the wetlands are likely to transition to more terrestrial and drought resistant species with over grazing and reduction of water supply.
	Sensitivity to Water Quality Changes	2	4	The wetlands act as sediments sinks and therefore are typically associated with high sediment loads given the minimal vegetation cover and harsh dry climate. This is evidenced in the alluvial deposits in the wetlands. The wetlands are known to be sodic and will have a good buffering capacity.
	Flood Storage, Energy Dissipation & Particulate/Element Removal	2	5	Not considered important locations for sediment trapping. Precipitation of minerals including phosphate minerals. Contribute to Nitrogen cycling.
MODIFYING DETERMINANTS	Protected Status	2	5	ESA according to the Northern Cape Conservation Plan, 2017
	Ecological Integrity	3	5	The overall PES of the wetlands was assessed to be Class A systems (Natural)
TOTAL		18	44	
MEDIAN		2		
OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE		**C Moderate**		

G. Wetland Buffer Zones

According to the DWA Buffer Tool a **buffer zone of 15m** for all the wetland features resources is to be implemented. According to the layout provided by the applicant, the facility's footprint is located well outside of this buffer with the closest wetland located approximately 30m from the facility's boundary.

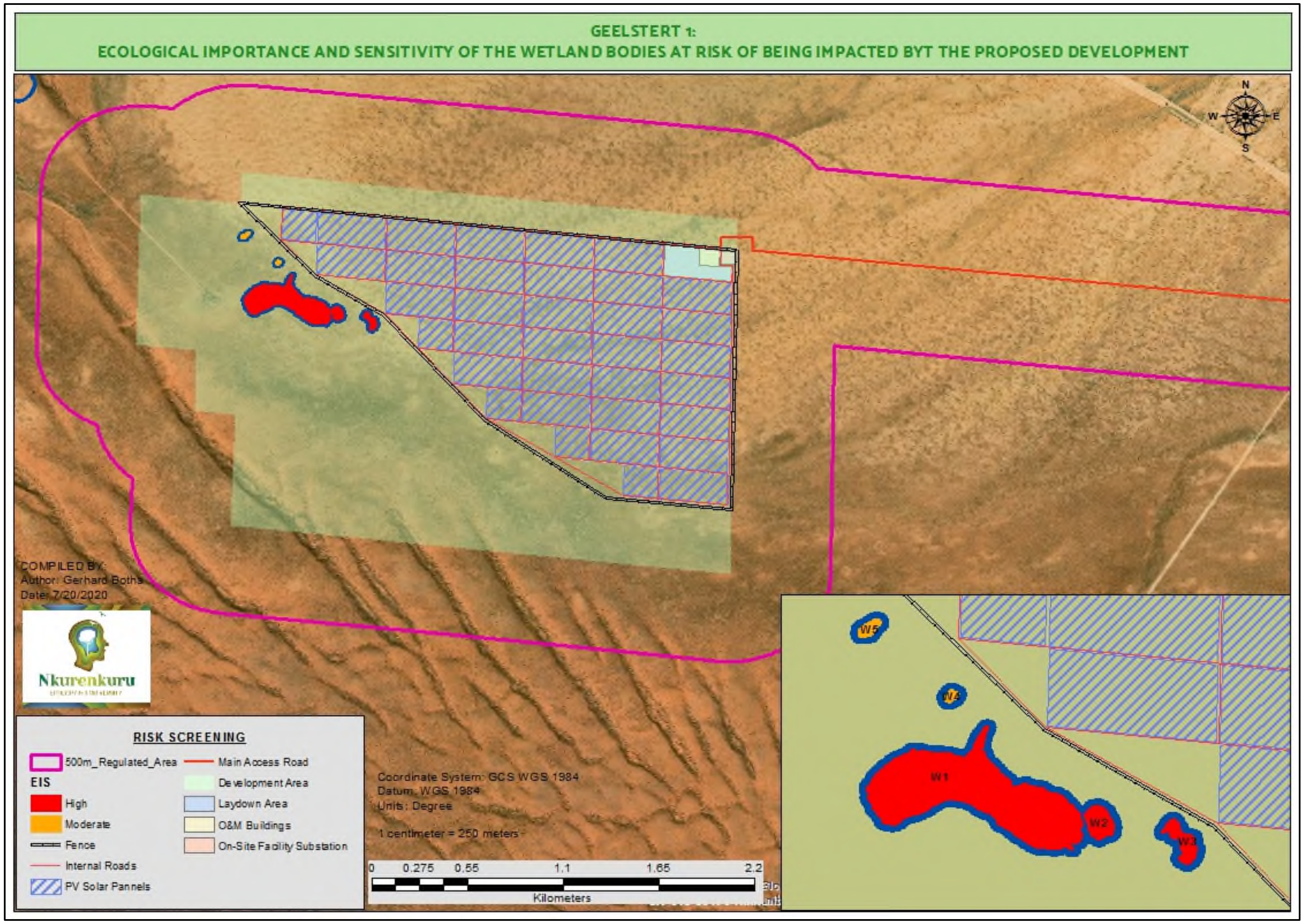

Figure 7: Ecological Importance and Sensitivity of the wetland features at risk of being impacted by the proposed Geelstert 1 development .

6. ASSESSMENT OF PROPOSED IMPACTS

Assumptions

The following is assumed and/or known:

- » A thorough botanical walkthrough of all footprint areas will be conducted to detect and relocate, where possible, all plant species of conservation concern by a suitably qualified botanist before the commencement of activities.
- » Throughout the construction and operation phase, the footprint will be routinely cleared of all alien invasive plants if detected.
- » The site establishment itself will be associated with clearing of vegetation within the footprint only.
- » After decommissioning, a continuous vegetation layer will be the most important aspect of ecosystem functionality within and beyond the project site.

- A weakened or absent vegetation layer not only exposes the soil surface but also lacks the binding and absorption capacity that creates the buffering functionality of vegetation to prevent or lessen erosion as a result of floods and subsequently impacting downstream wetland features.

Identification of Potential Impacts and Associated Activities

Construction and operation activities may lead to potential indirect loss of / or damage to wetlands. This may potentially lead to localised loss of wetland habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function and biodiversity. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to wetlands can have an impact on the functioning of those wetlands. Consequences may include:

- » increased loss of soil;
- » loss of/or disturbance to indigenous wetland vegetation;
- » loss of sensitive wetland habitats;
- » loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
- » fragmentation of sensitive habitats;
- » impairment of wetland function;
- » change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
- » reduction in water quality in wetlands downstream.

Assessment of Impacts

Planning and Construction Phase

Impact 1: *Potential loss of wetland vegetation*

All pans (including buffer areas) are located outside of the facility's footprint. Therefore, wetland vegetation will not be directly impacted by the development of the Geelstert 1. Vegetation may however be impacted indirectly due to erosion structures forming within the construction area as a result of increased surface runoff (Volume and Velocity). Subsequently, this impact of wetland vegetation disturbance will be dealt with during the discussion of the potential impacts associated with an increase in sedimentation and erosion.

Impact 2: *Impact on "pan" wetlands through the possible increase in surface water runoff during the Construction Phase*

Impact Nature: For the wetlands, the primary threat related to PV developments during the construction phase are increased run-off, sediment inputs, as well as turbidity. These occur during vegetation clearing for the PV arrays and excavation of pits for the foundations of the individual PV panels. An increase in volume and velocity of surface water flow from the cleared construction areas into the wetlands, may result in the loss of natural wetland vegetation and formation of erosion gullies.

The likelihood of these impacts occurring is however relatively low due to the geographical location of the proposed development footprint (within a relatively low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (8)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent	

Mitigation	» No activities may be allowed outside of the facility footprint area, and especially within the identified wetland areas. These areas are regarded as no-go areas. As all identified wetlands are located outside of the development footprint, the most likely potential impacts on the wetlands will be of an indirect nature and as such the following mitigation measures, although not directly associated with the wetlands, are recommended: » Any areas disturbed during the construction phase should be effectively rehabilitated as fast as possible. Where deemed necessary by the Contractor's EO, artificial rehabilitation (e.g. re-seeding with collected or commercial indigenous seed mixes) should be applied in order to speed up the rehabilitation process in critical areas (e.g. steep slopes and unstable soils). » No unnecessary vegetation clearance may be allowed, and vegetation should be allowed to persist under and around the PV panels once operational (some brush cutting of larger shrubs may be allowed).
Cumulative Impacts	Increase in surface run-off velocities, reduction in the potential for groundwater infiltration, and the spread of erosion into downstream wetlands.
Residual Impacts	Possible impact on the remaining catchment due to changes in run-off characteristics in the development site.

Impact 3: *Increase in sedimentation and erosion during the Construction Phase*

Impact Nature: For the wetlands, the primary threat related to PV developments during the construction phase, is increased run-off, sediment inputs, as well as turbidity. This is during vegetation clearing for the PV arrays and excavation of pits for the foundations of the individual PV panels. An increase in volume and velocity of surface water flow from the cleared construction areas into the wetlands, may result in erosion and an increase in sediment inputs into the pan wetlands in the vicinity of the development area.

The likelihood of these impacts occurring is however relatively low due to the geographical location of the proposed development footprint (within a relatively low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (8)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High

Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	As all identified wetlands are located outside of the development footprint, most potential impacts on the wetlands will be of an indirect nature and as such the following mitigation measures, although not directly associated with the wetlands, are recommended in order to avoid the encroachment of erosion into these habitats or a reduction in water quality due to an increase in sedimentation into these systems: » Any erosion problems observed as a result of the development should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential. » Roads used for project-related activities and other disturbed areas should be regularly monitored for erosion. Problem areas should receive follow-up monitoring to assess the success of the remediation. » Silt traps must be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. » Topsoil must be removed and stored separately and should be reapplied where appropriate, as soon as possible to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas. » Where practical, phased development and vegetation clearing should be applied so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time. » Construction of gabions and other stabilisation features on steep slopes to prevent erosion, if deemed necessary. » Where possible, activities at the site must be reduced after large rainfall events when the soils are wet. No driving off of hardened and internal roads should occur at any time, and particularly immediately following large rainfall events. » No activities and infrastructure may be allowed or placed within the recommended wetland buffer areas whose natural vegetation cover should be maintained.	
Cumulative Impacts	None	
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.	

Impact 4: *Impact on localized surface water quality*

Impact Nature: During the construction phase, chemical pollutants (hydrocarbons from equipment and vehicles), cleaning fluids, cement and contaminated water could be washed downslope into these pan wetlands and eventually affect water quality. The likelihood of this impact occurring is however relatively low due to the geographical location of the proposed development footprint (within a relatively low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.

	Without Mitigation	With Mitigation
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	High (8)	Moderate (6)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (39)**	**Low (16)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent.	
Mitigation	» Strict use and management of all hazardous materials used on site must be implemented. » Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.). » Containment of all contaminated water by means of careful run-off management on the development area must be undertaken. » Infrastructure may not be placed within the recommended buffer areas whose natural vegetation cover should be maintained in a natural condition. » Due to the low gradient of most of the development footprint any accidental spill or leakage of hazardous or harmful substances can be effectively contained around the source of the spillage. In the case of such an accidental spillage, prompt and effective action is required in order to prevent the spillage from spreading and to successfully rehabilitate the contaminated area.	
Cumulative Impacts	None	
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.	

Operation Phase

Impact 1: *Altered runoff patterns due to rainfall interception by PV panel infrastructure and compacted areas resulting in high levels of erosion, sedimentation and turbidity within the lower lying "pan" wetland areas.*

Impact Nature: Disturbance created during construction could take several years to fully stabilise and the presence of hardened surface (roads) will generate a large amount of runoff which will pose a significant erosion risk, if not managed. For wetlands, the primary threat related to PV developments during the operation phase are increased run-off, erosion, sediment inputs, as well as turbidity.

The likelihood of these impacts occurring is however relatively low due to the geographical location of the proposed development footprint (within a relatively low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Permanent (5)	Short-term (1)
Magnitude	Moderate (6)	Small (0)
Probability	Improbable (2)	Very improbable (1)
Significance	**Low (24)**	**Low (2)**
Status	Negative	Negative
Reversibility	Low	High
Irreplaceable loss of resources	Potential loss of important resources due to the disturbance of a stable vegetation cover.	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Regular monitoring of the site (minimum of twice annually) to identify possible areas of erosion is recommended, particularly after large summer thunderstorms have occurred (monitoring and inspections done by the Operations and Management Team). » All mitigation measures pertaining to erosion should be strictly adhered to and promptly executed, which include regular monitoring. » Due to the low gradient of most of the development area, any accidental spill or leakage of hazardous or harmful substances can be effectively contained around the source of the spillage and in the case of such an accidental spillage, prompt and effective action is required in order to prevent the spillage from spreading and to successfully rehabilitate the contaminated area.	
Cumulative Impacts	Downstream erosion and sedimentation of the downstream systems. During flood events, any unstable banks (eroded areas) and sediment bars (sedimentation downstream) may be vulnerable to erosion. However, due to low mean annual runoff within the region, this is not anticipated due to the nature of the development together with the proposed layout.	
Residual Impacts	Altered morphology. Due to the extent and nature of the development, this residual impact is unlikely to occur.	

Impact 2: *Impact on localized surface water quality*

Impact Nature: During the operational phase, chemical pollutants (hydrocarbons from equipment and vehicles), cleaning fluids, cement, and contaminated water, used/generated during maintenance activities, could be washed downslope into these pan wetlands and eventually affect water quality. The likelihood of this impact occurring is however relatively low due to the geographical location of the proposed development footprint (within a relatively low lying flat to slightly sloping landscape). The potential risk and significance of this impact will furthermore be significantly reduced through the implementation and

maintenance of the recommended buffer areas. The potential for these impacts to occur can also furthermore be eluded with diligent and effective mitigation measures in place.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Moderate (6)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (16)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent.	
Mitigation	» Strict use and management of all hazardous materials used on site must be implemented. » Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.). » Containment of all contaminated water by means of careful run-off management on the development area must be undertaken. » Infrastructure may not be placed within the recommended buffer areas whose natural vegetation cover should be maintained in a natural condition. » Due to the low gradient of most of the development footprint any accidental spill or leakage of hazardous or harmful substances can be effectively contained around the source of the spillage. In the case of such an accidental spillage, prompt and effective action is required in order to prevent the spillage from spreading and to successfully rehabilitate the contaminated area.	
Cumulative Impacts	None	
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.	

Decommissioning Impacts

During decommissioning all hard surfaces/infrastructure will be removed, this will result in bare, unvegetated areas vulnerable to erosion, these bare areas may result in an increase in surface water runoff into the wetland features (impacting their hydrological characters) and in turn may lead to an increase in sedimentation as well as the formation of erosional features within these wetlands. The above-mentioned impacts will result in a reduction in the water quality of these wetland features. Water quality may also be impacted through chemical pollutants (hydrocarbons from equipment and vehicles) and contaminated water, washing downstream into the identified wetland features.

Impacts for the decommissioning phase as well their significance is largely similar to that as described for the construction phase. Furthermore, mitigation of these impacts is similar to that recommended within the construction phase.

Impact 1: *Impact on wetlands through the possible increase in surface water runoff during the Decommissioning Phase*

Impact Nature: This is the primary threat during the construction phase and may result in increased sediment inputs, as well as turbidity. An increase in volume and velocity of surface water flow from the cleared, bare, decommissioned areas into the wetlands, may result in the loss of natural wetland vegetation and formation of erosion gullies.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (5)	Minor (2)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (30)**	**Low (8)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	Refer to construction phase mitigations	
Cumulative Impacts	Refer to construction phase mitigations	
Residual Impacts	Refer to construction phase mitigations	

Impact 2: *Increase in sedimentation and erosion during the Decommissioning Phase*

Impact Nature: An increase in volume and velocity of surface water flow from the bare, unvegetated decommissioned areas into the wetlands, may result in erosion and an increase in sediment inputs into the pan wetlands in the vicinity of the development area.		
	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Minor (2)

Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (8)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	Refer to construction phase mitigations	
Cumulative Impacts	Refer to construction phase mitigations	
Residual Impacts	Refer to construction phase mitigations	

Impact 3: *Impact on localized surface water quality*

Impact Nature:
Increase in sediment inputs from the decommissioned area may result in an increase in turbidity and an increase in total dissolved solids (TDS) within the downstream wetlands, subsequently negatively impacting the water quality of these features.

Also, during the decommissioning phase, chemical pollutants (hydrocarbons from equipment and vehicles), cleaning fluids, and contaminated water could be washed downslope into these pan wetlands and eventually affect water quality.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Improbable (2)
Significance	**Medium (33)**	**Low (12)**
Status	Negative	Negative
Reversibility	Low – if erosion has reached severe levels the impacts will not be remedied easily.	High
Irreplaceable loss of resources	Moderate Probability	Low Probability
Can impacts be mitigated?	Yes, to a large extent.	
Mitigation	Refer to construction phase mitigations	
Cumulative Impacts	Refer to construction phase mitigations	

Residual Impacts	Refer to construction phase mitigations

Assessment of Cumulative Impacts

Cumulative Impact 1: *Cumulative impacts due to nearby renewable energy developments – Influence on runoff and stormwater flow patterns and dynamics (Due to excessive clearing of vegetation)*

Impact Nature: The interception of rain by the impervious surface of the solar panels produces an "umbrella effect" that delineates a sheltered area. By contrast, its contour receives the collected fluxes, whose intensity or amounts may locally exceed those of the control conditions, depending on the dimensions, height and tilting angle of the panels as well as on wind velocity and direction. Cumulatively this alteration could cause excessive accelerated erosion of plains, lower lying small ephemeral to larger intermittent drainage lines, wetlands and river systems		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects within the area**
Extent	Local (1)	Regional (3)
Duration	Long Term (4)	Long Term (4)
Magnitude	Small (1)	Moderate (6)
Probability	Very Improbable (1)	Improbable (2)
Significance	**Low (6)**	**Low (26)**
Status	Neutral	Negative
Reversibility	Low	Low
Irreplaceable loss of resources	No	Moderate Probability
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» The development footprints of the individual developments must be kept to a minimum and natural vegetation should be encouraged to return to disturbed areas. This must be undertaken by each respective developer. » An open space management plan must be developed for the individual developments by each respective applicant, which should include management of biodiversity within the fenced area, as well as that in the adjacent rangeland. The following on-site mitigation measures are recommended throughout the operational phase in order to minimize the contribution of this development to the described impact: » Regular monitoring of the site is recommended (minimum of twice annually) to identify possible areas of erosion, particularly after large summer thunderstorms have occurred. » The higher level of shading anticipated from PV panels may prevent or slow down the re-establishment of some desirable species, therefore re-establishment should be monitored, and species composition adapted if vegetation fails to establish sufficiently.	

	» Alternatively, soil surfaces where no revegetation seems possible will have to be covered with gravel or small rock fragments to increase porosity of the soil surface, slow down runoff and prevent wind and water erosion. » Monitor the area below and around the panels regularly after larger rainfall events to determine where erosion may be initiated and then mitigate by modifying the soil micro-topography. » Due to the nature and larger runoff surfaces of the PV panels, the development area should, where possible, be adequately landscaped and rehabilitated to contain expected accelerated erosion. » Runoff may have to be specifically channeled, or storm water be adequately controlled to prevent localised rill and gully erosion. » Any erosion problems observed should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » Roads and other disturbed areas should be regularly monitored for erosion. Problem areas should receive follow-up monitoring to assess the success of the remediation.

7. CONCLUSION

Nkurenkuru Ecology and Biodiversity was appointed by Savannah Environmental (Pty) Ltd to undertake a surface water resource study and assessment for the proposed Geelstert 1 solar PV facility. The proposed PV solar facility will have a generating capacity of 125MW and will occupy an extent of ~245ha. The proposed facility will be located within the Remaining Extent of Bloemhoek 61. The affected property is located approximately 11km south-east of Aggeneys within the Khâi-Ma Local Municipality and the Namakwa District Municipality in the Northern Cape Province.

This study has been commissioned to meet the requirements of the EIA process in the form of a Basic Assessment (BA) as set out by the National Environmental Management Act (1998) and a Water Use Licence Application (WULA) as set out by the National Water Act (Act 36 of 1998).

According to the guidelines specified within GN509 of 2016 all wetlands within a radius of 500m of the facility footprint were identified and mapped.

- A total of five (5) wetlands (depressions) and three ephemeral streams/washes were identified.
- Following a risk screening assessment, it was determined that only the five depression wetlands will potentially be impacted by the development, either directly or indirectly.
- The ephemeral streams/washes within the 500m radius were either located in separate micro-catchments or some distance downslope and downstream of the proposed development, to such an extent that low and measurable impacts to these water resources would be unlikely. As such these surface water resources were assigned a Low Risk Rating.

- All five wetlands are located outside of the facility footprint (located between 30 and 75m west of the facility footprint), however the proposed facility footprint extends slightly into the catchments of all five wetlands (very slightly) and subsequently these wetlands were awarded a High-Risk Rating.
- Wetlands assigned either as High or Moderate Risk of being impacted are subjected to a detailed baseline assessment.

Catchment Context (Regional Hydrological Setting):

- The project site is located within the Lower Orange Management Area (WMA) and within the DWS Quaternary catchment D82C and is primarily drained by relatively short, endorheic, ephemeral watercourses.
- The proposed development area is situated within the Northern Cape Pan Veld Geomorphic Province (Partridge *et al.,* 2010). The main feature of this province, which straddles the uplifted Griqualand–Transvaal axis, is the frequency of pans (some of vast size e.g., Verneukpan and Grootvloer) that are remnants of earlier (Cretaceous) drainage systems (De Wit, 1993). Each pan has its own endoreic drainage network. These pans can be regarded as discontinuous groundwater windows, in which the substantial excess of evaporation over precipitation under the prevailing hot, dry climate, leads to rapid concentration of dissolved solids within each discrete basin. Some of the pans are linked by now defunct palaeo-valleys which, under the more humid conditions of the Miocene, contained substantial rivers. The Koa Valley traversing the central portion of the farm property (proposed development site located just north of this palaeo-valley) are such a relict feature.
- A review of the NFEPA coverage for the study area (Figure 5) revealed that no FEPAs (wetlands and rivers) are present within the development area. The project area furthermore falls within a within a non-prioritised sub-quaternary catchment in terms of the NFEPA project.

Baseline Wetland Assessment

- According to the baseline assessment a total of five wetlands were assessed, all of which were classified as ephemeral endorheic depressions or pans.
- All five wetlands share similar geomorphological characteristics and range in size from 798m^2 to 70 174m^2.
- The shapes of the depression wetlands vary from oval to kidney shape.
- These depression wetlands are endorheic, i.e. isolated from other surface water ecosystems, usually with inflowing surface water but no outflow.
- There is generally little or no direct connection with groundwater, and these pans tend to be fed by unchanneled overland flow and interflow following rainfall events.
- Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of these five (5) wetland units.

- The soil properties of all five wetlands were largely similar with the soil form Fernwood being the dominant form.
- From the reduced soil characteristic, it is clear that these depression wetlands experience occasional saturation and are regarded as ephemeral systems that are likely only saturated for short periods of time following sufficient rainfall events, and may remain dry for extended periods of time (several years).
- The findings of the baseline wetland assessment suggest that, owing to similar impacts with the wetlands, as well as their catchments, two wetland groups could be distinguished according to their PES scores.
  - Wetlands 3, 4 and 5 have been assessed to be Class A (Natural) with no definite signs of disturbance within the wetland, apart from a slight modification in the vegetation structure. The catchments have been slightly impacted due to a reduction in roughage as a result of grazing. This may have resulted in an increase in runoff input. However, this impact is very small within the catchments of these wetlands.
  - Wetlands 1 and 2 have been assessed as Class B (Largely Natural). The hydrological character of these wetlands has been somewhat altered due to a reduction in roughage within their catchments. The alterations of the vegetation within the catchment area are due to historical and current grazing activities and have been excessively exacerbated by the severe drought conditions experienced within the region. The impacts of this reduction in surface roughage are an increase in flood peaks and alteration of flows in the catchment. The geomorphology of these two wetlands have also been slightly impacted through trampling (by livestock in the area) and soil disturbance (small embankments have been created, especially within Wetland 1 in order to accumulate the water within a specified area of the wetland, probably in an attempt to decrease the surface area exposed to evaporation).
- Following the Ecological Importance and Sensitivity (EIS) assessment, it was found that the wetlands can be divided into two groups namely:
  - Those wetlands (W1, W2 & W3) that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. As such these three depression wetlands have been assessed to be Class B (High Ecological Importance and Sensitivity).
  - W4 and 5 are considered to be ecologically important and sensitive on a more local scale. The biodiversity of these wetlands is not as sensitive to flow and habitat modifications. As such these two depression wetlands have been assessed to be Class C (Moderate Ecological Importance and Sensitivity).
- According to the DWA Buffer Tool a **buffer zone of 15m** for all the wetland features resources is to be implemented. According to the layouts provided by applicant, the facility footprint is located well outside of this buffer with the closest wetland located approximately 30m from the facility's boundary.

Wetland Impacts and Mitigation

» The four key/major ecological impacts on the freshwater resources that are anticipated to occur during the construction, operation and decommision phase of the development are:
  - Loss/Disturbance of wetland habitat and fauna
  - Potential impact on localised surface water quality
  - Altered wetland hydrology due to interception / impoundment / diversion of flows
  - Increase in sedimentation and erosion

» Various activities and development aspects may lead to these impacts, however, these impacts can be adequately minimized or avoided provided the mitigation measures stated in this report are implemented and adhered to.

» A summary of pre- and post-mitigation impact significance ratings for the different impacts and risks factors identified for the proposed development are provided below (Table 9).

Table 9: Summary of pre and post-mitigation impact significance ratings.

Construction & Operational Phase			
Phase	**Impact**	**Significance Pre Mitigation**	**Significance Post Mitigation**
Construction	Potential loss of wetland vegetation	Medium (33)	Low (8)
	Impact on "pan" wetlands through the possible increase in surface water runoff during the Construction Phase	Medium (33)	Low (8)
	Increase sedimentation and erosion during the Construction Phase	Medium (33)	Low (8)
	Impact on localized surface water quality	Medium (39)	Low (16)
Operation	Altered runoff patterns due to rainfall interception by PV panel infrastructure and compacted areas resulting in high levels of erosion, sedimentation and turbidity within the lower lying "pan" wetland areas.	Low (24)	Low (2)
	Impact on localized surface water quality	Medium (33)	Low (2)
Decommission	Impact on wetlands through the possible increase in surface water runoff.	Medium (30)	Low (8)
	Increase sedimentation and erosion.	Medium (33)	Low (8)
	Impact on localized surface water quality	Medium (33)	Low (16)

Cumulative Impacts		
Impact	**Overall impact of the proposed project considered in isolation**	**Cumulative impact of the project and other projects within the area**
Cumulative impacts due to nearby renewable energy developments – Influence on runoff and stormwater flow patterns and dynamics (Due to excessive clearing of vegetation)	Low (6)	Low (24)

- Most of the wetland ecological impacts can be effectively mitigated on-site by implementing mitigations measures as specified within this report.

General recommendations:

- No activities may be allowed outside of the facility footprint area.
- All depression wetlands should be regarded as No-Go Areas and be excluded from the development footprint.
- The buffer areas recommended around the pan wetlands should be implemented and maintained in a natural condition to allow efficient functioning of these buffer areas.

The following mitigation measures are recommended:

- Regarding erosion and increase in sedimentation
  As all identified wetlands are located outside of the development footprint, most potential impacts on the wetlands will be of an indirect nature and as such the following mitigation measures, although not directly associated with the wetlands, are recommended in order to avoid the encroachment of erosion into these habitats or a reduction in water quality due to an increase in sedimentation into these systems:

  - Any erosion observed should be rectified immediately and monitored thereafter to ensure that they do not re-occur.
  - All bare areas, affected by the development, should be re-vegetated with locally occurring species, to bind the soil and limit erosion potential.
  - Re-instate as much of the eroded area to its pre-disturbed, "natural" geometry (no change in elevation and any banks not to be steepened).
  - Roads and other disturbed areas should be regularly monitored for erosion. Problem areas should receive follow-up monitoring by the Contractor's EO to assess the success of the remediation.
  - Silt traps must be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.
  - Construction of gabions and other stabilisation features on steep slopes to prevent erosion, if deemed necessary.
  - Topsoil should be removed and stored separately and should be re-applied where appropriate as soon as possible in order to encourage and facilitate rapid re-generation of the natural vegetation on cleared areas.
  - Practical phased development and vegetation clearing should be practiced so that cleared areas are not left un-vegetated and vulnerable to erosion for extended periods of time.
  - All roads and other hardened surfaces should have runoff control features which redirect water flow and dissipate any energy in the water which may pose an erosion risk.

- No activities and infrastructure may be allowed or placed within the recommended wetland buffer areas whose natural vegetation cover should be maintained.

» Regarding impact on localized surface water quality
- Strict use and management of all hazardous materials used on site must be implemented.
- Strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.).
- Containment of all contaminated water by means of careful run-off management on the development area must be undertaken.
- Infrastructure may not be placed within the recommended buffer areas whose natural vegetation cover should be maintained in a natural condition.
- Due to the low gradient of most of the development footprint, any accidental spill or leakage of hazardous or harmful substances can be effectively contained around the source of the spillage. In the case of such an accidental spillage, prompt and effective action is required in order to prevent the spillage from spreading and to successfully rehabilitate the contaminated area.

» Regarding altered runoff patterns due to rainfall interception by PV panel infrastructure and compacted areas resulting in high levels of erosion, sedimentation and turbidity within the lower lying "pan" wetland areas:
- Regular monitoring of the site is recommended (minimum of twice annually) to identify possible areas of erosion, particularly after the occurrence of large summer thunderstorms (monitoring and inspections done by the Operations and Management Team).
- All mitigation measures pertaining to erosion should be strictly adhered to and promptly executed, which include regular monitoring.
- Due to the low gradient of most of the development area, any accidental spill or leakage of hazardous or harmful substances can be effectively contained around the source of the spillage and in the case of such an accidental spillage prompt and effective action is required in order to prevent the spillage from spreading and to successfully rehabilitate the contaminated area.

With these mitigation measures in place, impacts on surface water resource integrity and functioning can be reduced to a sufficiently low level. This would be best achieved by incorporating the recommended management & mitigation measures into an Environmental Management Programme (EMPr) for the site, together with appropriate rehabilitation guidelines and ecological monitoring recommendations.

Based on the outcomes of this study, specifically also considering the fact that all wetlands are located outside of the Geelstert 1 footprint (well outside of the

recommended buffer areas), together with the fact that expected impacts can be mitigated to a low significance through the application of a number of easily implementable mitigation measures, it is my considered opinion that the proposed Geelstert 1 solar PV facility detailed in this report be authorised from a freshwater and wetland perspective.

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9. APPENDICES

Appendix 1. Methodology: Freshwater Resource

Survey methods

The assessment was initiated with a survey of the pertinent literature, past reports, and the various conservation plans that exist for the study region. Maps and Geographical Information Systems (GIS) were then employed to ascertain, which portions of the proposed development, could have the greatest impact on the wetlands and associated habitats.

The desktop delineation of all surface water resources (i.e. rivers, streams, and wetlands) within 500m of the proposed development (i.e. the DWS regulated area for Water Use in terms of Section 21 of the National Water Act) was undertaken by analysing available contour data and colour aerial photography, supplemented by Google Earth™ imagery where applicable. Digitization and mapping were undertaken using ArcMap GIS software. All of the mapped watercourses were then broadly subdivided into distinct resource units (i.e. classified as either riverine or wetland systems/habitat) based on professional experience, topographical setting, and drainage patterns. Following the mapping of water resource units within 500m of the proposed development, the risk posed by the development to freshwater ecosystems was screened at a desktop level and ascribed a qualitative risk rating. The potential risks were also identified based on the nature of the proposed development and professional experience with similar developments, as well as based on ground-truthing of mapped watercourses in the field.

A two-day site visit was then conducted (21st and 22nd of July, 2020) to ground-truth the above findings, thus allowing critical comments of the development when assessing the possible impacts and delineating the freshwater resource areas.

» The following equipment was utilized during fieldwork.
  - Canon EOS 450D Camera
  - Garmin Etrex Legend GPS Receiver
  - Soil Auger
  - Munsell Soil Colour Chart (2000)
  - Braun-Blanquet Data Form (for vegetation recording and general environmental recordings).

Freshwater resource areas were then assessed on the following basis:

» Identification and delineation of wetlands and riparian areas according to the procedures specified by DWAF (2005a).
» Vegetation type – verification of type and its state or condition-based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended), and the South African Biodiversity Information Facility (SABIF) database.
» Plant species were further categorised as follows:
  - Terrestrial/Upland: species are rarely found within the riparian zone (<25% probability) and characterize the terrestrial landscape that borders the riparian zones. Upland species usually occur naturally in the upper parts of the riparian zone, but with low relative abundance (DWAF, 2008).
  - Facultative riparian: species may occur in either riparian zones or the upland (25>% probability of occurrence in the riparian zone). They can habituate to more mesic conditions with a high probability of survival, or can tolerate higher levels of flooding disturbance or soil moisture. They are not good national indicators, but rather circumstantial indicators good for particular regions (DWAF, 2008).
  - Preferential riparian: these area species that are preferentially, but not exclusively, found in the riparian zone (>75% probability). They may be found in non-riparian areas as indicators of wetness. Where they do occur in the upland, they show progressive reductions in abundance, statue, and vigour farther from the riparian zone. Preferential riparian species may harden to drought conditions, but will always indicate sites with increased moisture availability, and are therefore consistent indicators across geographic boundaries (DWAF, 2008).
  - Obligate: these species occur almost exclusively in the riparian zone (>90% probability). They are seldom found in non-riparian areas, but where they are outside of riparian areas, they still indicate wetness. They are not likely to occur in the upland. Obligate riparian species are conservative as such i.e. an obligate will remain obligate throughout all geographic regions (DWAF, 2008).
» Assessment of the freshwater resources based on the method discussed below and the required buffers.
» Mitigation or recommendations required.

Classification System for Wetlands and other Aquatic Ecosystems in South Africa System (SANBI, 2013)

Since the late 1960's, wetland (including other freshwater ecosystems) classification systems have undergone a series of international and national revisions. These revisions allowed for the inclusion of additional wetland types, ecological and conservation rating metrics, together with a need for a system that would allude to the functional requirements of any given wetland (Ewart-Smith et al., 2006). Wetland function is a consequence of biotic and abiotic factors, and wetland classification should strive to capture these aspects.

The South African National Biodiversity Institute (SANBI) in collaboration with several specialists and stakeholders developed in 2010 the newly revised accepted National Wetland Classification Systems (NWCS, 2010). In 2013 however, this classification system (National Wetland Classification System) underwent a name change to now be known as the 'Classification System for Wetlands and other Aquatic Ecosystems in South Africa'. This was done to avoid confusion around the term 'wetland' which is defined differently by the RAMSAR Convention and the South Africa National Water Act (Act No. 36 of 1998). The scope of the Classification System has not been changed, however, in that it still includes all ecosystems that the RAMSAR Convention is concerned with.

This classification system includes and distinguishes between three broad types of inland aquatic/freshwater systems namely:

» Rivers, which are 'lotic' aquatic ecosystems with flowing water concentrated within a distinct channel, either permanently or periodically.
» Open water bodies, which are permanently inundated 'lentic' aquatic ecosystems where standing water is the principal medium within which the dominant biota live. In this system, open water bodies with a maximum depth of greater than 2m are called limnetic (lake-like) systems.
» Wetlands are transitional between aquatic and terrestrial systems and are generally characterised by (permanently to temporarily) saturated soils and hydrophytic vegetation. These areas are, in some cases, periodically covered by shallow water and/or may lack vegetation.

The basis upon which this classification system is based on is the principles of the Hydrogeomorphic (HGM) approach at higher levels, including structural features at the finer or lower levels of classification (SANBI, 2013) (Table 10).

Table 10: Hydrogeomorphic (HGM) Units for Inland Systems, showing the primary HGM Types at Level 4A and sub-categories at Levels 4B to 4C.

Level 4: Hydrogeomorphic (HGM) Units		
HGM Type	**Longitudinal zonation/Landform/Outflow drainage**	**Landform/Inflow drainage**
River	Mountain headwater stream	Active channel
		Riparian Zone
	Mountain Stream	Active channel
		Riparian Zone
	Transitional	Active channel
		Riparian Zone
	Upper foothills	Active channel
		Riparian Zone
	Lower foothills	Active channel
		Riparian Zone
	Lowland river	Active channel
		Riparian Zone

	Rejuvenated bedrock fall	Active channel
		Riparian Zone
	Rejuvenated foothills	Active channel
		Riparian Zone
	Upland floodplain	Active channel
		Riparian Zone
Channeled valley-bottom wetland	N/A	N/A
Unchanneled valley-bottom wetland	N/A	N/A
Floodplain	Floodplain depression	N/A
	Floodplain flat	N/A
Depression	Exorheic	With channeled inflow
		Without channeled inflow
	Endorheic	With channeled inflow
		Without channeled inflow
	Dammed	With channeled inflow
		Without channeled inflow
Seep	With channeled outflow	N/A
	Without channeled outflow	N/A
Wetland Flat	N/A	N/A

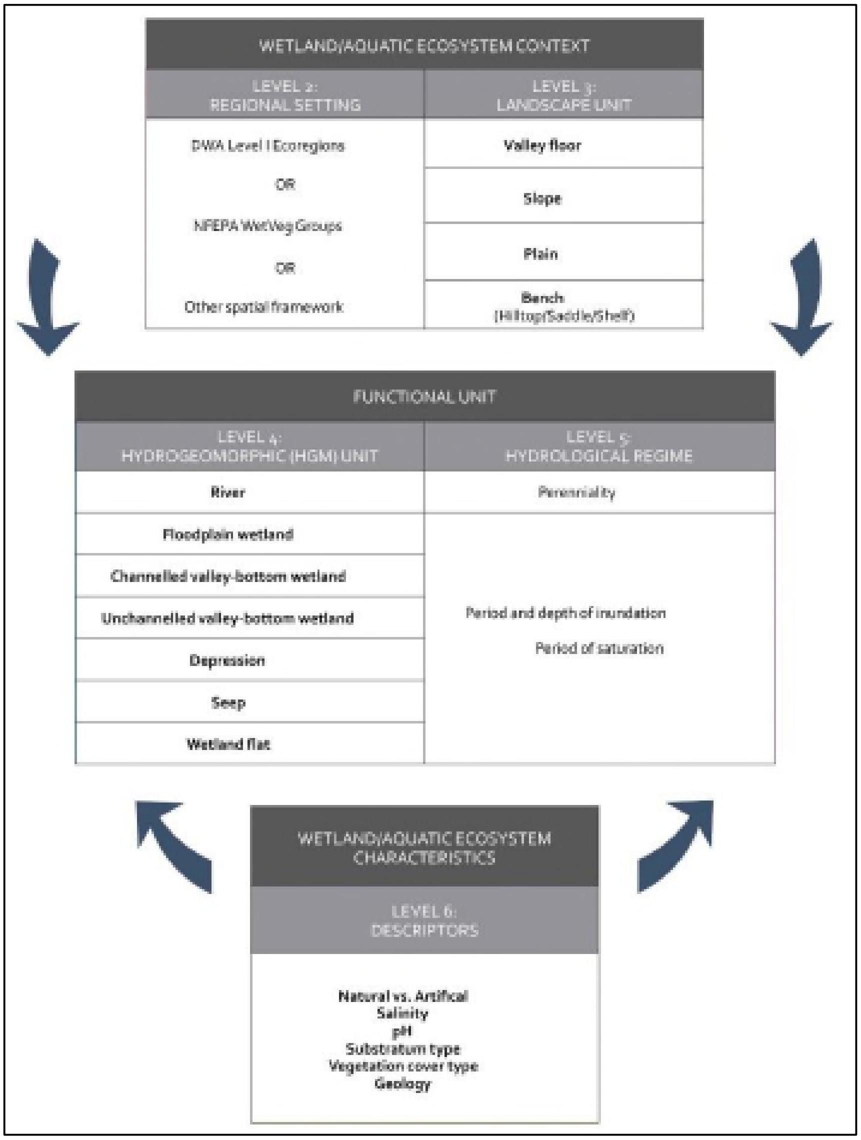

Figure 8: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

It is widely accepted that hydrology (i.e. the presence or movement of water) and geomorphology (i.e. landform characteristics and processes) are the two fundamental features that determine the way in which an inland aquatic ecosystem functions, regardless of climate, soils, vegetation or origin. Subsequently, it is significant that the HGM approach has now been included in wetland classification as the HGM approach has been adopted throughout the water resources management realm with regard the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All of these systems are then easily integrated using the HGM approach in line with the Eco-classification process of river and wetland reserve determinations used by the Department of Water Affairs.

In summary, the overall structure of this classification system comprises six tiers. This tiered structure is summarised in Figure 16 with Level 4 tier (HGM Units), as mentioned, forming the focal point of this system together with Level 5 tier (hydrological regime).

Some of the terms and definitions used in this document are present below:

Wetland definition

Although the National Wetland Classification System (SANBI, 2009) is used to classify wetland types it is still necessary to understand the definition of a wetland. Wetland definitions as with classification systems have changed over the years. Terminology currently strives to characterise a wetland not only on its structure (visible form) but also to relate this to the function and value of any given wetland.

The Ramsar Convention definition of a wetland is widely accepted as "**areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres**" (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of ten metres at low tide, as this is recognised seaward boundary of the shallow photic zone (Lombard et al., 2005). An additional minor adaptation of the definition is the removal of the term 'fen' as fens are considered a type of peatland. The adapted definition for the NWCS is, therefore, as follows (SANBI, 2009):

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten meters. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA), where wetlands are defined as "land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a watercourse (SANBI, 2009). The DWA is however reconsidering this position concerning the management of estuaries due to the ecological needs of these systems concerning water allocation. Table 11 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

Although a subset of Ramsar-defined wetlands was used as a starting point for the compilation of the first version of the National Wetland Inventory (i.e. "wetlands", as defined by the National Water Act, together with open water bodies), it is understood that subsequent versions of the Inventory include the full suite of Ramsar-defined wetlands to ensure that South Africa meets its wetland inventory obligations as a signatory to the Convention (SANBI, 2009).

Wetlands must, therefore, have one or more of the following attributes to meet the above definition (DWAF, 2005):

- » A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil.
- » Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils
- » The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water-loving plants).

It should be noted that riparian systems that are not permanently or periodically inundated are not considered true wetlands, i.e. those associated with the drainage lines.

Table 11: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	NWCS "wetland"	National Water Act wetland	DWAF (2005) delineation manual
Marine	YES	NO	NO
Estuarine	YES	NO	NO
Waterbodies deeper than 2 m (i.e. limnetic habitats often describe as lakes or dams)	YES	NO	NO
Rivers, channels and canals	YES	NO[3]	NO

[3] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act.

Inland aquatic ecosystems that are not river channels and are less than 2 m deep	YES	YES	YES
Riparian[4] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	YES	YES	YES3
Riparian areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	NO	NO	YES[5]

Rivers: a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow (unidirectional) of water. A river is taken to include both the active channel and the riparian zone as a unit (SANBI, 2013).

Dominant water sources for rivers include concentrated surface flow from upstream channels and tributaries. Other inputs can include diffuse surface or subsurface flow (e.g. from an upstream seepage wetland), interflow (e.g. from an upstream seepage wetland), interflow (e.g. from valley side-slopes), and/or groundwater inflow (e.g. from springs). Water moves through the system, at least periodically, as concentrated flow and usually exits as such, except where there is a sudden decrease in gradient causing the outflow to become diffuse (in which case the river would grade into one of the wetland types). Other water outputs from a river include evapotranspiration and infiltration (SANBI, 2013) (refer to Figure 9).

[4] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.

[5] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

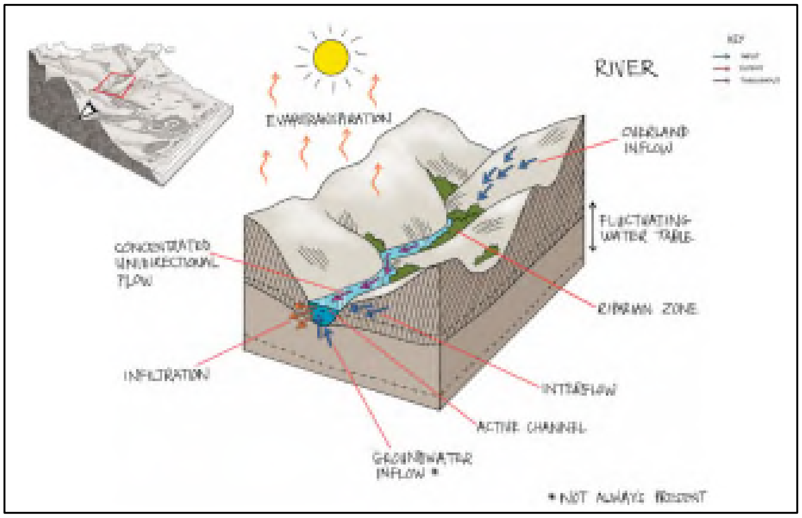

Figure 9: A conceptual illustration of a river as provided by SANBI, 2013.

Riparian zone: According to the definition provided by DWAF (2008), a riparian zone can be described as:

"*the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas*"

Furthermore, DWAF (2008) states that:

"*unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel*."

Riparian vegetation may be associated with both perennial and non-perennial watercourses/rivers. Riparian areas furthermore represent the transitional area between aquatic and terrestrial habitats. The vegetation associated with riparian zones typically require ample water and are adapted to shallow water table conditions as well as periodical flooding. Due to water availability and rich alluvial soils, riparian areas are usually very productive. Tree growth rate is high and the vegetation under the trees is usually lush in comparison to the upland terrestrial vegetation (refer to Figure 10).

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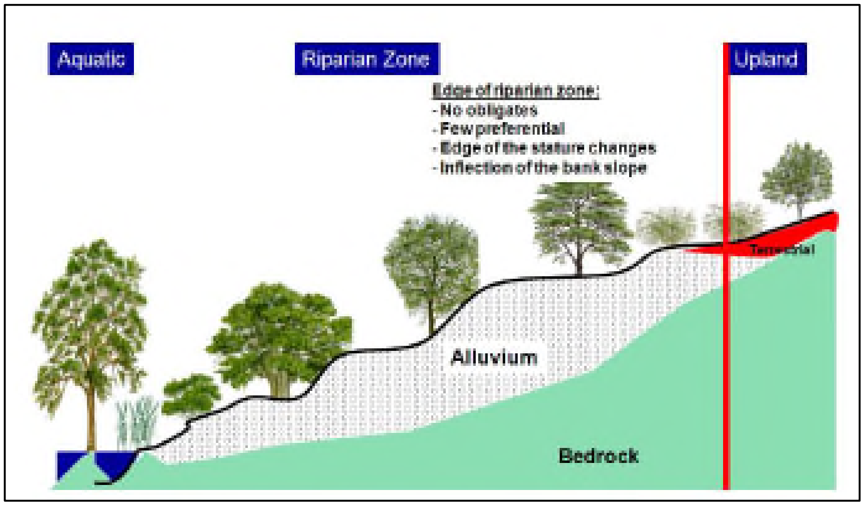

Figure 10: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river (DWAF, 2008).

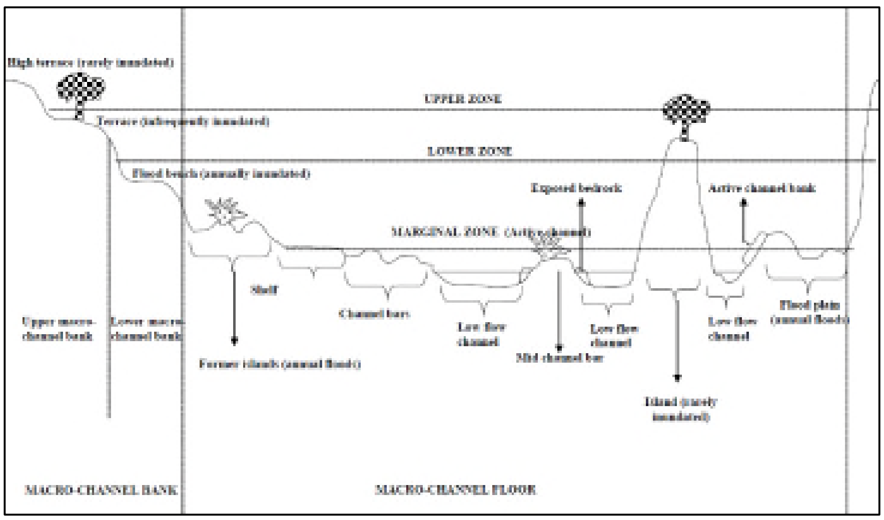

Figure 11: A schematic diagram illustrating (example) the different riparian zones relative to the different geomorphic zones typically associated with a river (Kleynhans *et al*., 2008).

The structure and dynamics of riparian zones are highly variable and are mostly an expression of the hydrological and geomorphological nature of watercourse (Figure 11 and Table 13). As such DWAF (2008) has recommended that the type of river or stream channel with which the riparian zone is associated be considered (Table 12).

Indicators of riparian areas include:

- » Landscape position:
  - » Riparian areas are associated with valley bottom landscape units (i.e. adjacent to the river/stream channel and floodplains).
- » Alluvial soils and recently deposited material:
  - » Alluvial soils are soils derived from material deposited by flowing water.

- » Alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas but it can be used to confirm the topographical and vegetative indicators.

» Topography:

- » The National Water Act definition of riparian zones refers to the structure of the banks and likely the presence of alluvium.
- » A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised "macro-channels" which are typical of many of southern Africa's eastern seaboard rivers.
- » Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus, the likely presence of wetlands.

» Vegetation:

- » The identification of riparian areas relies heavily on vegetative indicators (Unlike wetland delineation which relies on redoximorphic features in soil).
- » Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs:
  - ▪ in species composition relative to the adjacent terrestrial area; and
  - ▪ in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure, and/or numbers of individual plants.
- » In addition to indicators of structural differences in vegetation, indicator species themselves can be used to denote riparian areas (e.g. Obligate-, Preferential- and Facultative riparian species).

Table 12: Geomorphological longitudinal river zones for South African rivers as characterized by Rowtree & Wadeson (2000) (SANBI, 2013).

Longitudinal Zone (and zone class)	Characteristic gradient	Diagnostic channel characteristics
Zonation associated with a normal profile		
Source zone	Not specified	Low-gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
Mountain headwater stream	>0.1	A very steep-gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain stream	0.040-0.099	Steep-gradient steam dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, plane bed. Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Transitional	0.020-0.039	Moderately steep stream dominated by bedrock or boulders. Reach types include plane bed, pool-rapid, or pool-riffle. Confident or semi-confined valley floor with limited floodplain development.
Upper foothills	0.005-0.019	Moderately steep cobble-bed or mixed bedrock-cobble bed channel, with plane bed, pool-riffle reach types. Length of

		pools and riffles/rapids similar. Narrow floodplain of sand, gravel, or cobble often present.
Lower foothills	0.001-0.005	Lower gradient, mixed-bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock-controlled. Reach types typically include pool-riffle or pool-rapid, sand bars common in pools. Pools of a significantly greater extent than rapids or riffles. Floodplain often present.
Lowland River	0.0001-0.0010	Low-gradient, alluvial sand-bed channel, typically regime reach type. Often confined, but fully developed meandering pattern within a distinct floodplain develops in unconfined reaches where there is an increase in silt content in bed or banks.
B. Additional zones associated with a rejuvenated profile		
Rejuvenated bedrock fall/cascades	>0.02	Moderate to steep gradient, often confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool-rapid.
Rejuvenated foothills	0.001-0.020	Steepened section within middle reaches of the river caused by uplift, often within or downstream of gorge; characteristic similar to foothills (gravel/cobble-bed rivers with pool-riffle/pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a micro-channel activated only during infrequent flood events. A floodplain may be present between the active and macro-channel.
Upland floodplain	<0.005	An upland low-gradient channel, often associated with uplifted plateau areas as occurring beneath the eastern escarpment.

Table 13: A description of the different riparian vegetation zones typically associated with a river/stream system (Kleynhans *et al.*, 2008).

	Marginal	**Lower**	**Upper**
Alternative Description	Active features (Wet bank)	Seasonal features (Wet bank)	Ephemeral features (Dry bank)
Extends from	Water level at low flow	Marginal Zone	Lower Zone
Extends to	Geomorphic features/substrates that are hydrologically activated (inundated or moistened) for the greater part of the year	Usually a marked increase in lateral elevation.	Usually a marked decrease in lateral elevation
Characterized by	See above; Moist substrates next to water's edge; water loving-species usually vigorous due to near-permanent access to soil moisture	Geomorphic features that are hydrologically activated (inundated or moistened) on a seasonal basis. May have different species than marginal zone	Geomorphic features that are hydrological activated (inundated or moistened) on an ephemeral basis. Presence of riparian and terrestrial species with increased stature.

Importance and functions of riparian areas

Riparian areas perform a variety of functions that are of value to society, especially the protection and enhancement of water resources, and the provision of habitat for plant and animal species.

Riparian areas can variously:

» store water and help reduce flood peaks;
» stabilize stream banks;
» improve water quality by trapping sediment and nutrients;
» maintain natural water temperature through shading for aquatic species;
» provide shelter, food and migration corridors for the movement of both aquatic and terrestrial species;
» act as a buffer between aquatic ecosystems and adjacent upslope land uses;
» can be used as recreational sites; and
» provide material for building, muti, crafts, and curios.

However, as mentioned, the structure and dynamics of riparian zones are highly variable and as such not all riparian areas are capable of fulfilling all of these functions or to the same extent.

Habitat Integrity and Condition of the Affected Freshwater Resources:

To assess the Present Ecological State (PES) or condition of the observed wetlands, a modified Wetland Index of Habitat Integrity (DWAF, 2007) was used. The Wetland Index of Habitat Integrity (WETLAND-IHI) is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The output scores from the WETLAND-IHI model are presented in the standard DWAF A-F ecological categories (Table 13), and provide a score of the Present Ecological State of the habitat integrity of the wetland system being examined. The author has included additional criteria into the model-based system to include additional wetland types. This system is preferred when compared to systems such as WET-Health – wetland management series (WRC 2009), as WET-Health (Level 1) was developed with wetland rehabilitation in mind, and is not always suitable for impact assessments. This coupled to the degraded state of the wetlands in the study area, a complex study approach was not warranted, i.e. conduct a Wet-Health Level 2 and WET-Ecosystems Services study required for an impact assessment.

Table 14: Description of A – F ecological categories based on Kleynhans et al., (2005).

ECOLOGICAL CATEGORY	ECOLOGICAL DESCRIPTION	MANAGEMENT PERSPECTIVE
A	Unmodified, natural.	Protected systems; relatively untouched by human hands; no discharges or impoundments allowed
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.	Some human-related disturbance, but mostly of low impact potential
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	Often characterized by high human densities or extensive resource exploitation. Management intervention is needed to improve health, e.g. to restore flow patterns, river habitats or water quality
F	Critically / Extremely modified. Modifications have reached a critical level and the 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.	

The WETLAND-IHI model is composed of four modules. The "Hydrology", "Geomorphology" and "Water Quality" modules all assess the contemporary driving processes behind wetland formation and maintenance. The last module, "Vegetation Alteration", provides an indication of the intensity of human land use activities on the wetland surface itself and how these may have modified the condition of the wetland. The integration of the scores from these 4 modules provides an overall Present Ecological State (PES) score for the wetland system being examined. The WETLAND-IHI model is an MS Excel-based model, and the data required for the assessment are generated during a rapid site visit.

Additional data may be obtained from remotely sensed imagery (aerial photos; maps and/or satellite imagery) to assist with the assessment. The interface of the WETLAND-IHI has been developed in a format that is similar to DWAF's River EcoStatus models which are currently used for the assessment of PES in riverine environments.

Conservation importance of the individual wetlands was based on the following criteria:
Habitat uniqueness
Species of conservation concern
Habitat fragmentation concerning ecological corridors
Ecosystem service (social and ecological)

The presence of any or a combination of the above criteria would result in a HIGH conservation rating if the wetland was found in a near-natural state (high PES). Should any of the habitats be found modified the conservation importance would rate as MEDIUM, unless a species of conservation concern were observed (HIGH). Any systems that were highly modified (low PES) or had none of the above criteria, received a LOW conservation importance rating.

Wetland Ecological Importance and Sensitivity (EIS)

The outcomes of the wetland functional assessment were used to inform an assessment of the importance and sensitivity of wetland systems using the Wetland EIS (Ecological Importance and Sensitivity) assessment tool. The Wetland EIS tool includes an assessment of three components:

- Biodiversity support;
- Landscape-scale importance;
- Sensitivity of the wetland to floods and water quality changes.

The maximum score for these components was taken as the importance rating for the wetland which is rated using Table 14.

Table 15: Rating table used to rate level of ecosystem supply.

RATING	IMPORTANCE OR LEVEL OF SUPPLY OF ECOSYSTEM SERVICES
None, Rating=0	Rarely sensitive to changes in water quality/hydrological regime.
Low, Rating=1	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate, Rating=2	Some elements sensitive to changes in water quality/hydrological regime.
High, Rating=3	Many elements sensitive to changes in water, quality/hydrological regime.
Very High, Rating=4	Vary many elements sensitive to changes in water quality/hydrological regime.

Appendix 2. Methodology: Assessment of Impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

» The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.

» The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional,

Immediate area	1
Whole site (entire surface right)	2
Neighboring areas	3
Regional	4
Global (Impact beyond provincial boundary and even beyond SA boundary)	5

- The **duration**, wherein it was indicated whether:

Lifetime of the impact will be of a very short duration (0 – 1 year)	1
The lifetime of the impact will be of a short duration (2 – 5 years)	2
Medium-term (5 -15 years)	3
Long term (> 15 years)	4
Permanent	5

- The **magnitude**, quantified on a scale from 0 – 10,

small and will have no effect on the environment	2
minor and will not result in an impact on processes	4
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
very high and results in complete destruction of patterns and permanent cessation of processes	10

- The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1 -5,

very improbable (probably will not happen)	1
improbable (some possibility, but low likelihood)	2
probable (distinct possibility)	3
highly probable (most likely)	4
definite (impact will occur regardless of any prevention measures)	5

- The **significance**, was determined through a synthesis of the characteristics described above and can be assessed as;
  - **LOW**,
  - **MEDIUM** or
  - **HIGH**;

- the **status**, which was described as either positive, negative or neutral.
- the degree of which the impact can be reversed,
- the degree to which the impact may cause irreplaceable loss of resources,
- the degree to which the impact can be mitigated.

The significance was calculated by combining the criteria in the following formula:

S=(E+D+M)P where;

- S = Significance weighting
- E = Extent

- D = Duration
- M = Magnitude
- P = Probability

The significance weightings for each potential impact are as follows;

Table 16: Rating table used to rate level of significance.

RATING	CLASS	MANAGEMENT DESCRIPTION
< 30	**Low (L)**	Where the impact would not have a direct influence on the decision to develop the area.
30 - 60	**Medium (M)**	Where the impact could influence the decision to develop in the area unless it is effectively mitigated.
> High	**High (H)**	Where the impact must have an influence on the decision process to develop in the area.

Appendix 3. Description of the Biophysical Environment

Climate and Rainfall

The climate of the western areas of the Republic of South Africa is controlled to a great extent by the semi-permanent high pressure systems of the south Atlantic, the easterly moving low pressure systems of the sea areas in the region of 40°S and a low pressure system situated in the northern areas of Namibia. The movements of these pressure systems during the year and the influence of the cold Benguela current along the west coast combine to produce the arid climate of the north western part of the Western and Northern Cape Provinces.

During the summer, the South Atlantic High moves south and similarly the low pressure over northern Namibia also moves south causing moist air to flow from the tropical regions to the eastern portions of the country, causing precipitation in the form of violent thundershowers. These conditions are compounded by the topography in the east. Because of this movement of the air mass in a south-eastern (SE) direction, the western areas of the country are considerably more arid than the eastern and northern areas.

During winter, the low-pressure systems associated with the sea areas in the region of 40°S extend and influence northwards and a continuous series of frontal depressions with associated inclement weather cross the south western part of the old Cape Province.

At the same time a permanent high-pressure system develops over the eastern parts of the country which tends to block the eastward progress of these frontal depressions, steering them to the SE and giving rise to the strong northerly winds over the NW of the old Cape Province. These northerly winds have a tendency, during cold fronts, to veer southerly for short periods, causing low cloud and rain, the influence of which is mainly in the southern and western areas of the Cape, but which can extend as far as Aggeneys. Aggeneys is situated in the NW region of Bushmanland, an area which is marginal to the winter and summer rainfall zones in the North and Western Cape Province. Namaqualand to the west is considered to constitute a winter rainfall area while Gordonia to the east is a summer rainfall area. Aggeneys gets very little of either type of rain, resulting in desert conditions, although more rain tends to fall in the summer months. Protracted droughts are a common feature, and in the recent past, some parts of Bushmanland did not have any rain for an extended period.

The Aggeneys are is described as "Hot Desert" (Köppen classification), being one of the hottest and driest areas in South Africa, with maximum temperatures exceeding 40ºC in summer months and annual rainfall sometimes as low as a few tens of millimetres.

The Aggeneys area is characterized by temperatures ranging between -2° and 45°C. The mean summer temperatures are 31.4°C maximum and 20.2°C minimum, while the mean winter temperatures are 17.6°C maximum and 10.8°C minimum (Figure 12 & 13).

The average of the annual rainfall (mean annual precipitation, MAP) varies between 74 mm (Pella) to 110 mm (Aggeneys) for rainfall stations recording on the plains (Figure 12). Aggeneys has a higher MAP than Pella and Pofadder, and it is not possible to determine whether this is due to the longer record at Pella and Pofadder, or whether it is a true difference in rainfall distribution. There appears to be an orographic control on the rainfall distribution with the mountainous areas receiving higher rainfall. The variation in the annual rainfall indicated in the longer records of the Aggeneys, Pella and Pofadderstations, is extremely high. For example, at Aggeneys, the MAP is 110mm, with a minimum MAP of 4mm, and a maximum of 220 mm, representing a range from almost 0% to 200%. Essentially, given the range in data also highlighted by the high standard deviation in MAP, the concept of a 'mean annual precipitation' actually does not apply in the area. Precipitation may occur throughout the year, in summer and winter, although higher rainfall is experienced in late summer and March/April indicated as the wettest months, likely to be dominated by afternoon thunderstorms (Figure 11).

The mean annual evaporation rate is high (up to 2600 mm/a) compared to annual rainfall on the plains, hence a permanent water deficit exists in the area. This deficit reaches a peak of up to 400 mm in November to January and droughts are therefore common in the area.

The prevailing wind direction is southerly in summer and northerly in winter. The least common wind direction is north-westerly, which wind would seem to precede rain in the summer months. Wind velocities of up to 110km/hr have been recorded. The total evaporation rate over a year is 3.5m.

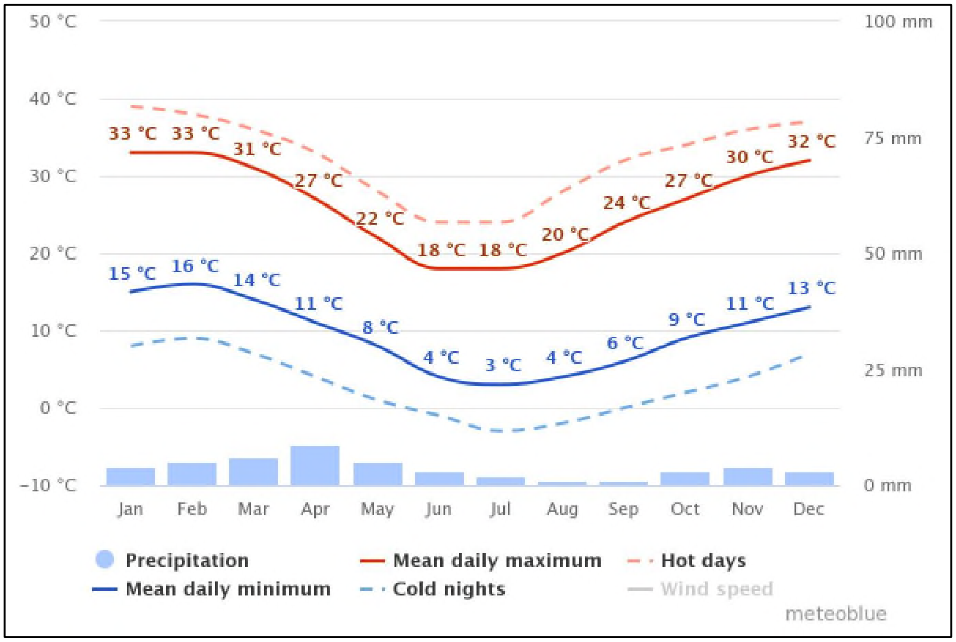

Figure 12: Climate graph for the Aggeneys region (https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/aggeneys_south-africa_3370556).

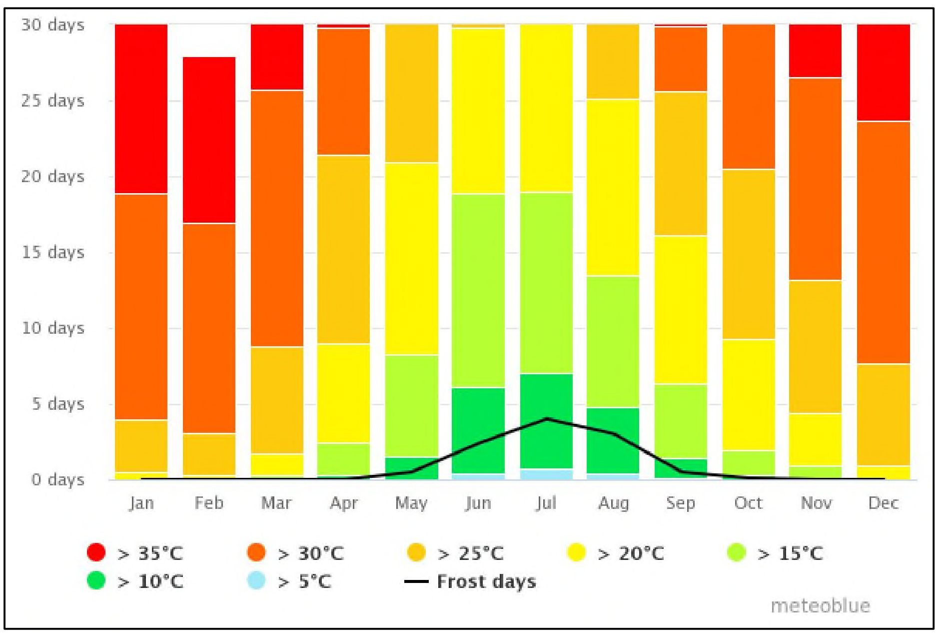

Figure 13: Maximum temperature diagram for the Aggeneys region (https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/aggeneys_south-africa_3370556).

Physiography and soils

Landscape Features

According to AGIS, 2007 the bulk of the development area is classified as a B2 terrain type (rolling or broken plains or plateaus with some relief) and is situated within a footslope landscape setting with a slight convex slope shape (Y). Percentage slope is generally between 0 and 3%.

At a finer scale using a Google elevation profile for the affected property can be described as a relatively flat area with a slight concave shape. This generally flat landscape is broken by a few isolated outcrops and inselbergs along the northern and southern boundaries of the property and a linear dune system within the central portion. This dune system comprises of low, linear sand dunes, trending NW to SE, and is largely associated with the Koa River-palaeovalley. As mentioned, the landscape of the property can be described as having a slight concave shape, with the highest lying areas found along the northern and southern boundaries. From these higher lying areas, the landscape gently slopes towards the central portion of the property where the Koa River-palaeovalley (running from SE to NW) is associated with the lowest area within the property. Most of the freshwater features are located north of the dune system, with most of the ephemeral channels and drainage lines running in a north to south direction from the Ghaamsberg Mountain. Most of these ephemeral channels, washes and drainage lines are diffuse, endorheic systems. Small, endorheic, depression wetlands are also a prominent feature of the landscape.

The property is situated between elevations 1055 m amsl and 811 m amsl, with an average elevation of 848 a.m.s.l. The average slope of the property is 0.7%.

The proposed development area is situated just north of the dune system within a flat to very gentle SW sloping landscape between elevations 852 m amsl and 836 m amsl with an average slope of 0.6%.

Geology

Regional Geology

A variety of resistant-weathering igneous and high-grade metamorphic rocks (mainly gneisses, schists, quartzites and amphibolites) of Late Precambrian (Mokolian / Mild-Proterozoic) age form the basement rocks underling the affected area (Almond, 2019 & Partridge *et al.* 2006). These ancient basement rocks are assigned to the Namaqua-Natal Province and are approximately one to two billion years old. Overlying these basement rocks are a spectrum of mostly unconsolidated superficial sediments of Late Cenozoic age. These include Quaternary to Recent sands and gravels of probable braided fluvial (alluvial fan) or sheet wash origin, as well as a veneer of downwasted surface gravels and colluvial deposits. The alluvial and colluvial sediments are locally overlain by unconsolidated aeolain (wind-blown) sands of the Gordonia Formation (Kalahari Group) that are Pleistocene to Holocene in age (Almond, 2019 & Partridge *et al.* 2006). Associated with the Koa River-palaeovalley, which runs in a SE to NW direction through the central portion of the affected property, are orange-hued linear sand dunes (trending in a NW to SE direction).

The Koa River-palaeovally represents a defunct south bank tributary of the River Orange of Neogene/ Late Tertiary age, that fed into the palaeo-Orange River near Henkries (Almond, Malherbe *et al,* 1986, De Wit 1990, 1993, 1999, De Wit *et al.* 2000 & Partridge, 2006). This palaeovalley is readily marked by intermittent pans and a veneer of orange-brown Kalahari aeolain sands.

Soil and Land Types

Detailed soil information is not available for broad areas of the country. A surrogate land type data was used to provide a general description of soil in the study area (land types are areas with largely uniform soils, topography, and climate). The majority of the development area is situated within the Af26 land type whilst the south-western corner of the development area extends into the Af21 land type (associated with the Koa River-palleovalley) (Land Type Survey Staff, 1987)

» Af land type refers to areas characterised by red, excessively drained sandy soils with high base status and dunes may be present.

A summary of the dominant soil characteristics of each land type is given in Table 1 and 2 below.

Table 17: Soil forms and coverage per terrain unit (%) for the Af26 land type.

Soil Form	% Cover per Terrain Unit			% Cover Total	Depth (mm)	Clay Content (%)		
	1	3	5					
Slope (%)	2-4	4-15	0-3			A	E	B21
Gaudam Hu31	50	50	20	45.5	>1200	2-4		2-4
Langebaan Fw21	20	20		17	>1200	1-4		
Roodepoort Hu30	20	20		17	>1200	2-4		2-4
Kalkbank Ms 22			60	9	10-50	2-4		
Sunbury Cv30, Sandspruit Cv31	10	10		8.5	>1200	2-4		2-4
Brenton Vf31			20	3	>1200	1-4	1-4	6-12

Table 18: Soil forms and coverage per terrain unit (%) for the Af21 land type.

Soil Form	% Cover per Terrain Unit				% Cover Total	Depth (mm)	Clay Content (%)		
	1	3	4	5					
Slope (%)	0-3	8-10	0-3	0-1			A	E	B21

Gaudam Hu31	100	100	45	15	75	>1200	2-4		2-4
Moriah Hu32			30	20	11	300-700	1-3		3-6
Portsmouth Hu35			15	5	5	300-500	3-6		6-10
Malonga Hu44			5	25	4	300-500	3-6		6-10
Kirkton (Oa23), Magersfontein Oa24				30	3	400-700	3-9		4-8
Loskop Ms12, Kalkbank Ms22			5	5	2	50-150	1-3		

Surface Hydrology

The development area is situated within the Lower Orange Management Area (WMA), Quaternary Catchment D82C, and Ecoregion 26.02 (Nama Karoo).

The proposed development area is situated within the Northern Cape Pan Veld Geomorphic Province (Partridge et al., 2010). The main feature of this province, which straddles the uplifted Griqualand–Transvaal axis, is the frequency of pans (some of vast size e.g., Verneukpan and Grootvloer) that are remnants of earlier (Cretaceous) drainage systems (De Wit, 1993). Each pan has its own endoreic drainage network. These pans can be regarded as discontinuous groundwater windows, in which the substantial excess of evaporation over precipitation under the prevailing hot, dry climate, leads to rapid concentration of dissolved solids within each discrete basin. Some of the pans are linked by now defunct palaeo-valleys which, under the more humid conditions of the Miocene, contained substantial rivers. The Koa Valley traversing the central portion of the farm property (proposed development site located just north of this palaeo-valley) are such a relict feature. These drainage systems were disrupted both by progressive aridification and by uplift along the Griqualand–Transvaal axis, causing the dismembering of several (Partridge & Maud, 2000).

Four main drainage systems traverse this geomorphic province; from east to west these are the Boesak, Vis/Hartbees and Brak rivers. The rivers in the extreme northwest (e.g., the Brak) are, however, characterised by narrower valley cross-sectional profiles and slightly steeper slopes than the rivers of the east. Furthermore, these rivers of the extreme northwest are characterised by convex longitudinal profiles and linear BFCs (Macro-reach Best Fit Curves: aggregading alluvial river systems where there is no significant lateral input of water or sediment), so that their sediment storage surrogate descriptors become BV (a sediment storage surrogate descriptor indicative of low sediment storage capability). The Brak River in fact follows the Koa valley, the course of which was disrupted by uplift along the Griqualand–Transvaal axis which crosses it at right angles.

From available spatial (NFEPA, NBA2018 Wetland coverage) no watercourses are present within the development area (as well as affected property). However, the affected property is characterised by a number of small depression wetlands, of which two are located within the development area. The most prominent drainage feature within the sub-quaternary catchment is an endorheic, ephemeral watercourse located approximately 8km north west of the development area. This ephemeral watercourse drains in a north west direction and is classified as a Lowland River (according to geomorphological zonation) with a V1 and/or V2 valley form. This water course, as well as the depression wetlands are classified as no-prioritised surface water recourses (Non-NFEPA) and furthermore falls within a non-prioritised sub-quaternary catchment in terms of the NFEPA project.

The affected quaternary catchment has a Largely Natural (Class B) Present Ecological Status (PES), while its Ecological Importance and Sensitivity (EIS) is regarded as Low/Marginal.

Existing Land Use

Land use within the project site is mostly for farming. Farming practices consist of cattle farming with some "free" roaming game. Due to the aridity of the area large tracts of land is still fairly natural. Infrastructure are mostly in the form of kraals, water points, boreholes and small dwellings.

Prominent anthropogenic features (natural and unnatural) within the region include the Ghamsberg Mine to the north, Black Mountain Mine to the north west, and the town of Aggeneys to the north west. The project site lies just south east of the N14 Route that links Springbok to Aggeneys and Pofadder. An existing 400kV power lines lies just north of the project site is located west of the project site. Apart from these anthropogenic features, vast areas of landscape are still mostly natural (very poorly developed) and predominantly used for livestock farming. Fences, occasional tracks and kraals tend to be the main anthropogenic features, within these areas.

Vegetation Overview

Broad-Scale Vegetation Patterns

According to the national vegetation map (Mucina & Rutherford 2006), the bulk of the development area is located within Bushmanland Arid Grassland, whilst the south western corner falls within Bushmanland Sandy Grassland. The Bushmanland Vloere vegetation unit represents both depression/pan wetlands and other ephemeral watercourse systems within this arid region. As the Bushmanland Vloere vegetation unit represents the vegetation of these surface water resource features, only this vegetation unit will be discussed below. The terrestrial vegetation patterns will be addressed within the terrestrial ecological study and assessment.

Bushmanland Vloere are vloere (salt pans) of the central Bushmanland Basin as well as the broad riverbeds of the intermittent Sak River (functioning as a temporary connection between some of the pans) as well as its numerous ancient (today dysfunctional) tributaries. The patches of this vegetation unit are embedded especially within Bushmanland Basin Shrubland and Bushmanland Arid Grassland. This vegetation unit is typically between 850 – 1450 m amsl. These depression/ ephemeral watercourse features occupy flat and very even surfaces. The centre of a pan (or the river drainage channel itself) is usually devoid of vegetation; loosely patterned scrub dominated by Rhigozum trichotomum and various species of Salsola and Lycium, with a mixture of nonsucculent dwarf shrubs of Nama-Karoo relationship. In places loose thickets of Parkinsonia Africana, Lebeckia leariifolia and Acacia karroo can be found.

These endorheic pans and alluvia of associated intermittent rivers are filled with silty and clayey alluvial deposits with a high content of concentrated salt (sodic soils). In some pans the orthic A horizon may overlie a soft carbonate subsoil. The alluvial terraces of the larger ephemeral watercourses may be quite deep (>1000mm), and are stratified and weakly structured and may in some areas be calcareous. Erosion in some places can become considerable, especially after unpredictable thunderstorms. Pans/depressions can be filled in wet summers and in autumn.

This vegetation unit is classified as Least threatened with a conservation target of 24%. Currently none of this vegetation unit is conserved in statutory conservation areas. Approximately 98% of these pans and ephemeral watercourses are still natural, with 2% being transformed through cultivation or dam building activities. Alien Prosopis occurs as scattered in some vloere and dry riverbeds. Several of these pans are mined for salt production.

Table 19: Key species associated with the Bushmandland Vloere according to Mucina and Rutherford (2006).

Growth Form	Key Species
Tall Shrubs	*Parkinsonia africana, Xerocladia viridiramis*
Low Shrubs	*Rhigozum trichotomum, Aizoon schellenbergii, Asparagus glaucus, Eriochephalus decussatus, E. spinescens, Pegolettia retrofracta*
Succulent Shrubs	*Salsola aphylla, S. glabrescens, S. rabieana, S. gemmifera, Lycium pumilum,*
Herbs	*Amaranthus dinteri subsp. dinteri, Lotononis minima*
Geophytic Herb	*Crinum variabile*
Graminoids	*Stipagrostis ciliata, S. obtusa, S. nervosus, S. namaquensis*

Conservation Planning/Context

National Level of Conservation Priorities (Threatened Ecosystems)

The vegetation types of South Africa have been categorized according to their conservation status which is, in turn, assessed according to the degree of transformation and rates of conservation. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. On a national scale, these thresholds are as depicted in the table below, as determined by the best available scientific approaches (Driver et al. 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver et al. 2005).

Table 20: Determining ecosystem status (from Driver et al. 2005). *BT = biodiversity target (the minimum conservation requirement.

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

A national process has been undertaken to identify and list threatened ecosystems that are currently under threat of being transformed by other land uses. The first national list of threatened terrestrial ecosystems for South Africa was gazetted on 9 December 2011 (National Environmental Management: Biodiversity Act or NEMBA: National list of ecosystems that are threatened and in need of protection, G 34809, GoN 1002, 9 December 2011). The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function, and composition of threatened ecosystems (SANBI, 2011). The NEMBA provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered (CR), endangered (EN), vulnerable (VU) or protected. There are four main types of implications of listing ecosystems:

- Planning related implications which are linked to the requirement in the Biodiversity Act (Act 10 of 2004) for listed ecosystems to be taken into account in municipal IDPs and SDFs;
- Environmental authorisation implications in terms of NEMA and the EIA regulations;
- Proactive management implications in terms of the National Biodiversity Act;
- Monitoring and reporting implications in terms of the Biodiversity Act.

As mentioned earlier only vegetation units and threatened ecosystems applicable to the surface water resource features will be discussed in this report.

According to Mucina and Rutherford (2006), the Bushmanland Vloere vegetation type is classified as Least Threatened, having a conservation target of 24%. Currently, none of this vegetation type is conserved in statutory conservation areas.

Furthermore, this area is **Not** listed within the Threatened Ecosystem List (NEMA:BA).

It is highly unlikely that this development will have an impact on the status of this Vegetation Type as all infrastructure is located outside of the surface water features with which this vegetation type is associated with.

National Freshwater Ecosystem Priority Areas (2011)

The National Freshwater Ecosystem Priority Area (NFEPA) project (Nel et al., 2011), is the first formally adopted national freshwater conservation plan that provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources that includes rivers, wetlands and estuaries. The importance of water resources in meeting national freshwater conservation targets is provided in the National Freshwater Ecosystems Priority Areas (NFEPA) outputs and coverage's (CSIR, 2011).

FEPAs were identified based on:

» Representation of ecosystem types and flagship free-flowing rivers.
» Maintenance of water supply areas in areas with high water yield.
» Identification of connected ecosystems.
» Representation of threatened and near-threatened fish species and associated migration corridors.
» Preferential identification of FEPAs that overlapped with:
    - Any free-flowing river
    - Priority estuaries identified in the National Biodiversity Assessment 2011
    - Existing protected areas and focus areas for protected area expansion identified in the National Protected Areas Expansion Strategy.

A review of the NFEPA coverage for the study area revealed that no FEPAs were present within the affected property. The most prominent drainage feature within the sub-quaternary catchment is an endorheic, ephemeral watercourse located approximately 8km north west of the development area. This ephemeral watercourse drains in a north west direction and is classified as a Lowland River (according to geomorphological zonation) with a V1 and/or V2 valley form. According to DWAFs 1999 Present Ecological State for mainstream rivers this watercourse was classified as largely natural (Class B) (Kleynhans, 2000). This watercourse is classified as a non-prioritised freshwater resource (Non-FEPA) and furthermore falls within a non-prioritised sub-quaternary catchment in terms of the NFEPA project. A number of small wetlands (all depression wetlands) were mapped on the affected property (two wetlands within the development area and none within the proposed PV solar facility's footprint), however these have not been identified as wetland FEPAs .

Critical Biodiversity Areas and Broad Scale Ecological Processes

Critical Biodiversity Areas have been identified for all municipal areas of the Northern Cape Province (Oosthuysen & Holness, 2016) and are published on the SANBI website (bgis.sanbi.org). This biodiversity assessment identifies CBAs which represent biodiversity priority areas that should be maintained in a natural to near-natural state. The CBA maps indicate the most efficient selection and classification of land portions requiring safeguarding in order to maintain ecosystem functioning and meet national biodiversity objectives (refer to Table 21) for the different land management objectives set out for each CBA category).

The identified CBA2 and ESA within the proposed development site, as well affected farm property, are associated with terrestrial features and subsequently these provincial conservation areas and the potential impact the development will have on these areas will be dealt within, in detail, within the terrestrial ecological study and assessment.

Table 21: Relationship between Critical Biodiversity Areas categories (CBAs) and land management objectives

CBA category	Land Management Objective
Protected Areas (PA) & CBA 1	***Natural landscapes:*** » Ecosystems and species are fully intact and undisturbed. » These are areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost, then targets will not be met. » These are landscapes that are at or past their limits of acceptable change.
CBA 2	***Near-natural landscapes:*** » Ecosystems and species are largely intact and undisturbed. » Areas with intermediate irreplaceability or some flexibility in terms of the area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets. » These are landscapes that are approaching but have not passed their limits of acceptable change.
ESA	***Functional landscapes:*** » Ecosystem moderately to significantly disturbed but still able to maintain basic functionality. » Individual species or other biodiversity indicators may be severely disturbed or reduced. » These are areas with low irreplaceability with respect to biodiversity pattern targets only.
ONA (Other Natural Areas) and Transformed	Production landscapes: Manage land to optimise sustainable utilisation of natural resources.

Appendix 4. Specialist CV.

CURRICULUM VITAE:

Gerhard Botha

Name:	:	Gerhardus Alfred Botha
Date of Birth	:	11 April 1986
Identity Number	:	860411 5136 088
Postal Address	:	PO Box 12500 Brandhof 9324
Residential Address	:	3 Jock Meiring Street Park West Bloemfontein 9301
Cell Phone Number	:	084 207 3454
Email Address	:	gabotha11@gmail.com
Profession/Specialisation	:	Ecological and Biodiversity Consultant
Nationality:	:	South African
Years Experience:	:	8
Bilingualism	:	Very good – English and Afrikaans

Professional Profile:

Gerhard is a Managing Director of Nkurenkuru Ecology and Biodiversity (Pty) Ltd. He has a BSc Honours degree in Botany from the University of the Free State Province and is currently completing a MSc Degree in Botany. He began working as an environmental specialist in 2010 and has since gained extensive experience in conducting ecological and biodiversity assessments in various development field, especially in the fields of conventional as well as renewable energy generation, mining and infrastructure development. Gerhard is a registered Professional Natural Scientist (Pr. Sci. Nat.)

Key Responsibilities:

Specific responsibilities as an Ecological and Biodiversity Specialist include, inter alia, professional execution of specialist consulting services (including flora, wetland and fauna studies, where required), impact assessment reporting, walk through surveys/ground-truthing to inform final design, compilation of management plans, compliance monitoring and audit reporting, in-house ecological awareness training to on-site personnel, and the development of project proposals for procuring new work/projects.

Skills Base and Core Competencies

- Research Project Management
- Botanical researcher in projects involving the description of terrestrial and coastal ecosystems.
- Broad expertise in the ecology and conservation of grasslands, savannahs, karroid wetland, and aquatic ecosystems.
- Ecological and Biodiversity assessments for developmental purposes (BAR, EIA), with extensive knowledge and experience in the renewable energy field (Refer to Work Experiences and References)
- Over 3 years of avifaunal monitoring and assessment experience.
- Mapping and Infield delineation of wetlands, riparian zones and aquatic habitats (according to methods stipulated by DWA, 2008) within various South African provinces of KwaZulu-Natal, Mpumalanga, Free State, Gauteng and Northern Cape Province for inventory and management purposes.
- Wetland and aquatic buffer allocations according to industry best practice guidelines.
- Working knowledge of environmental planning policies, regulatory frameworks, and legislation
- Identification and assessment of potential environmental impacts and benefits.
- Assessment of various wetland ecosystems to highlight potential impacts, within current and proposed landscape settings, and recommend appropriate mitigation and offsets based on assessing wetland ecosystem service delivery (functions) and ecological health/integrity.
- Development of practical and achievable mitigation measures and management plans and evaluation of risk to execution
- Qualitative and Quantitative Research
- Experienced in field research and monitoring
- Working knowledge of GIS applications and analysis of satellite imagery data
- Completed projects in several Provinces of South Africa and include a number of projects located in sensitive and ecological unique regions.

Education and Professional Status

Degrees:

- *2015:* Currently completing a M.Sc. degree in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2009:* B.Sc. Hons in Botany (Vegetation Ecology), University of the Free State, Bloemfontein, RSA.
- *2008:* B.Sc. in Zoology and Botany, University of the Free State, University of the Free State, Bloemfontein, RSA.

Courses:

- *2013*: Wetland Management (ecology, hydrology, biodiversity, and delineation) – University of the Free State accredited course.
- *2014*: Introduction to GIS and GPS (Code: GISA 1500S) – University of the Free State accredited course.

Professional Society Affiliations:

- The South African Council of Natural Scientific Professions: Pr. Sci. Nat. Reg. No. 400502/14 (Botany and Ecology).

Employment History

- December 2017 – Current: Nkurenkuru Ecology and Biodiversity (Pty) Ltd
- 2016 – November 2017: ECO-CARE Consultancy

- *2015 - 2016*: Ecologist, Savannah Environmental (Pty) Ltd
- *2013 – 2014*: Working as ecologist on a freelance basis, involved in part-time and contractual positions for the following companies
  - Enviroworks (Pty) Ltd
  - GreenMined (Pty) Ltd
  - Eco-Care Consultancy (Pty) Ltd
  - Enviro-Niche Consulting (Pty) Ltd
  - Savannah Environmental (Pty) Ltd
  - Esicongweni Environmental Services (EES) cc
- *2010 - 2012*: Enviroworks (Pty) Ltd

Publications

Publications:

- Botha, G.A. & Du Preez, P.J. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. S. *Afr. J. Bot*., **98**: 172-173.

Congress papers/posters/presentations:

- Botha, G.A. 2015. A description of the wetland and riparian vegetation of the Nxamasere palaeo-river's backflooded section, Okavango Delta, Botswana. 41st Annual Congress of South African Association of Botanists (SAAB). Tshipise, 11-15 Jan. 2015.
- Botha, G.A. 2014. A description of the vegetation of the Nxamasere floodplain, Okavango Delta, Botswana. 10th Annual University of Johannesburg (UJ) Postgraduate Botany Symposium. Johannesburg, 28 Oct. 2014.

Other

- Guest speaker at IAIAsa Free State Branch Event (29 March 2017)
- Guest speaker at the University of the Free State Province: Department of Plant Sciences (3 March 2017):

References:

- Christine Fouché
  Manager: GreenMined (Pty) LTD
  Cell: 084 663 2399
- Professor J du Preez
  Senior lecturer: Department of Plant Sciences
  University of the Free State
  Cell: 082 376 4404

Appendix 5. Specialist's Work Experience and References

WORK EXPERIENCES

&

References

Gerhard Botha

ECOLOGICAL RELATED STUDIES AND SURVEYS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Ecological Assessment (Basic Assessment)	Aurora Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Ecological Assessment (Scoping and EIA Phase Assessments)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Ecological Assessment (Basic Assessment)	Moeding Solar
2019	Expansion of the Raumix Aliwal North Quarry, Eastern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	GreenMined
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Faunal and Flora Rescue and Protection Plan	Zevobuzz
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Zevobuzz
2018	Proposed Kruisvallei Hydroelectric Power Generation Scheme in the Ash River, Free State Province	Ecological Assessment (Basic Assessment)	Zevobuzz
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Ecological Assessment (Basic Assessment)	Eskom
2018	Clayville Thermal Plant within the Clayville Industrial Area, Gauteng Province	Ecological Comments Letter	Savannah Environmental
2018	Iziduli Emoyeni Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Emoyeni Wid Farm Renewable Energy
2018	Msenge Wind Farm near Bedford, Eastern Cape Province	Ecological Assessment (Re-assessment)	Amakhala Emoyeni Renewable Energy

2017	H2 Energy Power Station near Kwamhlanga, Mpumalanga Province	Ecological Assessment (Scoping and EIA phase assessments)	Eskom
2017	Karusa Wind Farm (Phase 1 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	Soetwater Wind Farm (Phase 2 of the Hidden Valley Wind Energy Facility near Sutherland, Northern Cape Province)	Ecological Assessment (Re-assessment)	ACED Renewables Hidden Valley
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Ecological Assessment	Savannah Environmental
2016 - 2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Ecological Assessment (Scoping and EIA phase assessments)	Cresco
2016	Buffels Solar 2 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	Buffels Solar 1 PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Kabi Solar
2016	132kV Power Line and On-Site Substation for the Authorised Golden Valley II Wind Energy Facility near Bedford, Eastern Cape Province	Ecological Assessment (Basic Assessment)	Terra Wind Energy
2016	Kalahari CSP Facility: 132kV Ferrum–Kalahari–UNTU & 132kV Kathu IPP–Kathu 1 Overhead Power Lines, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Kalahari CSP Facility: Access Roads, Kathu, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Kathu Solar Park
2016	Karoshoek Solar Valley Development – Additional CSP Facility including tower infrastructure associated with authorised CSP Site 2 near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Karoshoek Solar Valley Development –Ilanga CSP 7 and 8 Facilities near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Karoshoek Solar Valley Development –Ilanga CSP 9 Facility near Upington, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Emvelo
2016	Lehae Training Academy and Fire Station, Gauteng Province	Ecological Assessment	Savannah Environmental
2016	Metal Industrial Cluster and Associated Infrastructure near Kuruman, Northern Cape Province	Ecological Assessment (Scoping Assessment)	Northern Cape Department of Economic Development and Tourism
2016	Semonkong Wind Energy Facility near Semonkong, Maseru District, Lesotho	Ecological Pre-Feasibility Study	Savannah Environmental
2015 - 2016	Orkney Solar PV Facility near Orkney, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015 - 2016	Woodhouse 1 and Woodhouse 2 PV Facilities near Vryburg, North West Province	Ecological Assessment (Scoping and EIA phase assessments)	Genesis Eco-Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy
2015	CAMCO Clean Energy 100kW PV Solar Facility, Thaba Eco Lodge near Johannesburg, Gauteng Province	Ecological Assessment (Basic Assessment)	CAMCO Clean Energy

2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 2 Solar PV Project near Upington, Northern Cape Province	Invasive Plant Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rehabilitation Management Plan	Aurora Power Solutions
2015	Sirius 1 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Sirius Phase 2 Solar PV Project near Upington, Northern Cape Province	Plant Rescue and Protection Plan	Aurora Power Solutions
2015	Expansion of the existing Komsberg Main Transmission Substation near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley
2015	Proposed Karusa Facility Substation and Ancillaries near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Eskom Karusa Switching Station and 132kV Double Circuit Overhead Power Line near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ESKOM
2015	Karusa Wind Farm near Sutherland, Northern Cape Province)	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Karusa Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley
2015	Soetwater Facility Substation, 132kV Overhead Power Line and Ancillaries, near Sutherland, Northern Cape Province	Ecological Assessment (Basic Assessment)	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province)	Invasive Plant Management Plan	ACED Renewables Hidden Valley
2015	Soetwater Wind Energy Facility near Sutherland, Northern Cape Province	Fauna and Flora Pre-Construction Walk-Through Assessment	ACED Renewables Hidden Valley
2015	Soetwater Wind Farm near Sutherland, Northern Cape Province	Plant Search and Rescue and Rehabilitation Management Plan	ACED Renewables Hidden Valley
2015	Expansion of the existing Scottburgh quarry near Amandawe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2015	Expansion of the existing AFRIMAT quarry near Hluhluwe, KwaZulu-Natal	Botanical Assessment (for EIA)	GreenMined Environmental
2014	Tshepong 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Ecological Assessment (Basic Assessment)	BBEnergy
2014	Transalloys circulating fluidised bed power station near Emalahleni, Mpumalanga Province	Ecological Assessment (for EIA)	Trans-Alloys
2014	Umbani circulating fluidised bed power station near Kriel, Mpumalanga Province	Ecological Assessment (Scoping and EIA)	Eskom
2014	Gihon 75MW Solar Farm: Bela-Bela, Limpopo Province	Ecological Assessment (for EIA)	NETWORX Renewables

2014	Steelpoort Integration Project & Steelpoort to Wolwekraal 400kV Power Line	Fauna and Flora Pre-Construction Walk-Through Assessment	Eskom
2014	Audit of protected *Acacia erioloba* trees within the Assmang Wrenchville housing development footprint area	Botanical Audit	Eco-Care Consultancy
2014	Rehabilitation of the N1 National Road between Sydenham and Glen Lyon	Peer review of the ecological report	EKO Environmental
2014	Rehabilitation of the N6 National Road between Onze Rust and Bloemfontein	Peer review of the ecological report	EKO Environmental
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein	Vegetation Rehabilitation Plan	EnviroWorks
2011	Rocks Farm chicken broiler houses	Botanical Assessment (for EIA)	EnviroWorks
2011	Botshabelo 132 kV line	Ecological Assessment (for EIA)	CENTLEC
2011	De Aar Freight Transport Hub	Ecological Scoping and Feasibility Study	EnviroWorks
2011	The proposed establishment of the Tugela Ridge Eco Estate on the farm Kruisfontein, Bergville	Ecological Assessment (for EIA)	EnviroWorks
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Vegetation Rehabilitation Plan for illegally cleared areas	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Invasive Plant Management Plan	NEOTEL
2010 - 2011	National long-haul optic fibre infrastructure network project, Bloemfontein to Beaufort West	Protected and Endangered Species Walk-Through Survey	NEOTEL
2011	Optic Fibre Infrastructure Network, Swartland Municipality	Botanical Assessment (for EIA) - Assisted Dr. Dave McDonald	Dark Fibre Africa
2011	Optic Fibre Infrastructure Network, City of Cape Town Municipality	Botanical Assessment (for EIA) - Assisted Dr. Dave McDonald	Dark Fibre Africa
2010	Construction of an icon at the southernmost tip of Africa, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS
2010	New boardwalk from Suiderstrand Gravel Road to Rasperpunt, Agulhas National Park	Botanical Assessment (for EIA)	SANPARKS
2010	Farm development for academic purposes (Maluti FET College) on the Farm Rosedale 107, Harrismith	Ecological Assessment (Screening and Feasibility Study)	Agri Development Solutions
2010	Basic Assessment: Barcelona 88/11kV substation and 88kV loop-in lines	Botanical Assessment (for EIA)	Eskom Distribution
2011	Illegally ploughed land on the Farm Wolwekop 2353, Bloemfontein	Vegetation Rehabilitation Plan	EnviroWorks

WETLAND DELINEATION AND HYDROLOGICAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
In progress	Steynsrus PV 1 & 2 Solar Energy Facilities near Steynsrus, Free State Province	Wetland Assessment	Cronimet Mining Power Solutions
2019	Lichtenburg 1 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 2 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Lichtenburg 3 100MW Solar PV Facility, Lichtenburg, North-West Province	Surface Hydrological Assessment (Scoping and EIA Phase)	Atlantic Renewable Energy Partners
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Wetland Assessment (Basic Assessment)	Moeding Solar
2018	Kruisvallei Hydroelectric 22kV Overhead Power Line, Clarens, Free State Province	Wetland Assessment (Basic Assessment	Zevobuzz
2017	Nyala 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy

2017	Eland 5MW PV facility within Harmony Gold's mining rights areas, Odendaalsrus	Wetland Assessment	BBEnergy
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Surface Hydrological Assessment (Basic Assessment)	Eskom
2017	Expansion of the Elandspruit Quarry near Ladysmith, KwaZulu-Natal Province	Wetland Assessment	Raumix
2017	S24G for the unlawful commencement or continuation of activities within a watercourse, Honeydew, Gauteng Province	Aquatic Assessment & Flood Plain Delineation	Savannah Environmental
2017	Noupoort CSP Facility near Noupoort, Northern Cape Province	Surface Hydrological Assessment (EIA phase)	Cresco
2016	Wolmaransstad Municipality 75MW PV Solar Energy Facility in the North West Province	Wetland Assessment (Basic Assessment)	BlueWave Capital
2016	BlueWave 75MW PV Plant near Welkom Free State Province	Wetland Delineation	BlueWave Capital
2016	Harmony Solar Energy Facilities: Amendment of Pipeline and Overhead Power Line Route	Wetland Assessment (Basic Assessment)	BBEnergy

AVIFAUNAL ASSESSMENTS

Date Completed	Project Description	Type of Assessment/Study	Client
2019	Sirius Three Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions
2019	Sirius Four Solar PV Facility near Upington, Northern Cape	Avifauna Assessment (Basic Assessment)	Aurora Power Solutions
2019	Moeding Solar PV Facility near Vryburg, North-West Province	Avifauna Assessment (Basic Assessment)	Moeding Solar
2018	Proposed Zonnebloem Switching Station (132/22kV) and 2X Loop-in Loop-out Power Lines (132kV), Mpumalanga Province	Avifauna Assessment (Basic Assessment)	Eskom
2017	Olifantshoek 10MVA 132/11kV Substation and 31km Power Line	Avifauna Assessment (Basic Assessment)	Eskom
2016	TEWA Solar 1 Facility, east of Upington, Northern Cape Province	Wetland Assessment (Basic Assessment	Tewa Isitha Solar 1
2016	TEWA Solar 2 Facility, east of Upington, Northern Cape Province	Wetland Assessment	Tewa Isitha Solar 2

ENVIRONMENTAL IMPACT ASSESSMENT

- Barcelona 88/11kV substation and 88kV loop-in lines – BA (for Eskom).
- Thabong Bulk 132kV sub-transmission inter-connector line – EIA (for Eskom).
- Groenwater 45 000 unit chicken broiler farm – BA (for Areemeng Mmogo Cooperative).
- Optic Fibre Infrastructure Network, City of Cape Town Municipality – BA (for Dark Fibre Africa (Pty) Ltd).
- Optic Fibre Infrastructure Network, Swartland Municipality – BA (for Dark Fibre Africa).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – EMP (for Eskom).
- Lower Kruisvallei Hydroelectric Power Scheme (Ash river) – EIA (for Kruisvallei Hydro (Pty) Ltd).
- Construction of egg hatchery and associated infrastructure – BA (For Supreme Poultry).

- Construction of the Klipplaatdrif flow gauging (Vaal river) – EMP (DWAF).

ENVIRONMENTAL COMPLIANCE AUDITING AND ECO

- National long haul optic fibre infrastructure network project, Bloemfontein to Laingsburg – ECO (for Enviroworks (Pty) Ltd.).
- National long haul optic fibre infrastructure network project, Wolmaransstad to Klerksdorp – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the existing 66kV network between Ruigtevallei Substation and Reddersburg Substation – ECO (for Enviroworks (Pty) Ltd.).
- Construction and refurbishment of the Vredefort/Nooitgedacht 11kV power line – ECO (for Enviroworks (Pty) Ltd.).
- Mining of Dolerite (Stone Aggregate) by Raumix (Pty) Ltd. on a portion of Portion 0 of the farm Hillside 2830, Bloemfontein – ECO (for GreenMined Environmental (Pty) Ltd.).
- Construction of an Egg Production Facility by Bainsvlei Poultry (Pty) Ltd on Portions 9 & 10 of the farm, Mooivlakte, Bloemfontein – ECO (for Enviro-Niche Consulting (Pty) Ltd.).
- Environmental compliance audit and botanical account of Afrisam's premises in Bloemfontein – Environmental Compliance Auditing (for Enviroworks (Pty) Ltd.).

OTHER PROJECTS:

- Keeping and breeding of lions (*Panthera leo*) on the farm Maxico 135, Ficksburg – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of lions (*Panthera leo*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Keeping and breeding of wild dogs (*Lycaon pictus*) on the farm Mooihoek 292, Theunissen – Management and Business Plan (for Enviroworks (Pty) Ltd.)
- Existing underground and aboveground fuel storage tanks, TWK AGRI: Pongola – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Erf 171, TWK AGRI: Amsterdam – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 14 000 L of fuel (diesel) aboveground on Erf 32, TWK AGRI: Carolina – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 23 000 L of fuel (diesel) above ground on Portion 10 of the Farm Oude Bosch, Humansdorp – Environmental Management Plan (for TWK Agricultural Ltd).
- Proposed storage of 16 000 L of fuel (diesel) aboveground at Panbult Depot – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks, TWK AGRI: Mechanisation and Engineering, Piet Retief – Environmental Management Plan (for TWK Agricultural Ltd).
- Existing underground fuel storage tanks on Portion 38 of the Farm Lothair, TWK AGRI: Lothair – Environmental Management Plan (for TWK Agricultural Ltd).