SCIENTIFIC AQUATIC SERVICES

FRESHWATER ECOSYSTEM AND AQUATIC ECOLOGICAL ASSESSMENT

AS PART OF THE ENVIRONMENTAL AUTHORISATION PROCESS FOR THE ADDITIONAL EXTENSION FOOTPRINT OF THE MOGALAKWENA PV SOLAR PLANT NEAR MOKOPANE, LIMPOPO PROVINCE.

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EXECUTIVE SUMMARY

A photovoltaic (PV) solar power generation facility and associated infrastructure (hereafter collectively referred to as the 'proposed Mogalakwena PV infrastructure' is proposed at the Mogalakwena Mine near Mokopane in the Limpopo province. A 500 m "zone of investigation" around the proposed Mogalakwena PV infrastructure, in accordance with Government Notice (GN) 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) was used as a guide in which to assess possible sensitivities of the receiving environment, and this was referred to as the investigation area.

During the field assessment, no freshwater ecosystems were identified within the project boundary, however various freshwater ecosystems were identified within the investigation area, and these include the Groot Sandsloot River, a single seep wetland and various ephemeral drainage lines (EDLs). These were all considered moderately modified and of moderate ecological importance and sensitivity.

Provided that site-specific mitigation measures are implemented during all phases of the project, with specific mention of ensuring that the construction activities for the proposed solar PV avoid indirect impacts on the freshwater ecosystems, and that inspections of all stormwater infrastructure are done routinely during the operational phase of the solar PV, the risk significance can be considered a limited. Given that the current layout which was optimised significantly to avoid traversing or encroaching into these freshwater ecosystems, the overall risk impact for the seep wetland, Groot-Sandsloot River and the EDLs was assessed to be between 'Minor – Negative' to 'Negligible – Negative' with recommended mitigations applied.

It is the opinion of the specialist that the proposed Mogalakwena solar PV infrastructure poses a low-risk significance to the ecological integrity of the identified freshwater ecosystems, and with adherence to the suggested mitigation measures the project can be considered.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecosystem and aquatic ecological assessment as part of the Environmental Impact Assessment (EIA) and Water Use Authorisation (WUA) processes for the proposed photovoltaic (PV) infrastructure associated with the Mogalakwena Mine near Mokopane in the Limpopo province. The proposed Mogalakwena PV includes overhead transmission line corridors, development areas where the PV facilities are to be located and substations; hereafter collectively referred as the 'proposed Mogalakwena PV infrastructure'. The proposed Mogalakwena PV infrastructure is located directly adjacent to the N11 highway and approximately 22.9 km north of the town of Mokopane, and 8.37 km north-west of the settlement of Mahwereleng-B and falls within the Mogalakwena Local Municipality.

The purpose of this report is to define the ecology of the area in terms of freshwater ecosystems characteristics, including mapping of the freshwater ecosystems, discuss key ecological drivers and to define the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), as well as the socio-cultural and ecological service provision of the freshwater ecosystems utilising current industry "best practice" assessment methods in order to ascertain what, if any, impact the activities will have on the freshwater ecosystems associated with the project boundary. Additionally, this report aims to define the Recommended Management Objectives (RMO) and Recommended Ecological Category (REC) for the freshwater ecosystems. The assessment took the following approach:

- A desktop study was conducted, in which possible freshwater ecosystems were identified for on-site investigation, and relevant national and provincial databases were consulted;

- The initial field assessment was undertaken in June 2021 and an additional field assessment was undertaken in May 2022 to ground-truth the freshwater ecosystems associated with the proposed Mogalakwena PV infrastructure. During the assessment, four freshwater ecosystems were identified to be associated with the Mogalakwena PV infrastructure, two were classified as rivers (Groot Sandsloot River), a seep wetland and various ephemeral drainage lines (EDL's) within the investigation area;
- They were then classified according to the Ollis et al. (2013) classification system; and
- The characteristics of the freshwater ecosystems were defined including the PES, EIS, REC, RMO and BAS.

The results of the field assessment are presented in Section 4 and 5 of this report, and are summarised in the table below:

Table A: Summary of the assessment results.

Freshwater Ecosystem	Present Ecological State (PES) / Ecostatus	Ecoservices	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category / Recommended Management Objective / Best Attainable State
Groot-Sandsloot River	Category C (Moderately Modified)	Intermediate	Moderate	REC Category: C/D BAS Category: C RMO: Maintain
Ephemeral Drainage Lines	Category C (Moderately Modified)	Intermediate	Moderate	REC Category: C BAS Category: C RMO: Maintain
Seep Wetland	Category C (Moderately Modified)	Intermediate	Moderate	REC Category: C BAS Category: C RMO: Maintain
Extent of modification	**Low** The assessed freshwater ecosystems (Seep wetland, Groot-Sandsloot and EDLs) will not directly be traversed by the proposed Mogalakwena PV infrastructure. The layout has been optimised to avoid the freshwater systems, as such reducing any potential impacts to these systems, therefore the extent of modification is considered low. In terms of the layout of the solar PV in relation to the floodlines of the Groot-Sandsloot River, according to the hydrological report (SMEC 2022), the modelling results showed that the solar PV plant is positioned well clear of the floodlines and that there is no flood risk to the infrastructure.			

Following the assessment, the Zutari impact assessment was applied to ascertain the significance of possible impacts which may occur because of the activities associated with the proposed Mogalakwena PV infrastructure. The assessment of the identified impacts is based on determining the following aspect: impact intensity, duration, extent, consequence, probability and impact reversibility. The impact rating system considers the confidence level that can be placed on the successful implementation of mitigation. The summary of the impact assessment is shown below:

Table B: Summary of the DWS Risk Assessment outcomes.

Ref:	Project phase	Impact	Without Mitigation Significance	With Mitigation Significance
1	Construction	Removal of vegetation within the development footprint and associated disturbances to soil resulting in loss of freshwater habitat.	Minor - Negative	Negligible - negative
2	Construction	Modification of hydrological function and water quality of the freshwater ecosystems	Minor - Negative	Negligible - negative
3	Construction	Changes to the freshwater geomorphological processes and sedimentation	Minor - Negative	Negligible - negative
4	Construction	Impacts on the freshwater ecosystems leading to the loss of biota.	Minor - Negative	Negligible - negative
5	Operation	Removal of vegetation within the development footprint and associated disturbances to soil resulting in loss of freshwater habitat.	Negligible - negative	Negligible - negative
6	Operation	Modification of hydrological function and water quality of the freshwater ecosystems	Negligible - negative	Negligible - negative

7	Operation	Changes to the freshwater geomorphological processes and sedimentation	Negligible - negative	Negligible - negative
8	Operation	Impacts on the freshwater ecosystems leading to the loss of biota.	Minor - negative	Negligible - negative

A stormwater management plan was designed to ensure that requirements from the relevant authorities are met, and these include specifically, designing a stormwater management plan to prevent off-site migration of contaminated stormwater/increased soil erosion, ensuring implementation of the appropriate design measures to allow surface and subsurface movement of water along drainage lines, to not impede natural surface and subsurface flows. Important mitigation measures which must be considered as part of the design of the stormwater management plan include the following:

- It must be ensured that no channels and no outlets associated with the stormwater plan are located within the delineated boundary of the freshwater ecosystems. Authorisation must be obtained from the relevant authorities for stormwater infrastructure proposed within the 32 m boundary of the freshwater systems;
- At the proposed discharge points, it must be ensured that energy dissipating structures and structures encouraging diffused flows are included to reduce the overall risk of erosion, especially given the nature of the soils in the Mogalakwena area;
- In the design of the stormwater management plan, it must be ensured that no concrete is used, and the channels must be natural and well vegetated. According to a study on the assessment of hydrologic impacts of solar panels, it was stated that addition of solar panels over a grassy field does not have much of an effect on the volume of runoff, the peak discharge, nor the time to peak while gravel and pavement increased runoff volume significantly (Cook and McCuen 2013). Given these findings it must be ensured that as much indigenous vegetation is used as part of the stormwater management plan to mitigate for any potential changes in runoff volume within the proposed development footprint; and
- In addition, consideration for additional stormwater outlets must be done, particularly where volume released from a single outlet has the potential to increase the risk of soil erosion to the freshwater ecosystems.

Provided that site-specific mitigation measures are implemented during all phases of the project, with specific mention of ensuring that the construction activities for the proposed solar PV avoid indirect impacts on the freshwater ecosystems, and that inspections of all stormwater infrastructure are done routinely as recommended in the hydrological report (SMEC 2022) during the operational phase of the solar PV, the risk significance can be considered a limited.

Given that the current layout which was optimised significantly to avoid traversing or encroaching into these freshwater ecosystems, the overall impact significance for the seep wetland, Groot-Sandsloot River and the EDLs was assessed to be between ‘Minor – Negative’ to ‘Negligible – Negative’ with recommended mitigations applied. It is the opinion of the specialist that the proposed Mogalakwena solar PV infrastructure poses a low-risk significance to the ecological integrity of the identified freshwater ecosystems, and with adherence to the suggested mitigation measures the project can be considered.

DOCUMENT GUIDE

The table below provides the specialist report requirements for the assessment and reporting of impacts on aquatic biodiversity in terms of Government Notice 320 as promulgated in Government Gazette 43110 of 20 March 2020 in line with the Department of Environmental Affairs screening tool requirements, as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998).

No.	Requirements	Section in report
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist	Front Page and Appendix E
2.2	Description of the preferred development site, including the following aspects-	
2.2.1	a. Aquatic ecosystem type b. Presence of aquatic species and composition of aquatic species communities, their habitat, distribution, and movement patterns	Section 4
2.2.2	Threat status, according to the national web based environmental screening tool of the species and ecosystems, including listed ecosystems as well as locally important habitat types identified	Section 3 and 4
2.2.3	National and Provincial priority status of the aquatic ecosystem (i.e. is this a wetland or river Freshwater Ecosystem Priority Area (FEPA), a FEPA sub- catchment, a Strategic Water Source Area (SWSA), a priority estuary, whether or not they are free-flowing rivers, wetland clusters, etc., a CBA or an ESA; including for all a description of the criteria for their given status	Section 3
2.2.4	A description of the Ecological Importance and Sensitivity of the aquatic ecosystem including: a. The description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); b. The historic ecological condition (reference) as well as Present Ecological State (PES) of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel, flow regime (surface and groundwater)	Section 3
2.3	Identify any alternative development footprints within the preferred development site which would be of a "low" sensitivity as identified by the national web based environmental screening tool and verified through the Initial Site Sensitivity Verification	Section 5
2.4	Assessment of impacts - a detailed assessment of the potential impact(s) of the proposed development on the following very high sensitivity areas/ features:	Section 7
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Section 7
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	Section 7
2.4.3	How will the development impact on fixed and dynamic ecological processes that operate within or across the site, including: a. Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); b. Change in the sediment regime (e.g. sand movement, meandering river mouth/estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub-catchment; c. The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.). d. Assessment of the risks associated with water use/s and related activities.	Section 7
2.4.4	How will the development impact on the functionality of the aquatic feature including: a. Base flows (e.g. too little/too much water in terms of characteristics and requirements of system); b. Quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of overabstraction or instream or off-stream impoundment of a wetland or river); c. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland); d. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); and e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal).	Section 7
2.4.5	How will the development impact on key ecosystem regulating and supporting services especially Flood attenuation; Streamflow regulation; Sediment trapping; Phosphate assimilation; Nitrate assimilation; Toxicant assimilation; Erosion control; and Carbon storage.	Section 7

2.4.6	How will the development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 7
2.4.7	In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: size of the estuary; availability of sediment; wave action in the mouth; protection of the mouth; beach slope; volume of mean annual runoff; and extent of saline intrusion (especially relevant to permanently open systems).	Section 7
3.	**The report must contain as a minimum the following information:**	
3.1	Contact details and curriculum vitae of the specialist including SACNASP registration number and field of expertise and their curriculum vitae;	Appendix G
3.2	A signed statement of independence by the specialist;	Appendix G
3.3	The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 2
3.4	The methodology used to undertake the impact assessment and site inspection, including equipment and modelling used, where relevant;	Section 1.2, 2 and Appendix C
3.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.3
3.6	Areas not suitable for development, to be avoided during construction and operation (where relevant);	Section 5
3.7	Additional environmental impacts expected from the proposed development based on those already evident on the site and a discussion on the cumulative impacts;	Section 5
3.8	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted protocol;	Section 5
3.9	Impact management actions and impact management outcomes proposed by the specialist for inclusion in the EMPr;	Section 5 and 6
3.10	A motivation where the development footprint identified as per 2.3 were not considered stating reasons why these were not being not considered; and	Section 7
3.11	A reasoned opinion, based on the finding of the specialist assessment, regarding the acceptability or not, of the development and if the development should receive approval, and any conditions to which the statement is subjected.	Section 8
3.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies.	Section 6
3.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr).	Section 8
3.14	A motivation must be provided if there were development footprints identified as per paragraph 2.3 for reporting in terms of Section 24(5)(a) and (h) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) that were identified as having a “low” aquatic biodiversity and sensitivity and that were not considered appropriate.	
3.15	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not.	Section 8
3.16	Any conditions to which this statement is subjected.	Section 8

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Endorheic	As it relates to a depression wetland: inward-draining with no transport of water into downstream systems via subsurface or surface flow. Water leaves via evapotranspiration and infiltration only.
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas.
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurrences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius.
BAR	Basic Assessment Report
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
CDM	Capricorn District Municipality
CSIR	Council of Scientific and Industrial Research
DRDLR	Department of Rural Development and Land Reform's
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
EDL	Ephemeral Drainage Line
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMP	Environmental Management Program
ESA	Ecological Support Area
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
m	Meter
MAP	Mean Annual Precipitation
MR	Mining Right
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NBA	National Biodiversity Assessment
NWA	National Water Act
OHL	Overhead Line
PES	Present Ecological State
REC	Recommended Ecological Category
RMO	Resource Management Objective
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
SQR	Sub quaternary catchment reach
STS	Scientific Terrestrial Services
subWMA	Sub-Water Management Area
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WMS	Water Management System
WRC	Water Research Commission
WULA	Water Use License Application

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater ecosystem assessment as part of the Environmental Impact Assessment (EIA) processes for the additional extension footprint of the Mogalakwena photovoltaic (PV) solar infrastructure associated with the Mogalakwena Mine near Mokopane in the Limpopo province. The proposed Mogalakwena PV includes overhead transmission line corridors, development areas where the PV facilities are to be located and substations; hereafter collectively referred as the 'proposed Mogalakwena PV infrastructure'. The proposed Mogalakwena PV infrastructure is located directly adjacent to the N11 highway and approximately 22.9 km north of the town of Mokopane, and 8.37 km north-west of the town of Mahwereleng-B and falls within the Mogalakwena Local Municipality. The footprint area where the proposed infrastructure is located is hereafter referred to as the "project boundary").

To identify all freshwater ecosystems that may potentially be impacted by the proposed Mogalakwena PV infrastructure, a 500 m "zone of investigation" around the project boundary, in accordance with Government Notice (GN) 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) was used as a guide in which to assess possible sensitivities of the receiving environment. This 500 m "zone of investigation" will henceforth be referred to as the 'investigation area'.

The purpose of this report is to define the ecology of the area in terms of freshwater ecosystems characteristics, including mapping of the freshwater ecosystems, discuss key ecological drivers and to define the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), as well as the socio-cultural and ecological service provision of the freshwater ecosystems utilising current industry "best practice" assessment methods in order to ascertain what, if any, impact the activities will have on the freshwater ecosystems associated with the proposed Mogalakwena PV infrastructure. Additionally, this report aims to define the Recommended Management Objectives (RMO) and Recommended Ecological Category (REC) for the freshwater ecosystems. The objective of the study is to provide detailed information when considering the existing activities in the vicinity of the freshwater ecosystems, to ensure the ongoing functioning of the ecosystem such that local and regional conservation requirements and the provision of ecological services in the local area are supported while considering the need for sustainable economic development.

This report, after consideration and a description of the ecological integrity of the project boundary, must guide the Environmental Assessment Practitioner (EAP), and the relevant

specialist, by means of the presentation of results and recommendations, as to the final design of the layout for the proposed Mogalakwena PV infrastructure.

1.1.1 Project description[1]

Mogalakwena Mine is a wholly owned subsidiary of Anglo-American Platinum Limited (AAP) and is situated within the Mogalakwena Local Municipality, which forms part of the greater Waterberg District Municipality of the Limpopo Province. The AAP seeks to appoint an Independent Power Producer (IPP) for the development, financing, ownership, construction, operation and maintenance of a Solar PV Plant. The Solar PV Plant will supply energy on an exclusive basis to the AAP's Mogalakwena Mine in Limpopo, South Africa in terms of a Power Purchase Agreement (PPA) with an operating Term of 25 years, as may be extended or amended in accordance with the terms of the PPA. The project will not be transferred to AAP or its selected nominee on the expiry or early termination of the Term. This IPP shall be chosen through a Request for Proposal process, which is currently underway and nearing completion. The optimal Solar PV generation capacity shall be determined by the IPP based on their own calculations.

Previous studies were undertaken for the proposed Mogalakwena Solar PV Plant (refer to SAS 202186) in 2021 with the layout subsequently updated and reduced in 2022. This 2022 study is focused on the amended project boundary (Figure 1 - 2) and further includes specific focus areas that was highlighted by the screening tool as potentially sensitive habitat and/or that was not part of the previously assessed area (Figure 3).

The proposed Mogalakwena Solar PV Plant will comprise the following (Figure 3):

- Development area (Indicated as the project boundary). The Development areas will host the solar arrays;
- Two overhead transmission lines connecting to the existing substations;
- Substation;
- Three laydown areas (Layout 1 – 3); and
- O & M Building; and
- Stormwater management plan which includes channels for managing water within the panels and associated stormwater outlets.

The footprint area where the proposed infrastructure is located, and the overhead transmission line corridors are hereafter referred to as the "project boundary".

[1] Note: the information in this section was extracted from the layout provided by the proponent.

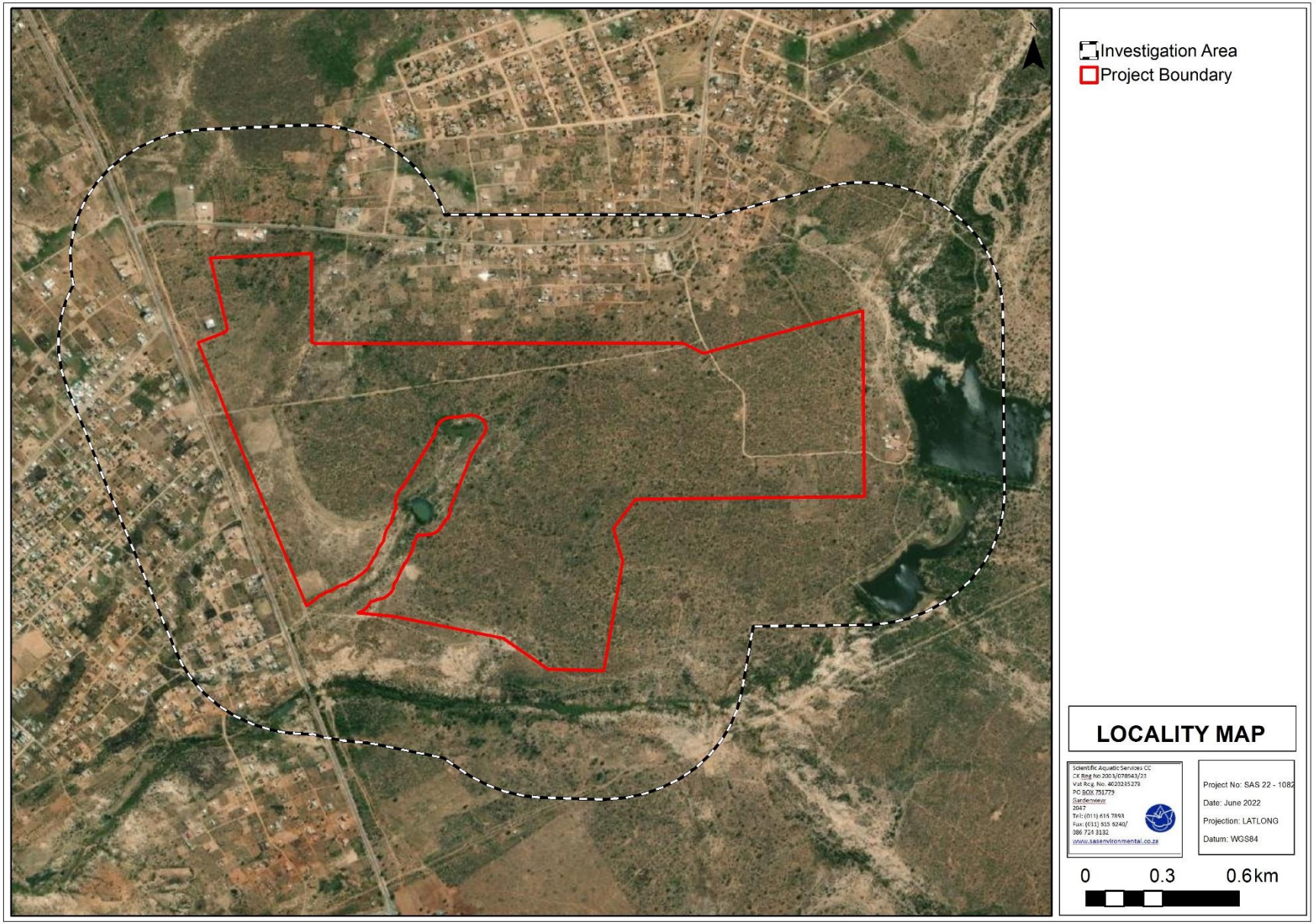

Figure 1: Digital satellite image depicting the location of the proposed Mogalakwena PV infrastructure and investigation areas in relation to the surrounding environment.

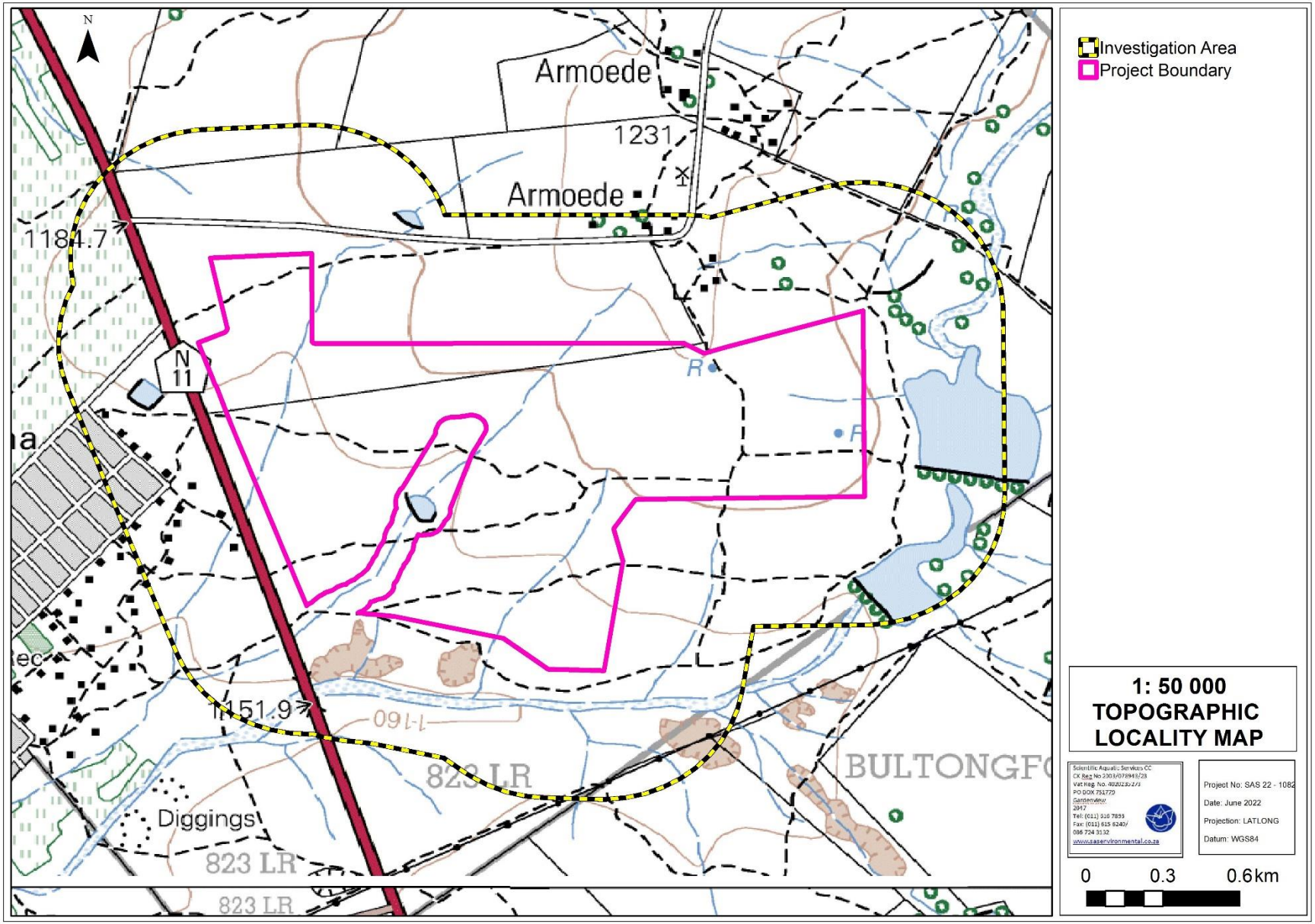

Figure 2: The project boundary and investigation area associated with the Mogalakwena PV infrastructure depicted on a 1:50 000 topographical map in relation to the surrounding environment.

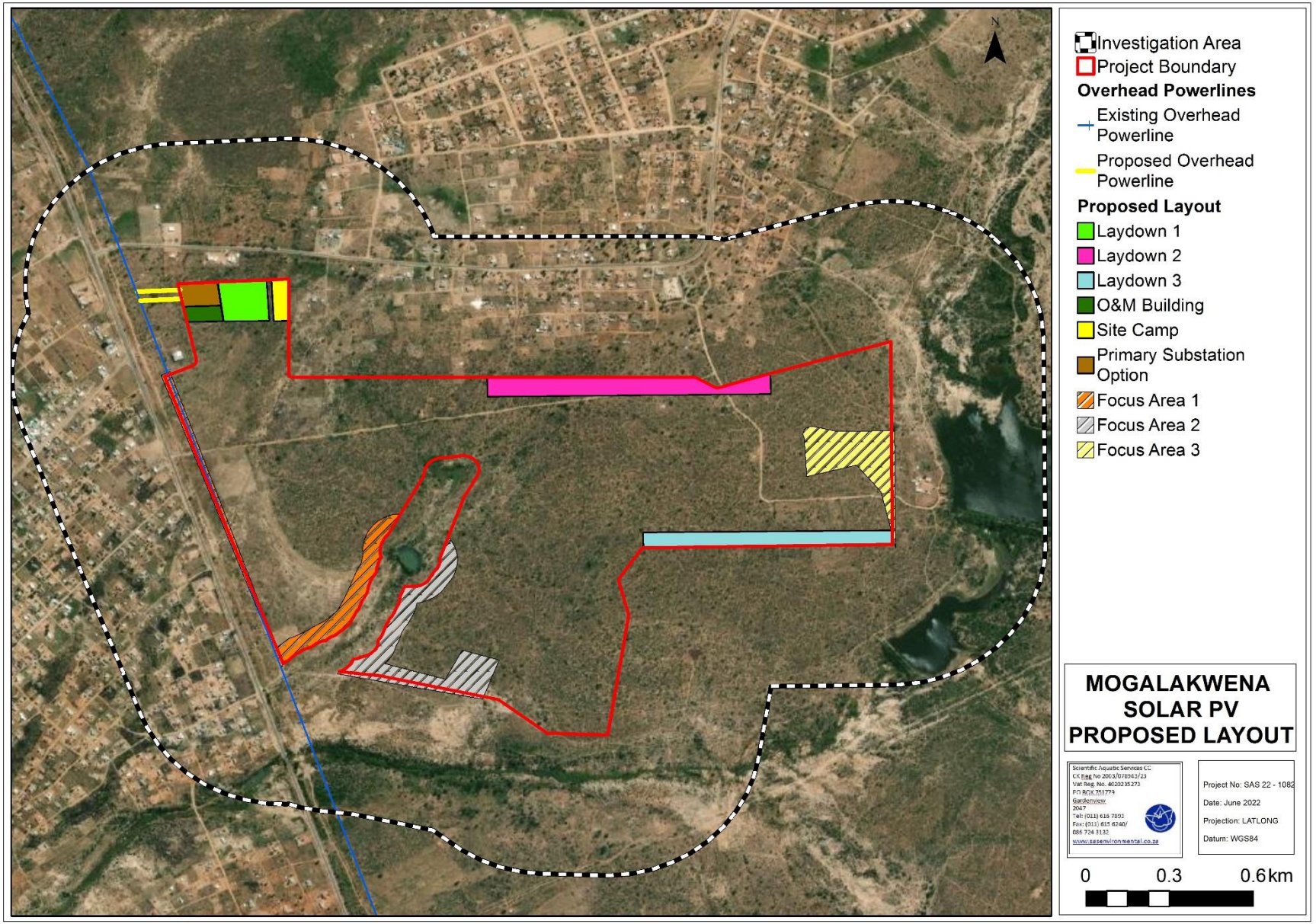

Figure 3: The proposed layout associated with the project boundary and investigation area depicted on digital satellite imagery in relation to the surrounding environment.

1.2 Scope of Work

Specific outcomes in terms of this report are outlined below:

- A background study of relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA] 2011 database; the Department of Water and Sanitation Research Quality Information Services [DWS RQIS PES/EIS], 2014 database, the Limpopo Conservation Plan (Limpopo - CPLAN, 2013) and National Biodiversity Assessment (NBA) 2018 was undertaken to aid in defining the PES and EIS of the freshwater ecosystems;
- All freshwater ecosystems within the investigation area were delineated using desktop methods in accordance with GN509 of 2016 as it relates to activities as stipulated in the National Water Act, 1998 (Act No. 36 of 1998) and verified where possible according to the "Department of Water Affairs and Forestry (DWAF)2 (2005)3: A practical field procedure for identification of wetlands and riparian areas". Aspects such as soil morphological characteristics, vegetation types and wetness were used to verify the freshwater ecosystems;
- The freshwater ecosystem classification assessment was undertaken according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis et al., 2013);
- The EIS of the freshwater ecosystem was determined according to the method described by Rountree and Kotze, (2013);
- The PES of the freshwater ecosystems was assessed according to the resource directed measures guideline as advocated by Macfarlane et al. (2008);
- The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans et al. 2008);
- The freshwater ecosystems were mapped according to the hydrogeomorphic units in relation to the proposed Mogalakwena PV infrastructure. In addition to the freshwater ecosystem boundaries, the appropriate provincial recommended buffers and legislated zones of regulation were depicted where applicable;
- Allocation of a suitable RMO, REC and Best Attainable State (BAS) to the freshwater ecosystems based on the results obtained from the PES and EIS assessments; and
- To present management and mitigation measures which should be implemented going forward to assist in minimising the impact on the receiving environment.

[2] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA) and subsequently as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.
[3] Even though an updated manual is available since 2008 (Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas), this is still considered a draft document currently under review.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- All freshwater ecosystems associated with the proposed Mogalakwena PV infrastructure, where access was possible, were ground-truthed, however freshwater ecosystems within 500 m of the proposed Mogalakwena PV infrastructure were delineated in fulfilment of GN509 of the NWA using various desktop methods including use of topographic maps, historical and current digital satellite imagery and aerial photographs. Desktop delineations were ground-truthed where feasible;
- The delineations as presented in this report are regarded as a best estimate of the temporary boundaries based on the site conditions present at the time of assessment;
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required, the freshwater ecosystems will need to be surveyed and pegged according to surveying principles and with survey equipment;
- The freshwater ecosystems in the surrounding area are largely non-perennial systems that only become active in response to extreme rainfall events. Given the absence of such events, most areas currently show terrestrial characteristics and as such temporary zone delineation of these systems proved difficult in some areas. To mitigate this limitation, satellite imagery over time was used to verify boundaries. Despite this, the delineations as presented in this report are regarded as a best estimate of the boundaries based on the site conditions present, as observed during the site assessment and are deemed accurate enough to guide the authorisation process;
- Wetland, riparian and terrestrial ecosystem zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater ecosystem boundary may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results;
- With regards to data sources used to provide background information on the sensitivity of the assessed areas, it is important to note that although all data sources provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the study project boundary's actual site characteristics at the scale required to inform the environmental authorisation processes;
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. A more reliable assessment of the biota would

require seasonal sampling, with sampling being undertaken under both low flow and high flow conditions. However, it is expected that the existing activities have been accurately assessed and considered, based on the field observations and the consideration of existing studies and monitoring data in terms of aquatic, riparian and wetland ecology.

1.4 Legislative Requirements and Provincial Guidelines

The following legislative requirements and relevant provincial guidelines were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in Appendix B:

- Constitution of the Republic of South Africa, 1996[4];
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998);
- The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA);
- The National Environmental Management: Biodiversity Act: Alien and Invasive Species Regulations, 2014;
- The Limpopo Environmental Management Act, 2003 (Act No.7 of 2003) (LEMA); and
- The Department of Environment, Forestry and Fisheries (DEFF), (2020) National Web-based Environmental Screening Tool (hereafter the “screening tool”);

2 ASSESSMENT APPROACH

2.1 Freshwater Ecosystem Definition

For the purposes of this investigation, the definition of a watercourse and wetland habitat were taken as per that in the National Water Act, 1998 (Act No. 36 of 1998). The definitions are as follows:

A **watercourse** means:
(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

[4] Since 1996, the Constitution has been amended by seventeen amendments acts. The Constitution is formally entitled the ‘Constitution of the Republic of South Africa, 19996”. It was previously also numbered as if it were an Act of Parliament – Act No. 108 of 1996 – but since the passage of the Citation of Constitutional Laws Act, neither it nor the acts amending it are allocated act numbers.

(d) any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse,
and a reference to a watercourse includes where relevant, its bed and banks.

Wetland habitat is “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 typically adapted to life in saturated soil.”

Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized 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.

Thus, for the purposes of this investigation, the definition of a freshwater ecosystem is considered to be synonymous with the definition of a watercourse as per the National Water Act, 1998 (Act No. 36 of 1998) and the terms may be used interchangeably in this report.

2.2 Freshwater Ecosystem Field Verification

As mentioned in Section 1.3 use was made of historical aerial photographs, historical and current digital satellite imagery, topographic maps, and available provincial and national wetland databases to aid in the delineation of those portions of the freshwater ecosystems associated with the proposed Mogalakwena PV infrastructure following the field assessment. The following was taken into consideration when utilising the above during delineation:

- Linear features: since water flows/moves through the landscape, freshwater ecosystems often have a distinct linear element to their signature which makes them discernible on aerial photography or satellite imagery;
- Vegetation associated with freshwater ecosystems: a distinct increase in density as well as shrub size near flow paths;
- Hue: water flow paths often show as white/grey or black and outcrops or bare soil displaying varying chroma created by varying vegetation cover, geology and soil conditions. Changes in the hue of vegetation with freshwater ecosystem vegetation often indicated on black and white images as areas of darker hue (dark grey and black). In colour imagery these areas mostly show up as darker green and olive colours or brighter green colours in relation to adjacent areas where there is less soil moisture or surface water present; and

- Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions.

The freshwater ecosystem delineation was verified in the field at pre-selected points, and this delineation took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" (DWAF, 2008). The foundation of the method is based on the fact that freshwater ecosystems have several distinguishing factors including the following:

- Landscape position;
- The presence of water at or near the ground surface;
- Distinctive hydromorphic soil;
- Vegetation adapted to saturated soil; and
- The presence of alluvial soil in stream systems.

A initial field assessment was undertaken in June 2021 during the dry winter season and follow up assessment done in May 2022 (late autumn season), during which the presence of any riparian or wetland characteristics as defined by DWAF (2008) and by the National Water Act, 1998 (Act No 36 of 1998) were noted (please refer to Section 4 of this report). In addition to the delineation process, detailed assessments of the delineated freshwater ecosystems were undertaken, at which time, factors affecting the integrity of the freshwater ecosystems were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the freshwater ecosystems. A detailed explanation of the methods of assessment undertaken is provided in Appendix C of this report.

2.3 Sensitivity Mapping

All freshwater ecosystems associated with the proposed Mogalakwena PV infrastructure were delineated on a desktop basis, with these delineations being ground-truthed in the field at certain pre-selected points where possible with the use of a Global Positioning System (GPS). Geographic Information System (GIS) was used to project these features onto digital satellite imagery and topographic maps. The sensitivity map presented in Section 5 should guide the design and layout of the proposed Mogalakwena PV infrastructure.

2.4 Risk Assessment and Recommendations

Following the completion of the assessment, a risk assessment was conducted (please refer to Appendix D for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed Mogalakwena PV infrastructure. These recommendations also include general 'best practice' management measures, which apply to

proposed Mogalakwena PV infrastructure as a whole, and which are presented in Appendix F. Mitigation measures have been developed to address issues in all phases throughout the life of the proposed Mogalakwena PV infrastructure including construction, operation and small-scale rehabilitation. The detailed site-specific mitigation measures are outlined in Section 6 of this report.

3 RESULTS OF THE DESKTOP ANALYSIS

3.1 Analyses of Relevant Databases

The following section contains data accessed as part of the desktop assessment and are presented as a “dashboard style” report (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible to allow for integration of results by the reader to take place. Where required, further discussion and interpretation is provided.

It is important to note that although all data sources used provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the assessed areas actual site characteristics at the scale required to inform the environmental authorisation and/or water use licensing application processes. Nevertheless, this information is considered useful as background information to the study, is important in legislative contextualisation of risk and impact, and was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance. It must, however, be noted that site verification of key areas may potentially contradict the information contained in the relevant databases, in which case the site verified information must carry more weight in the decision-making process. Actual site conditions at the time of the assessment may differ to the background information provided by various datasets. Please refer to Section 4 for details pertaining to the site investigation.

Table 1: Desktop data (from available databases only) relating to the character of the freshwater ecosystems associated with the proposed Mogalakwena PV infrastructure and surrounding region.

Aquatic ecoregion and sub-regions in which the project boundary is located	
Ecoregion	Eastern Bankenveld
Catchment	Limpopo
Quaternary Catchment	A61G
WMA	Limpopo
subWMA	Mogalakwena

Detail of the area of interest in terms of the national freshwater ecosystem priority area (NFEPA) (2011) Database	
River FEPA	The project boundary falls within an **Upstream Management Catchment**. Upstream Management Areas are sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas.
NFEPA Wetlands	According to the NFEPA Database there no wetlands within the project boundary. However, there are several artificial channelled valley bottom wetlands, one artificial/ natural channelled valley bottom wetland and one artificial flat wetland situated within investigation area. These wetlands are considered heavily to critically modified (Class Z2 and Z3).
Wetland vegetation Type	The entire project boundary falls within the Central Bushveld Group 4 (Vulnerable) wetland vegetation type (Mbona *et al.* 2015).
NFEPA Rivers	According to the NFEPA database there are no rivers within the project boundary, the Groot-Sandsloot River traverses the investigation area. The PES 1999 classification as well as the NFEPA Database identifies the river as moderately modified (Class C).

National Biodiversity Assessment (2018): South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (National Wetland Map 5 is included in the NBA)
According to the NBA 2018: SAIIAE there are no wetlands or rivers within the project boundary and associated Focus Areas. The database indicates a portion of the Groot-Sandsloot River that is traversing the southern portion of the investigation area, this is identified as a natural channelled valley bottom wetland. The artificial wetland features located within the investigation area as identified by the NFEPA Dataset (2011) are classified as dams according to NBA Dataset. The channelled valley bottom wetland is currently affected by artificial features – most likely instream dams, roads and a degraded river system therefore its ecological condition is currently heavily to critically modified (Class DEF). The channelled valley bottom wetland is currently not protected (Ecosystem Protection Level (EPL)), and therefore critically endangered (Ecosystem Threat Status (ETS)). As identified by the NFEPA Dataset, the Groot-Sandsloot River traverses the project boundary, and according to this dataset the river is seriously modified (Class E), poorly protected (EPL) and critically endangered (ETS).

National Web-based Screening Tool (2020)
The screening tool is intended to allow for pre-screening of sensitivities in the landscape to be assessed within the EA process. this assists with implementing the mitigation hierarchy by allowing developers to adjust their proposed development footprint to avoid sensitive areas.
For the aquatic biodiversity theme, the project boundary is considered to have an overall **sensitivity of very high,** however the majority (90%) of the project boundary has a **low sensitivity.** The triggered sensitivity features include wetland which is most likely the Groot-Sandsloot River.

Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)	
Sub-quaternary reach	A61G – 00266 (Groot-Sandsloot River)
Proximity to the area of interest	Traverses the project boundary
Assessed by expert?	Yes
PES Category Median	Seriously Modified (Class E)
Mean Ecological Importance (EI) Class	Moderate
Mean Ecological Sensitivity (ES) Class	Very Low
Stream Order	1
Default Ecological Class (based on median PES and highest EI or ES mean)	Moderate (Class C)

Dominant characteristics of the Eastern Bankenveld Ecoregion level II (9.01) (Kleynhans *et al.,* 2007)	
Ecoregion	9.01 (Eastern Bankenveld)
Dominant primary terrain morphology	Closed Hills, mountains; moderate and high relief
Dominant primary vegetation types	Clay Thorn Bushveld
Altitude (m a.m.s.l)	1100 to 1700
MAP (mm)	300 to 600
Coefficient of Variation (% of MAP)	25 to 34
Rainfall concentration index	60 to >65
Rainfall seasonality	Early to mid-summer
Mean annual temperature. (°C)	16 to 20

Winter temperature (July)	2 – 20 ºC
Summer temperature (Feb)	12 – 28 ºC
Median annual simulated runoff (mm)	20 to 40 (limited); 40 to 80
Detail of the project boundary in terms of the Limpopo Conservation Plan v2 (2013)	
CBA 1	A small south eastern portion of the project boundary falls within a **Category 1 Critical Biodiversity Area (CBA).** These are Irreplaceable Sites required to meet biodiversity pattern and / or ecological processes targets. Land Management Recommendations: Obtain formal conservation protection where possible. Implement appropriate zoning to avoid net loss of intact habitat or intensification of land use. Incompatible Land-Use: Urban land-uses including Residential (including golf estates, rural residential, resorts), Business, Mining & Industrial; Infrastructure (roads, power lines, pipelines).
ESA 1	The central portion of the project boundary falls within a **Category 1 Ecological Support Area (ESA).** These are natural, near natural and/or degraded areas that are selected to support CBAs by maintaining ecological processes. Land Management Recommendations: Implement appropriate zoning and land management guidelines to avoid impacting on ecological processes. Avoid intensification of land use and fragmentation of natural landscapes. Incompatible Land-Use: Urban land-uses including Residential (including golf estates, rural residential, resorts), Business, Mining & Industrial; Infrastructure (roads, power lines, pipelines). Note: Certain elements of these activities could be allowed subject to detailed impact assessment to ensure that developments were designed to maintain the overall ecological functioning of ESAs.
ESA 2	There is a small portion of the investigation area that falls within a **Category 2 ESA.** ESA 2s are areas no longer intact but potentially retain significant importance from a process perspective (e.g., maintaining landscape connectivity). Land Management Recommendations: Maintain current land-use. Avoid any intensification of the current land-use which may result in additional impact on ecological processes. Incompatible Land-Use: Any land use or activity that results in additional impacts on ecological functioning mostly associated with the intensification of land use in these areas (e.g., Change of floodplain from arable agriculture to urban land use or from recreational fields and parks to urban).
Other Natural Areas	The north-western portion of the project boundary falls was considered to be classified as **Other Natural Areas**. These are natural and intact areas but are not required to meet targets, nor have they been identified as Critical Biodiversity Areas or Ecological Support Areas. No management objectives, land management recommendations or land-use guidelines are prescribed. These areas are nevertheless subject to all applicable town and regional planning guidelines and policy. Where possible existing "Not Natural" areas should be favoured for development before "Other natural areas".
No Natural Remaining	Portions of the investigation area, outside of the project boundary area are classified as **No Natural Habitat Remaining**. These are areas with no significant direct biodiversity value. These are either not natural areas or degraded natural areas that are not required as ESA. These areas include intensive agriculture, urban, industry; and human infrastructure. No management objectives, land management recommendations or land-use guidelines are prescribed. These areas are nevertheless subject to all applicable town and regional planning guidelines and policy. Where possible existing "Not Natural" areas should be favoured for development before "Other natural areas".

DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; m.a.m.s.l = Metres above Mean Sea Level; MAP = Mean Annual Precipitation; mm = millimetres; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State; WMA = Water Management Area

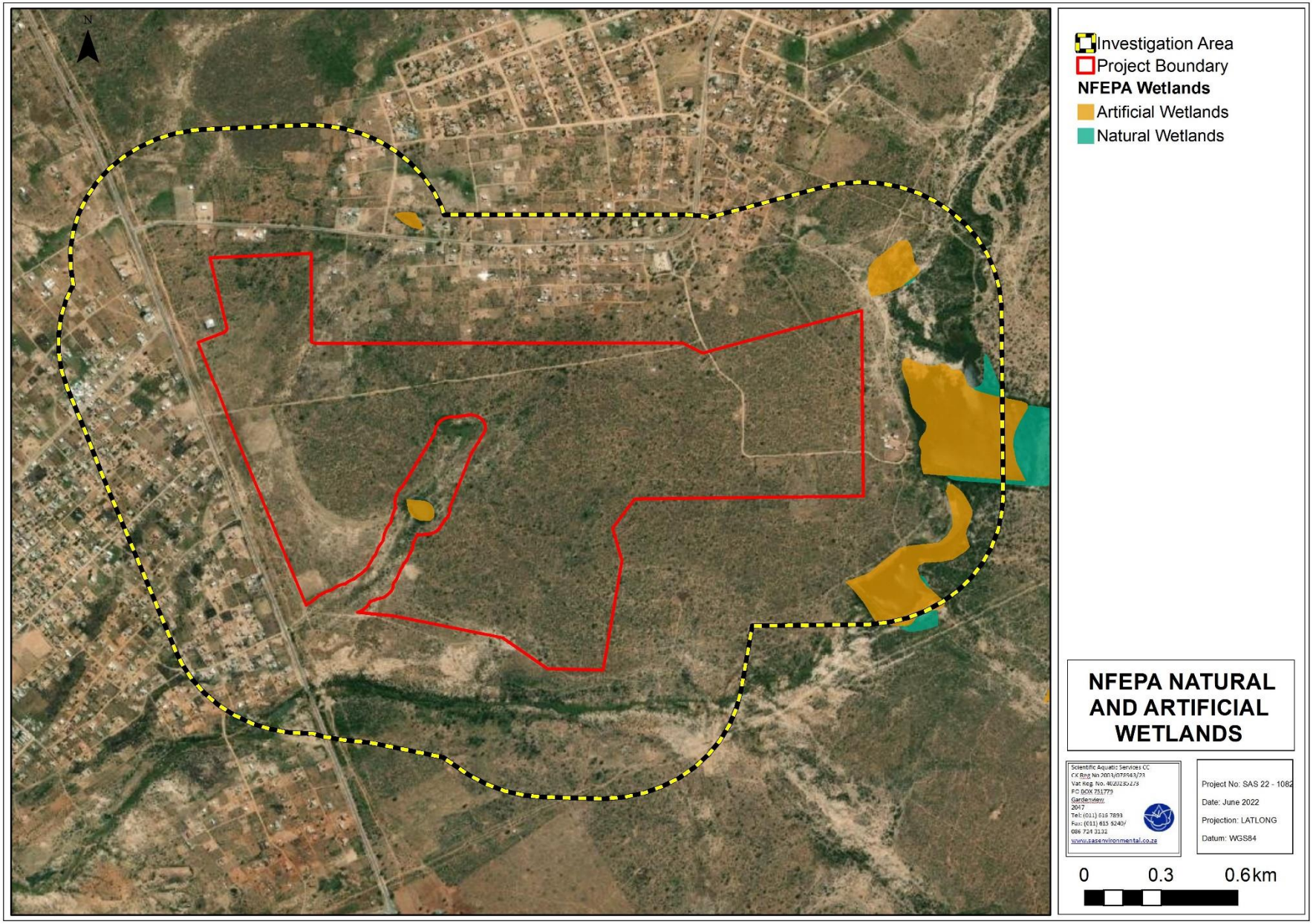

Figure 4: NFEPA natural and artificial wetlands associated with the project boundary and investigation area.

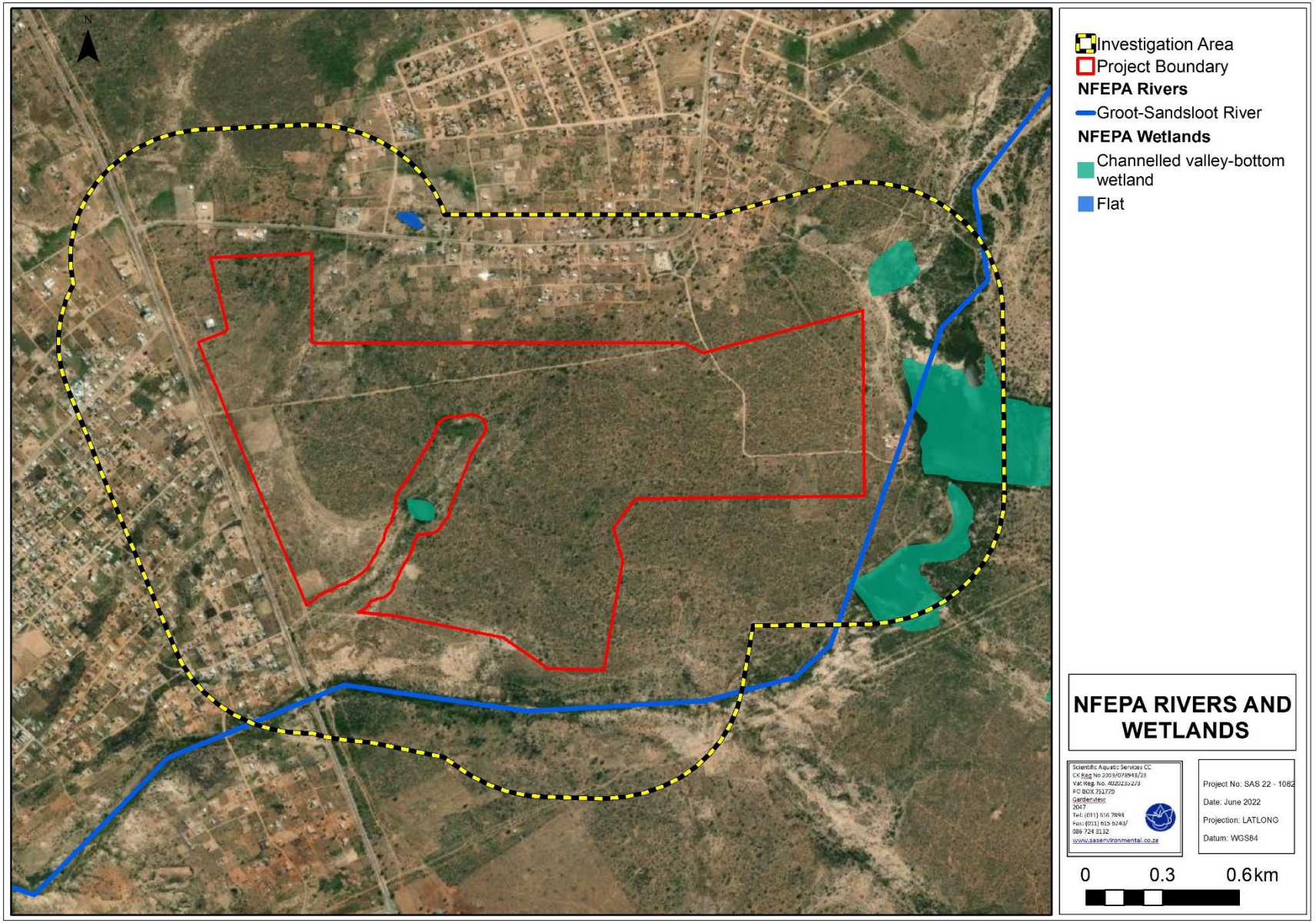

Figure 5: Wetlands and river systems indicated by the Freshwater Ecosystem Priority Areas (NFEPA 2011) relative to the project boundary and investigation area.

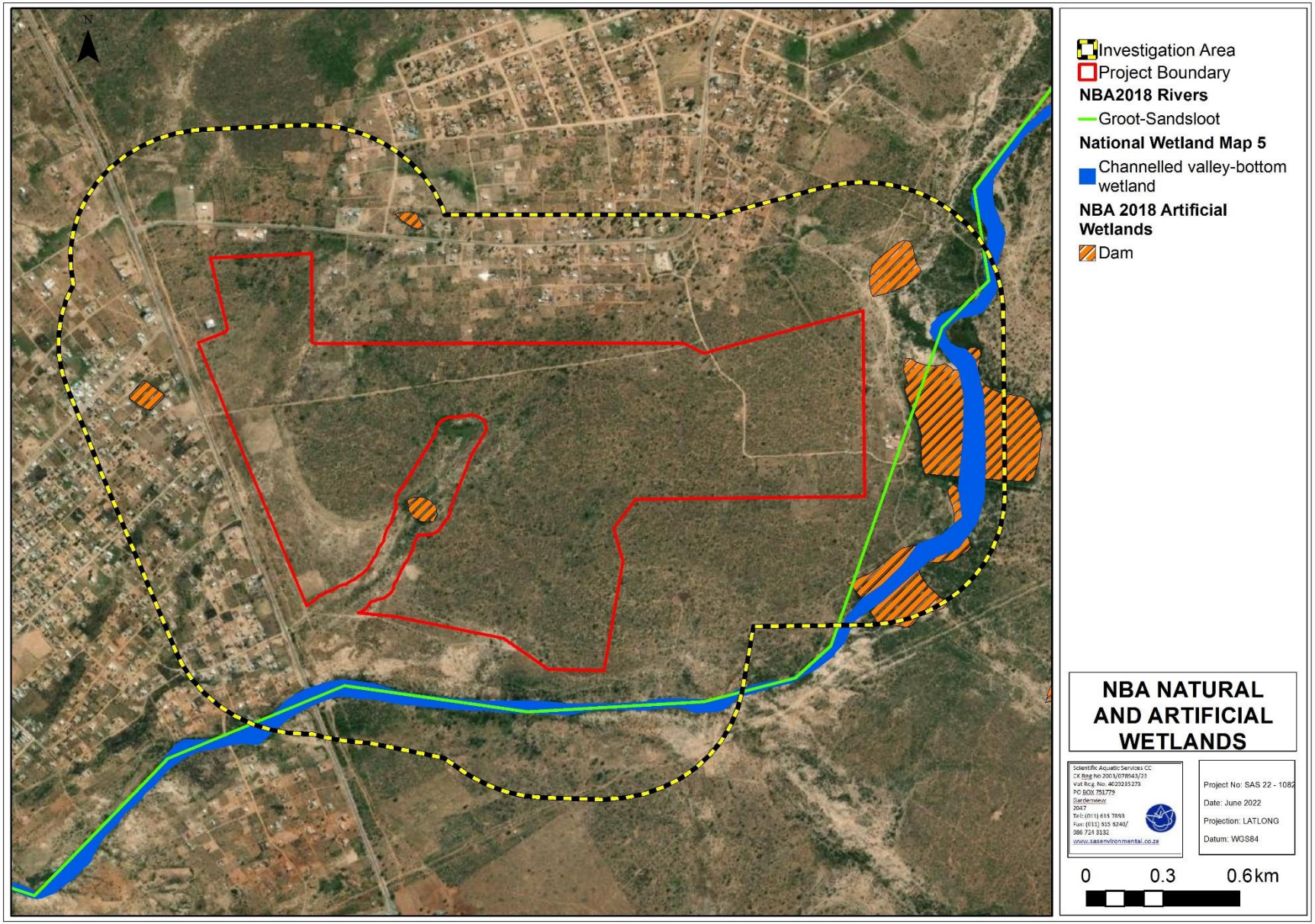

Figure 6: Hydrogeomorphic (HGM) unit indicated by the National Biodiversity Assessment (NBA) (2018) associated with the project boundary and investigation area.

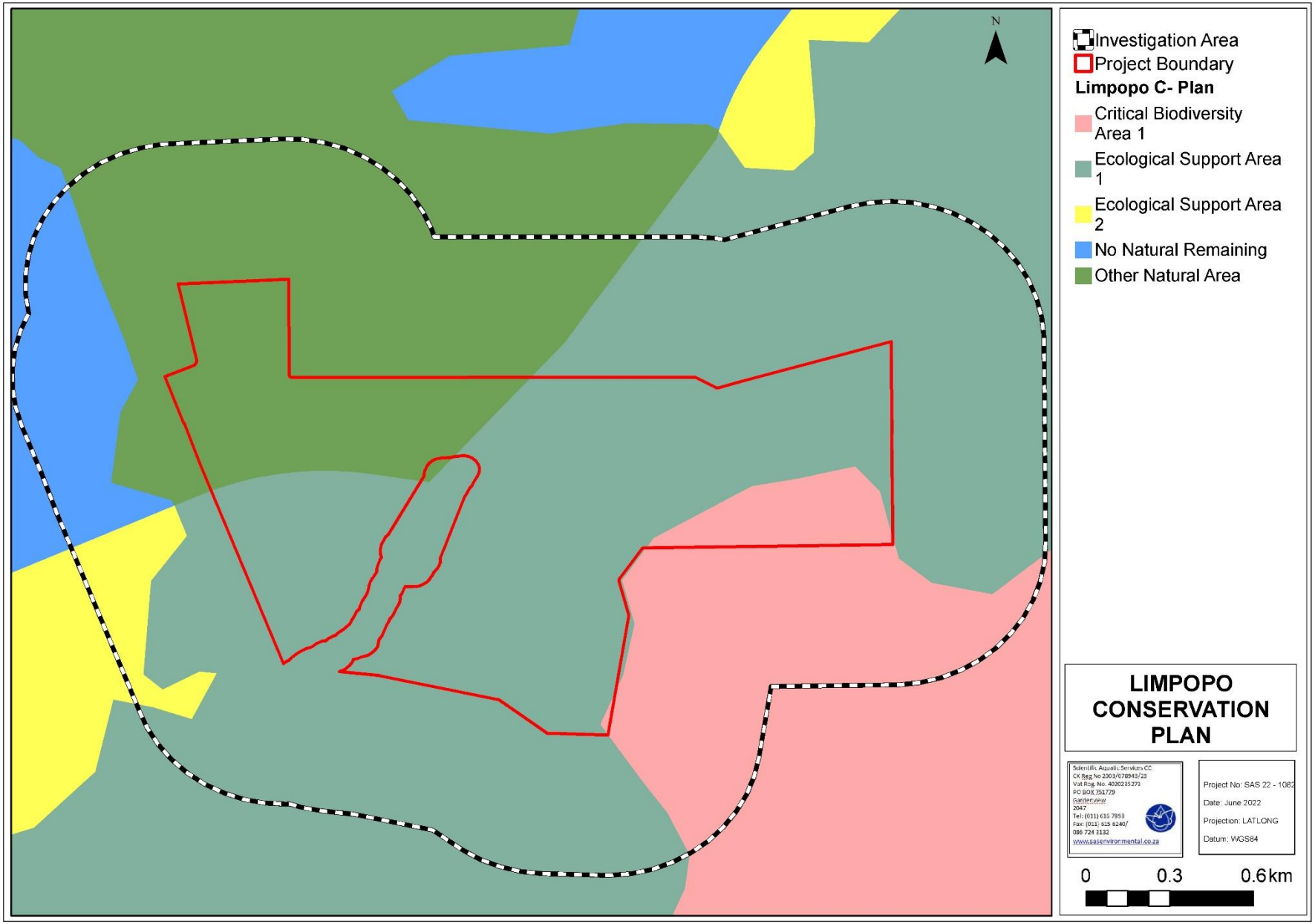

Figure 7: Critical Biodiversity Areas (CBA's) and Ecological Support Areas (ESA's) associated with the project boundary and investigation area

3.2 Ecological Status of Sub-Quaternary Catchments [Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS Database]

The PES/EIS database, as developed by the DWS RQS department, was utilised to obtain additional background information on the project area. The information from this database is based on information at a sub-quaternary catchment reach (SQR) level with the descriptions of the aquatic ecology based on the information collated by the DWS Resource Quality Information Services (RQIS) department from all reliable sources of reliable information such as South Africa River Health Programme (SA RHP) sites, Ecological Water Requirement (EWR) sites and Hydro Water Management System (WMS) sites.

In this regard, information for the SQR for the Groot-Sandsloot River (A61G – 00266) is applicable. Key information on background conditions associated with the development, as contained in this database and pertaining to the Present Ecological State (PES), ecological importance and ecological sensitivity for the River, is tabulated in Table 2 and illustrated in Figure 8.

According to the EI data for the Groot-Sandsloot River (A61G – 00266) there are no fish species expected to occur at this site. The EI data for SQR Groot-Sandsloot River (A61G – 00266), indicate that there are no macro-invertebrate taxa expected to occur at this site.

Table 2: Summary of the ecological status of the sub-quaternary catchment (SQ) reach Groot-Sandsloot River (A61G – 00266) based on the DWS RQS PES/EIS database.

Synopsis (SQ reach Groot-Sandsloot River (A61G – 00266))					
PES[1] category median	**Mean EI[2] class**	**Mean ES[3] class**	**Length**	**Stream order**	**Default EC[4]**
E (Seriously Modified)	Moderate	Very Low	39.71	2	C (Moderate)
PES details					
Instream habitat continuity MOD		Large	**Riparian/wetland zone MOD**		Serious
RIP/wetland zone continuity MOD		Serious	**Potential flow MOD activities**		Large
Potential instream habitat MOD activities		Serious	**Potential physico-chemical MOD activities**		Large
EI details					
Fish spp/SQ		NA	**Fish average confidence**		NA
Fish representativity per secondary class		NA	**Fish rarity per secondary class**		NA
Invertebrate taxa/SQ		NA	**Invertebrate average confidence**		NA
Invertebrate representativity per secondary class		NA	**Invertebrate rarity per secondary class**		NA
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		Low	**Habitat diversity class**		Very High

Habitat size (length) class	Moderate	**Instream migration link class**	Moderate
Riparian-wetland zone migration link	Low	**Riparian-wetland zone habitat integrity class**	Low
Instream habitat integrity class	Low	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**	High
Riparian-wetland natural vegetation rating based on expert rating			Low
ES details			
Fish physical-chemical sensitivity description	NA	**Fish no-flow sensitivity**	NA
Invertebrates physical-chemical sensitivity description	NA	**Invertebrates velocity sensitivity**	NA
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description			Very Low
Stream size sensitivity to modified flow/water level changes description			Low
Riparian-wetland vegetation intolerance to water level changes description			Low

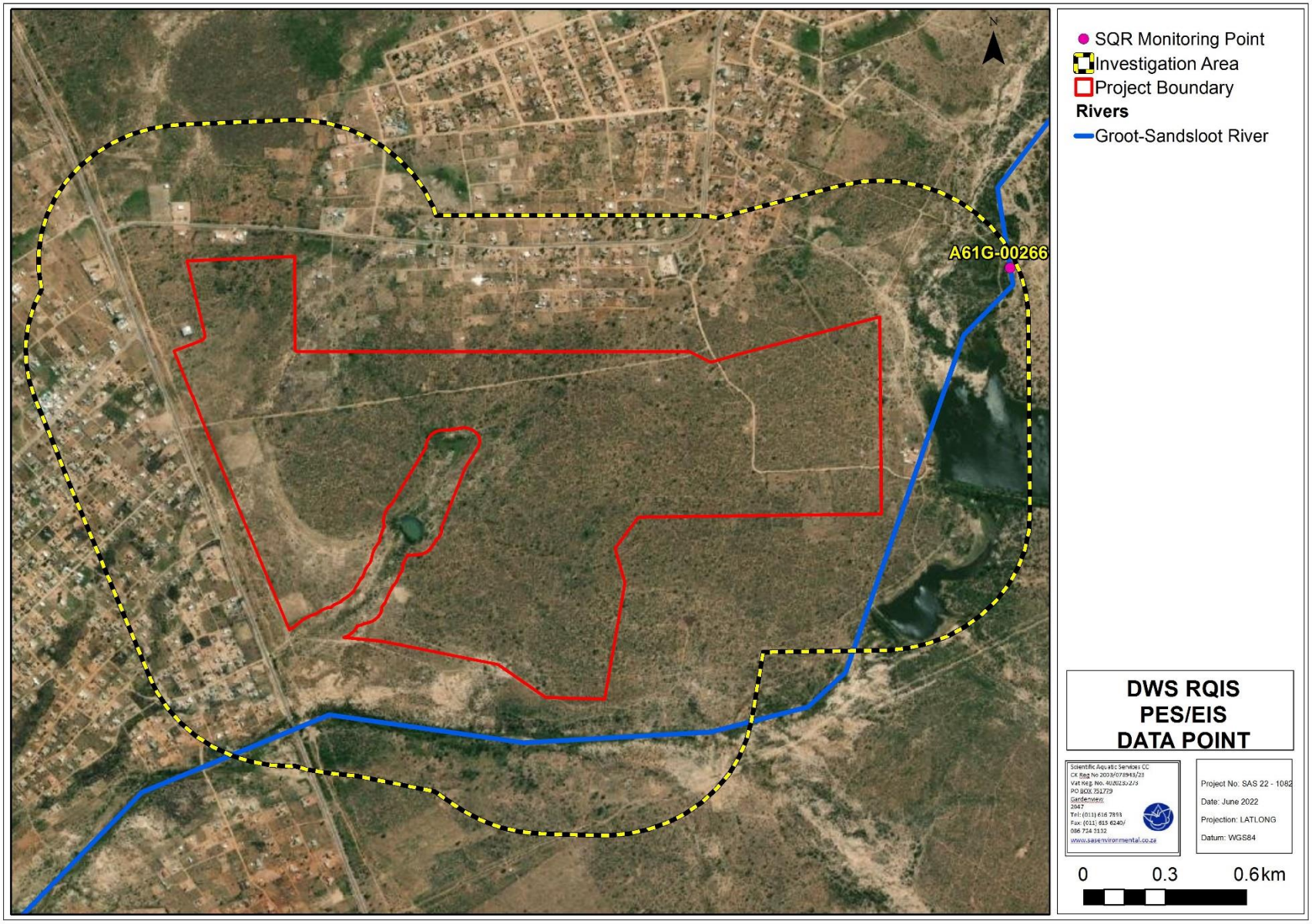

Figure 8: The DWS RQIS PES/EIS data point used to define Ecological Status of the most proximal sub-quaternary reach.

4 RESULTS: FRESHWATER ECOSYSTEM ASSESSMENT

4.1 Freshwater Ecosystem Characterisation

In preparation for the field assessment, aerial photographs, digital satellite imagery and provincial and national wetland databases (as outlined in Section 2 of this report) were used to identify areas of interest at a desktop level. All possible measures were undertaken to ensure all freshwater ecosystems which may be affected by the proposed Mogalakwena PV infrastructure were identified, delineated and assessed.

During the field assessment, no freshwater ecosystems were identified within the project boundary, however various freshwater ecosystems were identified within the investigation area and assessed as part of the study. These were identified as follows:

- The Groot-Sandsloot River is located along the southern portion of the investigation area;
- A single seep wetland located east of the N11 highway within the investigation area; and
- Various ephemeral[5] drainage lines (EDLs) associated with the Groot-Sandsloot River are located within the investigation area.

These freshwater ecosystems were classified according to the Classification System (Ollis *et al*., 2013) as Inland Systems, falling within the Limpopo Plain Aquatic Ecoregion. The wetland vegetation group associated with the project boundary was the Central Bushveld Group 4 which is considered to be Vulnerable according to Mbona *et al.* (2015). At Levels 3 (Landscape Unit) and 4 (HGM Type) of the Classification System, the systems were classified as per the summary in Table 3 below.

Table 3: Characterisation of the freshwater ecosystems associated with the project boundary and investigation area according to the Classification System (Ollis *et. al*., 2013).

Freshwater Ecosystem	Level 3: Landscape unit	Level 4: HGM Type
Ephemeral Drainage Lines, and Groot-Sandsloot River.	**Valley floor:** The base of a valley, situated between two distinct valley side-slopes.	**River**: A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit.
Seep Wetland	**Slope:** An inclined stretch of ground typically located on the side of a mountain, hill or valley, not forming part of a valley	**Seep wetland**: A wetland located on gently to steeply sloping land and dominated by colluvial (i.e gravity-driven), unidirectional movement of water and material down-slope.

[5] Ephemeral systems flow for less time than they are dry. Flow or flood for short periods of most years in a five-year period, in response to unpredictable high rainfall events. Support a series of pools in parts of the channel. Flow is absent between 26%-75% of the year.

Freshwater Ecosystem	Level 3: Landscape unit	Level 4: HGM Type
	floor. Includes scarp slopes, mid-slopes and foot-slopes.	

According to Ollis *et al*., (2013) rivers are characterised by “concentrated, unidirectional flow within a distinct active channel, either permanently or periodically. Although the riparian zone associated with the EDL’s was less well-defined and absent in some sections, the alluvial soil deposits and the terrain setting clearly indicate a distinct active channel that receives periodic flows and formed the basis of classification for the ephemeral systems.

Figure 9: Representative soil profiles along the EDL’s associated with the project boundary and investigation area showing the presence of a weakly defined riparian zone and alluvial deposition.

In addition, based on the definition of a watercourse (see Section 2.1) water flows intermittently within these EDL’s, conveying water from the upgradient catchment area into the downgradient tributaries and eventually into the Groot-Sandsloot River. As such, they were considered as watercourses due to their importance for hydrological functioning and were therefore included in this assessment.

4.2 Freshwater Ecosystem Delineation

As noted in Section 2.1, the freshwater ecosystems associated with the proposed Mogalakwena PV infrastructure were initially delineated using desktop methods (use of aerial photographs, digital satellite imagery and topographical maps), and refined in the field by ground-truthing the desktop delineation at certain pre-selected points where access limitations did not pose any challenges. The delineations as presented in this report are thus regarded as a best estimate of the freshwater ecosystem boundaries based on the site conditions present at the time of assessment.

The following indicators were used to delineate the boundaries of the temporary zones associated with the identified freshwater ecosystems:

- Terrain units were used as the primary indicator, as the terrain of the project boundary, particularly low-lying areas where water is likely to collect and/or move through the landscape;
- Vegetation was utilised as the secondary indicator, particularly along the Groot-Sandsloot River which possessed a distinct riparian zone. Vegetation along the EDLs associated with the river was less distinctive, however, still provided an indication of the presence and position of movement of increased volumes of water within the system;
- The presence of alluvial soil deposits along the Groot-Sandsloot River and the various EDLs was a useful indicator in conjunction with topography and vegetation in delineating the boundary associated with the freshwater ecosystems.

4.3 Analyses of Historical Aerial Imagery

Aerial photographs associated with the proposed Mogalakwena PV infrastructure were obtained from the Department of Rural Development and Land Reform's (DRDLR) National Geo-spatial Information database (http://cdngiportal.co.za/cdngiportal/) to further aid in the identification and delineation of the various features identified during the site assessment. In addition, historical aerial photography and digital satellite imagery are considered useful tool in showing how land has been transformed due to anthropogenic activities within a landscape.

The historical imagery dated 1967 shows the condition of the project boundary prior to any mining activities in the area and the current satellite imagery (2021) shows the condition of the project boundary to date (Figure 10). The red line indicates the location of the N11 Highway for ease of referencing for the reader. The yellow arrow indicates areas of increased sheet and gully erosion which are common in the area due to the high erodibility of the soil. This nature of erosion according to historical imagery is characteristic of the area since it can be observed from imagery prior to the intensification of mining activities or the increase in activities such as grazing which would further intensify the vulnerability of the landscape to soil erosion impacts.

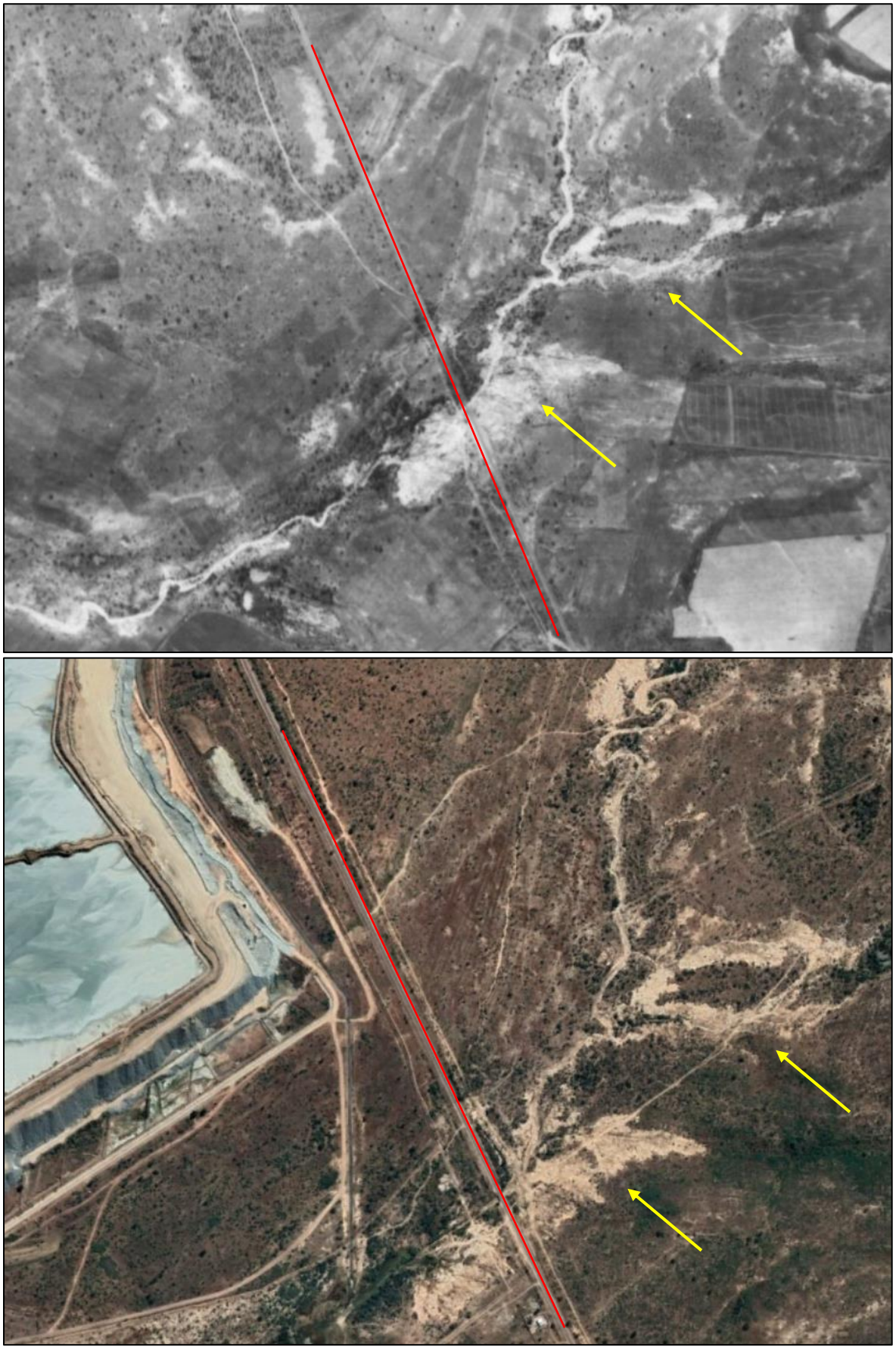

Figure 10: Aerial photographs dated 1967 (top) and current digital satellite imagery dated 2021 (bottom) showing presence of sheet and gully erosion formations in the area. The erosion features (indicted by yellow arrows).

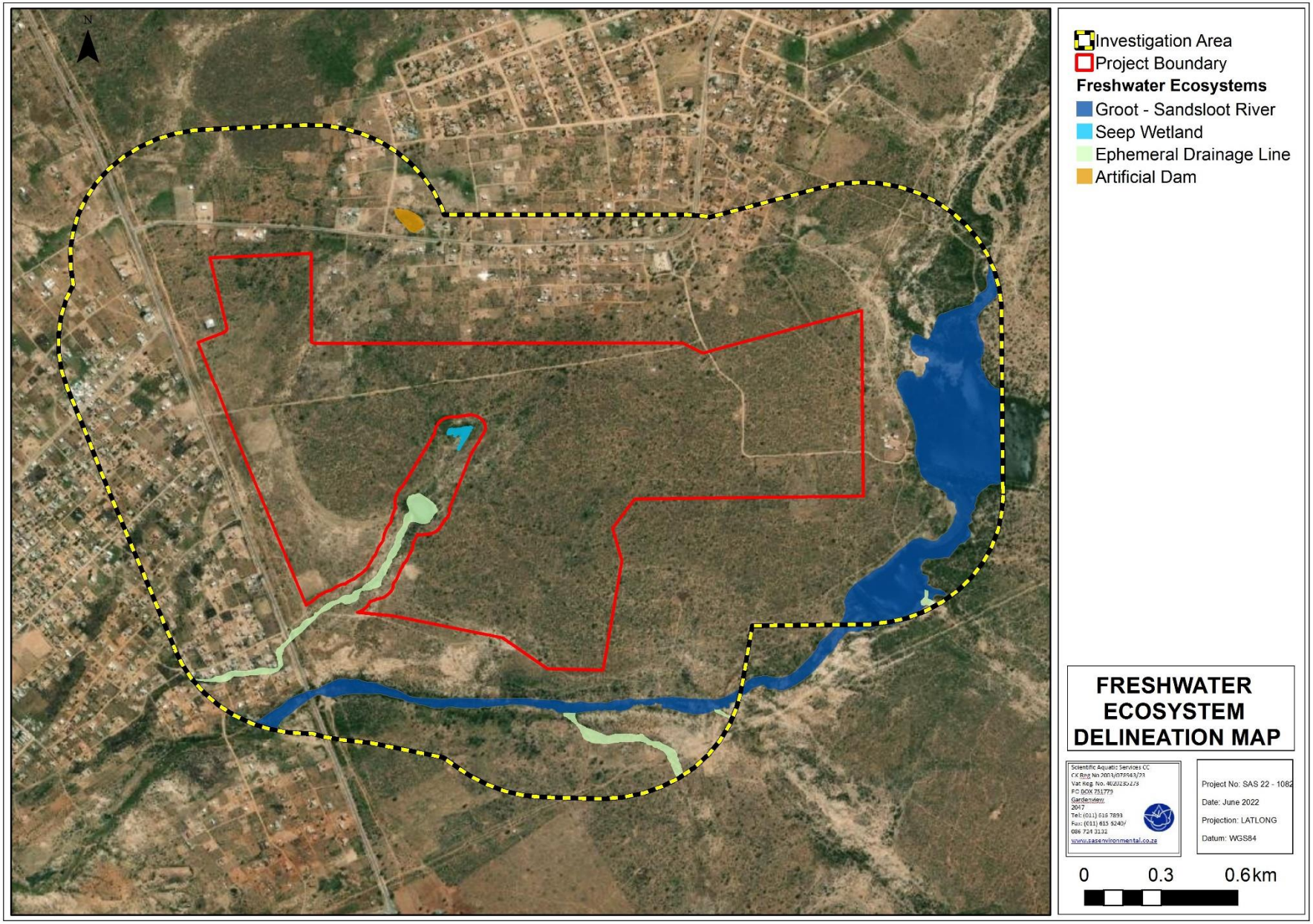

Figure 11: The location of the delineated freshwater ecosystems associated with the project boundary and investigation area.

4.4 Field Verification Results

As mentioned in Section 4.3, the area in which the proposed Mogalakwena PV infrastructure is located is characterised by highly erodible soils and as a result the landscape is dominated by gully (Figure 12, left) and sheet erosion (Figure 12, right).

Figure 12: Example of some of the areas dominated by soil erosion in the landscape identified during the field assessment.

Following the site visit, various assessments were undertaken to determine the PES, EIS, and ecological service provision of the identified freshwater ecosystems as well as to assign an appropriate REC, RMO and BAS as described in Section 1.2 of this report. These assessments were conducted for the Groot-Sandsloot River and the EDL's associated with the Groot-Sandsloot River which are located within the investigation area. Due to the similar characteristics of the various EDLs, and having been subjected to the same anthropogenic impacts, the ecoservice provision, hydrological regime, geomorphological characteristics, water quality and habitat of these freshwater ecosystems were assessed in a combined fashion and discussed in a single 'dashboard' report.

Table 4: Summary of the assessment of the Groot-Sandsloot River associated with the investigation area of the proposed Mogalakwena PV infrastructure.

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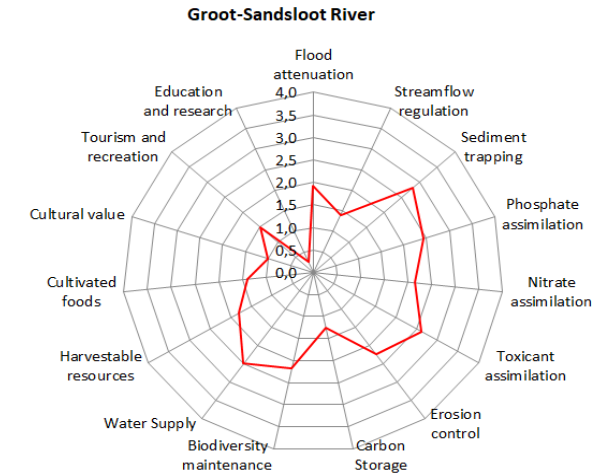
<tr><td colspan="4">Ecological & socio-cultural service provision graph:
 
</td><td colspan="2"> 

Figure 13: Representative photographs of the Groot-Sandsloot River and associated dam (left) located east of the proposed Mogalakwena PV infrastructure.</td></tr>
<tr><td>IHI and VEGRAI discussion</td><td>Riparian IHI Category: C (Moderately modified)
VEGRAI Category: C
The hydraulic regime of the Groot-Sandsloot River has been altered by an impoundment upstream of the project boundary and infrastructure within the active channel, specifically the N11 road crossing. The presence of gravel access roads has resulted in fragmentation of the system whereby the poorly designed culverts and sedimentation have impeded flow to some degree. Primary impacts on the system include transformation of some portions of the riparian and non-marginal vegetation zone by encroachment of Dichrostachys cinerea. In addition, the top-soil layer within parts of the Groot-Sandsloot was very shallow and bedrock was exposed within the active channel indicating significant historical sediment laden runoff during periods of heavy rainfall.</td><td>Ecoservice provision</td><td>Intermediate (Score – 1.8)
The ecological service provisioning of the Groot-Sandsloot River was assessed to be intermediate for provisioning of ecoservices such as erosion control, flood attenuation, sediment trapping, phosphate, nitrate and toxicant assimilation. As a result of the notable transformation of habitat within some reaches of the system due to soil erosion impacts and encroaching by anthropogenic activities, some faunal habitat has been lost. However, the presence of instream dams also improves the river's capacity to provide a diversity of habitat for bird species.</td></tr>
<tr><td>EIS discussion</td><td>EIS Category: Moderate
The Groot-Sandsloot River was assessed to be of moderate Ecological Importance and Sensitivity (EIS) largely due to the hydro-functional importance (i.e. provisioning of services such as flood attenuation, sediment trapping, phosphate and erosion control) of the river. The direct human benefits of the Groot-Sandsloot River are also considered to be of moderate ecological importance and sensitivity as a result of the provision of water for human use and harvestable resources. In addition, the presence of the dams and reeds along the dam has also improved the freshwater ecosystems ability to provide a diversity of some habitat for bird species.</td><td>REC, RMO & BAS Category</td><td>REC:C
BAS: C
RMO: Maintain
The Recommended Management Objective (RMO) for the Groot-Sandsloot River based on the PES and the EIS scores is to maintain the ecological integrity of the system. No further degradation should be permitted and as such mitigation measures should be implemented during the construction and operational phases of the proposed Mogalakwena PV infrastructure. Furthermore, portions of the river to be affected by the proposed Mogalakwena PV (whether directly or by edge effects) should be rehabilitated once the infrastructure installation has been completed. This rehabilitation must ensure that within the affected portions, the natural topography is reinstated to avoid formation of preferential flow paths.</td></tr>
</table>

Freshwater ecosystem drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):	
The hydrological regime of the system has been impacted to a degree by various informal road crossings which have fragmented the system or resulted in partial hydraulic disconnection of the system within some areas. The impoundments within the upper reach of the system although considered important for provision of habitat have also impacted on the natural retention and distribution of flow and sediment to downstream reaches of the river. During the field assessment, water quality was assessed at three points along the system, which included upstream of the dam, at the dam and downstream of the dam. Specific in-situ parameters measured included pH, Dissolved Oxygen (DO) and Electrical Conductivity (EC). The EC measured at each assessment point respectively was 58.5 mS/m, 62.8 mS/m and 109.4 mS/m indicating an increase in a downstream direction. High EC measured downstream is likely due to increased evapoconcentration of salts since flow was limited below the dam where measurements were done. Despite the observed soil erosion being considered largely natural, the extent of sand mining (unauthorised activities not associated with Mogalakwena Mine) within the active channel is deemed to be a significant contributor to altered geomorphological processes, exacerbating the extent and severity of the erosion / incision, however this is not located within the proposed footprint of the PV infrastructure. This in turn results in altered sediment loads being transported to the downstream areas, which may in turn affect channel competency (further bank incision and/or bed scouring, as well as sediment deposition) and possible water quality alterations. The habitat within the Groot-Sandsloot River has been modified by impacts such as overgrazing and trampling of cattle causing bush encroachment (particularly *Dichrostachys cinerea*) along the banks of the river and erosion within other portions of the river (STS 2021). The presence of the dam has encouraged utilisation by faunal species and the vegetation cover of *Typha capensis* and *Phragmites australis* along the dam where sediment deposits and allows for reed establishment provides a degree of foraging and feeding habitat for less sensitive avifauna, mammals, reptiles and invertebrates.	
Extent of modification anticipated	**None** The Groot-Sandsloot River will not be directly traversed by the proposed Mogalakwena PV infrastructure according to the current layout provided by the proponent. The layout has been largely optimised to avoid the EDLs, as such reducing any potential impacts to these systems.
Impact Significance & Business Case:	
Low	The proponent has provided a proposed layout that avoids directly encroaching on the Groot-Sandsloot River and this reduces the potential impact significance to the system to a low impact. In terms of the layout of the solar PV in relation to the floodlines of the Groot-Sandsloot River, according to the hydrological report (SMEC 2022), the modelling results showed that the solar PV plant is positioned well clear of the floodlines and that there is no flood risk. This is not only important for the ecological functioning of the system but also more important for the protection of the infrastructure. For detailed discussion regarding the impact significance and recommended mitigation measures, please refer to Section 6 and Appendix F of this report.

Table 5: Summary of the assessment of the various ephemeral drainage lines (EDLs) associated with the investigation area of the proposed Mogalakwena PV infrastructure.

Ecological & socio-cultural service provision graph:

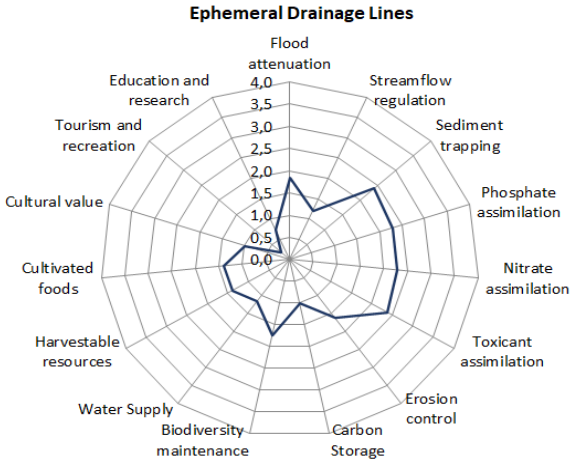


Figure 14: Representative photographs of the ephemeral drainage line (EDLs) associated with the proposed Mogalakwena PV infrastructure.

PES and VEGRAI discussion	**Riparian IHI PES Category: C (Moderately modified)** **VEGRAI Category: C** During the field assessment, the EDLs were mostly dry. Identified impacts associated with the EDLs include the transformation of some portions of the riparian and non-marginal zone to due to encroaching informal and peri-urban residential areas. The EDLs where characterised by deposition of alluvial sediment which is typical of systems of this nature. Some of the EDLs were relatively shallow and bedrock was exposed within the active channel. Other impacts include informal road crossings traversing the EDLs and trampling by domestic livestock.	**Ecoservice provision**	**Intermediate (Score – 1.5)** The EDLs were found to provide an intermediate degree of ecological service provisioning. Ecological services provided by these systems included sediment trapping, flood attenuation, erosion control and to a degree phosphate assimilation. The opportunity to provide ecological services such as cultivated foods and harvestable resources was high owing to the level of poverty in the area, however limited effectiveness due to the lack of multiple harvestable resources. In addition, due to the prolonged absence of flows in these systems, their effectiveness for providing water supply for communities is very limited.
EIS discussion	**EIS Category: (Moderate)** The EDLs were shown be of moderate EIS. This was largely attributed to the landscape scale of the EDLs including the vegetation type and context of the ecological integrity within the landscape. The EIS was also in part due to the hydro-functional importance of the EDLs including flood attenuation, sediment trapping and assimilation of toxicants, nitrates and phosphates as previously discussed. Given the nature of flow of the EDLs socio-cultural services were all noted to be largely limited, particularly direct provision of water for human use.	**REC, RMO & BAS Category**	**REC: C** **BAS: C** **RMO: Maintain** Based on the PES and the EIS of the EDLs, the Recommended Management Objective (RMO) of the EDLs is to maintain the ecological condition of the systems and appropriate mitigation measures must be implemented to ensure that the significance of impacts is minimised as much as possible. Where the EDLs will be traversed by the proposed infrastructure and where trenching will be undertaken and unless directional drilling approaches are used, suitable rehabilitation measures must be implemented immediately following completion of construction activities.

Freshwater ecosystem drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):	
Given the hydrological nature (flows only in response to unpredictable high rainfall events), the EDLs were mostly without flows at the time of the assessment. Observed erosion and gully formation within some of the EDLs has resulted in the alteration of the natural timing and delivery of water and sediment to the lower reaches of these systems. *In-situ* water quality parameters were not measured as the EDLs were dry at the time of the field assessment. Given the absence of impacts such as mining infrastructure (i.e tailings dams) along the EDLs the water quality in the area would only be impacted by domestic activities. Although flow was absent within the EDLs, one of these systems had an instream dam which contained water,. although this is mostly used for cattle and does not represent water quality of the EDLs, *in-situ* water quality parameters such as EC, pH and DO were sampled. These parameters were measured as follows 40.6 mS/m, 8.85 and 85.2% respectively, indicating fair water quality conditions. In terms of habitat provision, the EDLs were limited in their ability to provide habitat for aquatic species (both faunal and floral) due to the absence of flows for prolonged periods. The vegetation communities within parts of the system have also been impacted by overgrazing of livestock (donkeys, goats and cows) and this has likely contributed to the observed transformation of some portions of the riparian and non-marginal vegetation zone and significant encroachment of *Dichrostachys cinerea*.	
Extent of modification anticipated	**Low** According to the current layout provided by the proponent, the extent of modification anticipated on the EDLs is considered to be low. The layout has been largely optimised to avoid the EDLs, as such reducing any potential impacts to these systems.
Impact Significance & Business Case:	
Low	As mentioned above, the layout provided by the proponent avoids directly encroaching with the EDLs which reduces the potential impact significance. The extent of some EDLs has been reduced due to deposition of sediment from surrounding areas and upon observation during the field work, sections of the EDLs did not show characteristics of conveying water although they are considered important particularly during periods of significant flows. Despite this, according to the hydrological report (SMEC 2022), the modelling results showed that the solar PV plant is positioned well clear of the floodlines and that there is no flood risk. For detailed discussion regarding the impact significance and recommended mitigation measures, please refer to Section 6 and Appendix F of this report.

Table 6: Summary of the assessment of the seep wetland associated with the investigation area of the Mogalakwena PV infrastructure.

Ecological & socio-cultural service provision graph:

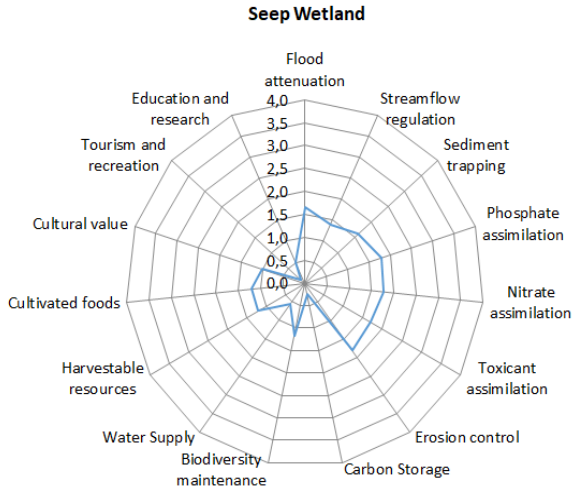


Figure 15: Representative photographs of the seep wetland associated with the proposed Mogalakwena PV infrastructure (Left). The soil sampled within the site shows indicators of a fluctuating water table (mottles) associated with frequent saturation.

PES Discussion	**PES Category: C (Largely Modified)** The seep wetland was observed to be surrounded by mostly woody vegetation (especially *Dichrostachys cinerea*). The presence of the woody vegetation has likely impacted on the water inputs into the seep wetland. The primary modifiers noted were impacts to the vegetation, primarily as a result of grazing and trampling by domestic livestock. The resulting reduction in natural vegetation cover has led to encroachment by floral species associated with disturbance, however this is not considered to be severe. Other impacts include a gravel road adjacent to the seep which has likely impacted on the natural extent of functional wetland area.	**Ecoservice provision**	**Intermediate (Score – 1.8)** The ecological service provision by the seep wetland was assessed to be intermediate due to services such as sediment trapping, nitrate assimilation and erosion control. The seep covers a very small footprint (0.40 ha) and was not observed to have diversity of habitat available, as a result it was considered limited in terms of habitat provision for biodiversity support. However, the ecoservice provision of the system is largely seasonal and is strongly influence by presence of surface water within the wetland.
EIS discussion	**EIS Category: Moderate** The ecological importance and sensitivity (EIS) of the wetland was assessed to be moderate. The seep wetland likely provides, although limited some habitat, foraging and migratory sites for various faunal species on a seasonal basis especially when surface water is present. According to a local resident, during summer periods water saturates the wetland and the pools that form are able to accommodate amphibians and macro-invertebrates.	**REC, RMO & BAS Category**	**REC:C** **BAS: C** **RMO: Maintain** The Recommended Management Objective (RMO) for the seep wetland based on the PES and the EIS scores is to maintain the ecological integrity of the system. No further degradation should be permitted and as such it is recommended that the proposed Mogalakwena PV infrastructure avoids encroaching on the wetland. In addition, any edge effects must be rehabilitated to ensure the natural topography is reinstated to avoid formation of preferential flow paths.

Freshwater ecosystem drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):	
Very few impacts to the hydraulic regime and geomorphological processes were observed to be occurring on the seep wetland during the site assessment, with the exception of the gravel road adjacent to the wetland and minimal topsoil disturbances caused by trampling of livestock. *In-situ* water quality parameters were not measured as there was no surface water present at the time of the assessment. Given the absence of activities which would significantly alter water quality (mining infrastructure) the water quality within the wetland is considered to be fair when present. In addition, according to a local resident, the major driver of the wetland is groundwater seepage which results in the presence of stagnant water particularly during the dry season. The geomorphology within the wetland was considered largely unimpacted (apart from impacts associated with cattle trampling) and this was due to the good vegetation cover provided by the short grasses and sedges identified within the wetland. The seep wetland had a good vegetation cover which was dominated by various grasses and sedges. The grass layer was dominated by grasses commonly found in moisture rich/wet areas which included species such as *Sporobolus africanus, Cynodon dactylon, Chloris virgata* and *Brachiaria nigropedata*. In addition, alien and encroacher species such as *Bidens Pilosa* and *Zanthium strumarium* were also found to be dominated within the seep.	
Extent of modification anticipated	**Medium** The seep wetland will be traversed by the Development Area 1(B) that is associated with the proposed Mogalakwena PV infrastructure. It is strongly recommended that the design of the PV infrastructure be reconsidered to avoid encroaching within this freshwater ecosystem to avoid any potential modification to the wetland.
Impact Significance & Business Case:	
Low	The proposed Mogalakwena PV infrastructure poses a medium-risk impact to the seep wetland given that the system is located within the proposed Development area 1(B) according to the current layout design. Realignment of the development area footprint should be considered in-line with the mitigation hierarchy to ensure the wetland is avoided. This is considered important for the safety of the infrastructure too, since it is not ideal for any structures to be within areas which are periodically saturated.

5 RESULTS: AQUATIC ECOLOGICAL ASSESSMENT

The instream aquatic ecological assessment presents the results of two aquatic survey points, conducted in early June and at a when the Groot Sandsloot was characterised by absence of significant flow.

5.1 Site characteristics

For the purpose of the current assessment, two sites were assessed as part of the aquatic ecological assessment.

Table 7: Geographic co-ordinates for the assessment points located on the Groot Sandsloot River.

Site Name	Description	Co-ordinates	
		South	East
Mogalakwena UPS	The upstream biomonitoring point is located on the assessed Groot Sandsloot River, upstream of the dam.	23°59'34.97"S	28°57'37.24"E
Mogalakwena DS	The downstream biomonitoring point is located on the assessed Groot Sandsloot River, along the N11 highway.	23°58'40.37"S	28°59'1.83"E

During the time of the assessment flow at the downstream site was limited and depth was relatively shallow (0.3 – 0.6 m) with very slow to moderate flows. The upstream site was sampled immediately upstream of the dam, and due to the impoundment of the dam, the depth at which the upstream point was sampled was deeper (>1 m). No odour was present at the time of the assessment at both sites and proliferation of algae was observed to be significant only at the downstream site.

Table 8: Results of the assessment site located upstream of the Groot Sandsloot River.

<table>
<tr><th colspan="2">Groot Sandsloot River Upstream</th><th colspan="4">In situ physico-chemical water quality</th><th colspan="4">Aquatic macro-invertebrate community integrity</th></tr>
<tr><td colspan="2" rowspan="3"> 
Figure 16: Downstream view of the dam associated with the Groot Sandsloot River and the Upstream monitoring point at the time of the June 2021 assessment.</td><td>Parameter</td><td>June 2021</td><td colspan="2">RWQO of South Africa (DWA, 2011)</td><td>Parameter</td><td>June 2021</td><td colspan="2">Site specific spatial water quality variations (% var) from:</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td></td><td></td><td>Parameter</td><td>Upstream spatial reference</td></tr>
<tr><td>pH
EC (mS/m)
DO (mg/L)
DO (% sat)
Temp (C)</td><td>7.78
50.2
6.47
73.6
15.3</td><td>pH
EC (mS/m)</td><td>>6.5 - <8.4
<30 (Ideal)
30 - 50 (Acceptable)
50 - 85 (Tolerable)
>85 (Unacceptable)</td><td>SASS5 score
Number of taxa
ASPT score
IHAS score
MIRAI score</td><td>40
11
3.64
42
40.8 (D/E)</td><td>SASS5
ASPT
IHAS</td><td>NA (No upstream spatial reference)</td></tr>
<tr><td colspan="4">Discussion
➢ The Electrical Conductivity (EC) measured at the assessment point was within the tolerable (< 85 mS/m) range limit according to DWA (2011);
➢ The Dissolved Oxygen (DO) saturation was below the recommended 80 – 120% saturation range during the June 2021 assessment, but did however exceed the 60% sub-lethal concentration. This is likely due to absence of turbulent flows and presence of aquatic vegetation which likely increases biological oxygen demand, no significant impact on the aquatic ecology was anticipated;
➢ The pH measured in June 2021 was within the recommended ideal range (DWA 2011);
➢ Temperature was considered largely natural in relation to the diurnal and seasonal cycles; and
➢ Overall, no significant impacts on the water quality were observed at the monitoring point. Impacts on the water quality at the monitoring point likely include domestic use of the river and dam including use by cattle.</td><td colspan="4">Discussion
➢ The aquatic macro-invertebrate community diversity and sensitivity was classified as a Category D/E (largely to seriously modified) condition according to the MIRAI Ecostatus tool;
➢ Macro-invertebrates not suitably adapted, or which have a requirement for improved flows, as part of their biology, will likely not be present at this site. This has the potential to lower the overall abundance and diversity of the macro-invertebrate community present at the site; and
➢ The IHAS score was assessed to be poor during the June 2021 assessment, with limited biotope diversity present at the site with no stones habitat and sampling limited to mostly marginal and aquatic vegetation as well as gravel, sand and mud (GSM).</td></tr>
<tr><th colspan="6">Visual assessment and site description</th></tr>
<tr><td colspan="2">Algal proliferation</td><td colspan="6">Limited algal proliferation was observed.</td></tr>
<tr><td colspan="2">Depth profiles</td><td colspan="6">Mostly dominated by deeper pools (average depth 1-1.5 meter).</td></tr>
<tr><td colspan="2">Flow condition</td><td colspan="6">Limited flows, mostly ponding water.</td></tr>
<tr><td colspan="2">Riparian zone characteristics</td><td colspan="6">Riparian area dominated by grasses and short sedges.</td></tr>
<tr><td colspan="2">Water clarity and odour</td><td colspan="6">Slightly discoloured at time of assessment and no odour present.</td></tr>
</table>

Table 9: Results of the assessment site located downstream of the Groot Sandsloot River.

Figure 17: Downstream view of the Groot Sandsloot River and the Downstream monitoring point at the time of the June 2021 assessment.

Parameter	June 2021	% var. from Upstream	RWQO of South Africa (DWA, 2011)		Parameter	June 2021	Site specific spatial water quality variations (% var) from:	
							Parameter	Upstream spatial reference
pH	7.98	+2.6	**pH**	>6.5 - <8.4	**SASS5 score**	18		
EC (mS/m)	118.0	**+135.1**	**EC (mS/m)**	30 (Ideal)	**Number of taxa**	5	**SASS5**	**-55.0**
DO (mg/L)	4.48	**-30.8**		30 - 50 (Acceptable)	**ASPT score**	3.6	**ASPT**	-1.1
DO (% sat)	55.0	**-25.3**		50 -85 (Tolerable)	**IHAS score**	38	**IHAS**	-9.5
Temp (C)	18.4	+20.3		>85 (Unacceptable)	**MIRAI score**	39.0 (D/E)		

Discussion

- The EC measured at the assessment point was within the unacceptable (> 85 mS/m) range limit according to DWA (2011). The increase in EC was likely due to the lack of instream connectivity and low flows at the assessment point which is compounded by the increase in evapoconcentration at the time of the assessment;
- The DO saturation was below the recommended 80 – 120% saturation range and below 60% sub-lethal limit during the June 2021 assessment. This is likely due to absence of turbulent flows and presence of significant algal proliferation observed at the assessment point;
- The pH measured in June 2021 was within the recommended ideal range (DWA 2011);
- Temperature was considered largely natural in relation to the diurnal and seasonal cycles; and
- Overall, slight impacts on the water quality were observed at the monitoring point (elevated EC and low DO). Impacts on the water quality at the monitoring point likely include flow modification, domestic use of the river and dam river including use by cattle.

Discussion

- A significant decrease in the SASS5 score was measured when compared to the upstream assessment point. This is likely due to the slight decrease in habitat suitability (isolated pool) and lack of instream connectivity compounded by the observed increase in EC as well as a decrease in dissolved oxygen;
- The aquatic macro-invertebrate community diversity and sensitivity was classified as a Category D/E (largely to seriously modified) condition according to the MIRAI Ecostatus tool, indicating a deterioration in the system when compared to the upstream community diversity. In addition to impaired water quality, this is likely due to very poor habitat conditions at the assessment point;
- Macro-invertebrates not suitably adapted, or which have a requirement for improved flows, as part of their biology, will likely not be present at this site. This has the potential to lower the overall abundance and diversity of the macro-invertebrate community present at the site;
- The IHAS score was assessed to be poor during the June 2021 assessment, with limited biotope diversity present at the site with no stones habitat and sampling limited to mostly marginal and aquatic vegetation as well as gravel, sand and mud (GSM).

Visual assessment and site description	
Algal proliferation	Moderate to high algal proliferation was observed.
Depth profiles	Mostly dominated by shallow pools (average depth 0.5 – 1.0 meter).
Flow condition	Limited flows, mostly ponding water.
Riparian zone characteristics	Riparian area dominated by sedges.
Water clarity and odour	Slightly discoloured at time of assessment and no odour present.

Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; **Bold text = significant change (compared to guideline);** **Red text = significant deterioration**; **Blue text = significant improvement.**

6 INTERNATIONAL FINANCE CORPORATIONS (IFC) PERFORMANCE STANDARDS ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY

The International Finance Corporations (IFC) Sustainability Framework articulates the Corporation's strategic commitment to sustainable development and is an integral part of IFC's approach to risk management. The sustainability framework comprises IFC's Policy and Performance standards on Environmental and Social Sustainability, and IFC's Access to Information Policy. The Performance Standards are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate and manage risks and impacts as a wat of doing business in a sustainable manner.

This memo serves to address the application of Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources) of the International Finance Corporation (IFC) and to categorise the observed habitat units into the relevant IFC defined habitat categories.

The IFC habitat categories are defined as follows:

Modified Habitat

Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.

This Performance Standard applies to those areas of modified habitat that include significant biodiversity value, as determined by the risks and impacts identification process required in Performance Standard 1. The client should minimize impacts on such biodiversity and implement mitigation measures as appropriate.

Natural Habitat

Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

The client will not significantly convert or degrade natural habitats, unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified habitat;
- Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation; and
- Any conversion or degradation is mitigated according to the mitigation hierarchy.

In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity where feasible. Appropriate actions include:

- Avoiding impacts on biodiversity through the identification and protection of set-asides;
- Implementing measures to minimize habitat fragmentation, such as biological corridors;
- Restoring habitats during operations and/or after operations; and
- Implementing biodiversity offsets.

Critical Habitat

Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;
- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

In such cases where a client is able to meet the requirements defined in paragraph 17, the project's mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains of those biodiversity values for which the critical habitat was designated.

In instances where biodiversity offsets are proposed as part of the mitigation strategy, the client must demonstrate through an assessment that the project's significant residual impacts on biodiversity will be adequately mitigated to meet the requirements of paragraph 17.

GN9. The requirements for the baseline study will vary depending on the nature and scale of the project. For sites with potentially significant impacts on natural and critical habitats and ecosystem services, the baseline should include field surveys over multiple seasons, to be undertaken by competent professionals and with the involvement of external experts, as necessary. Field surveys and assessments should be recent, and data should be acquired for the direct project footprint, including related and associated facilities, the project's area of influence, and potentially beyond

GN22. For projects located in critical habitats (including legally protected and internationally recognized areas), clients must ensure that external experts with regional experience are involved in the biodiversity

and/or critical habitat assessment. If habitat is critical due to the presence of critically endangered or endangered species, recognized species specialists must be involved (for example, including individuals from IUCN Species Survival Commission Specialist Groups). In areas of critical habitat, clients will benefit from establishing a mechanism for external review of the project's risks and impacts identification process and proposed mitigation strategy. This is especially relevant where uncertainty is high, where potential impacts are complex and/or controversial, and/or where no precedent exists for proposed mitigations (such as some types of offsets). Such a mechanism would also promote the sharing of good international practice between projects and improve transparency in decision making

GN28. Both natural and modified habitats may contain high biodiversity values, thereby qualifying as critical habitat. Performance Standard 6 does not limit its definition of critical habitat to *critical natural* habitat. An area may just as well be *critical modified* habitat. The extent of human-induced modification of the habitat is therefore not necessarily an indicator of its biodiversity value or the presence of critical habitat.

GN36. Clients should endeavour to site the project in modified habitat rather than on natural or critical habitat and demonstrate this effort through a project alternatives analysis conducted during the risks and impacts identification process.

GN37. Performance Standard 6 requires that projects with significant biodiversity values in modified habitats minimize their impacts and implement mitigation and management measures as needed to conserve those values. Significant biodiversity values that might occur in modified habitat include species of conservation concern (for example, species that are threatened or otherwise identified as important by stakeholders) and remnant ecological features that persist in the modified landscape, especially those that perform important ecological functions. In some cases, significant biodiversity values may cause natural or critical habitat requirements to be applied, in which case they should be treated using the guidelines for those habitat designations.

GN58. *Relatively broad landscape and seascape units might qualify as critical habitat.* The scale of the critical habitat assessment depends on the biodiversity attributes particular to the habitat in question and the ecological patterns and processes required to maintain them. Even within a single site designated as critical habitat there might be areas or features of higher or lower biodiversity value. There also will be cases where a project is sited within a greater area recognized as critical habitat, but the project site itself has been highly modified. *A critical habitat assessment therefore must not focus solely on the project site.* The client should be prepared to conduct desktop assessments, consult with experts and other relevant stakeholders to obtain an understanding of the relative importance or uniqueness of the site with respect to the regional and even the global scale, and/or conduct field surveys beyond the boundaries of the project site. These considerations would form part of the landscape/seascape analyses as referred to in paragraph 6 of Performance Standard 6 and in paragraph GN17 of this note.

GN104. In many cases, invasive species will have already been established in the region in which the project is located. In these cases, the client has the responsibility to take measures to prevent the

species from further spread into areas in which it has not already been established. For example, in the case of linear infrastructure, invasive weeds might be spread into forested habitats, especially if the forest canopy is not able to re-establish itself (due to maintenance of the right-of-way for operational purposes). This is exacerbated if opportunistic agricultural or logging activities further widen the right-of-way, thereby facilitating spread. In these cases, the client is expected to determine the severity of the threat and the mode of spread of that species. The situation should be monitored as part of the overall ESMS, and the client should seek effective mitigation measures in coordination with local and national authorities.

GN106. Performance Standard 6 defines ecosystem services as “the benefits that people, including businesses, obtain from ecosystems” (paragraph 2), which is in line with the definition provided by the Millennium Ecosystem Assessment (GN23). As described in paragraph 2 and footnote 1 of Performance Standard 6, ecosystem services are organized into four major categories:

- Provisioning ecosystem services, include, among others, (i) agricultural products, seafood and game, wild foods, and ethnobotanical plants; (ii) water for drinking, irrigation, and industrial purposes; and (iii) forest areas, which provide the basis for many biopharmaceuticals, construction materials, and biomass for renewable energy;
- Regulating ecosystem services, include, among others, (i) climate regulation and carbon;
- storage and sequestration; (ii) waste decomposition and detoxification; (iii) purification of water and air; (iv) control of pests, disease, and pollination; and (v) natural hazard mitigation;
- Cultural services, include, among others, (i) spiritual and sacred sites; (ii) recreational purposes such as sport, hunting, fishing, and ecotourism; and(iii) scientific exploration and education; and
- Supporting services, are the natural processes that maintain the other services, such as (i) nutrient capture and recycling, (ii) primary production, and (iii) pathways for genetic exchange.

The table below lists the various habitat units as discussed in the biodiversity reports with reference to the IFC habitat units mentioned above.

Table 10: Habitat units as per biodiversity reports applicable IFC habitat and applicable criteria

Habitat Units as per Biodiversity Reports	Applicable IFC Habitat and applicable Criteria	IFC Habitat Unit Discussion
Freshwater Habitat		
Groot-Sandsloot River	**Modified Habitat** Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands. **Additional considerations:** GN28	Consideration was given to the biodiversity values of the riparian and instream habitat of the Groot-Sandsloot River as well as of the scale and extent of anthropogenic impacts, when designating an appropriate Habitat Category: • The hydraulic regime of the Groot-Sandsloot River has been altered by an impoundment and infrastructure within the active channel, specifically the N11 road crossing; • The presence of gravel access roads has resulted in fragmentation of the system whereby the poorly designed culverts and sedimentation have impeded flow to some degree; • Impacts on the system include transformation of some portions of the riparian and non-marginal vegetation zone by encroachment of *Dichrostachys cinerea*; • In addition, the top-soil layer within parts of the Groot-Sandsloot was very shallow and bedrock was exposed within the active channel indicating significant historical sediment laden runoff during periods of heavy rainfall; and • Despite the notable transformation in the habitat, the ecological service provisioning of the Groot-Sandsloot River was assessed to be intermediate for provisioning of ecoservices such as erosion control, flood attenuation, sediment trapping, phosphate, nitrate and toxicant assimilation. Thus, the degree and extent of modification is deemed sufficient to categorise these systems as 'modified' (in terms of the IFC definition).
Episodic Drainage Lines (EDLs)	**Modified Habitat** Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands. **Additional considerations**: GN28	Consideration was given to the biodiversity values of the riparian (albeit less well defined) and instream habitat of the EDLs associated with the Groot-Sandsloot River, as well as of the scale and extent of anthropogenic impacts, when designating an appropriate Habitat Category: • Identified impacts associated with the EDLs include the transformation of some portions of the riparian and non-marginal zone to due to encroaching informal and peri-urban residential areas; • The EDLs where characterised by deposition of alluvial sediment which is typical of systems of this nature; • Some of the EDLs were relatively shallow and bedrock was exposed within the active channel; • Additional impacts include informal road crossings traversing the EDLs and trampling by domestic livestock; and • The EDLs were found to provide an intermediate degree of ecological service provisioning. Ecological services provided by these systems included sediment trapping, flood attenuation, erosion control and to a degree phosphate assimilation. Thus, the degree and extent of modification is deemed sufficient to categorise these systems as 'modified' (in terms of the IFC definition).
Seep wetland systems	**Modified Habitat** Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands. **Additional considerations:** GN28	Consideration was given to the biodiversity values of the seep wetlands as well as of the scale and extent of anthropogenic impacts, when designating an appropriate Habitat Category: • The seep wetland was observed to be surrounded by mostly woody vegetation (especially Dichrostachys cinerea). The presence of the woody vegetation has likely impacted on the water inputs into the seep wetland; • The modifiers noted were impacts to the vegetation, primarily as a result of grazing and trampling by domestic livestock; • The resulting reduction in natural vegetation cover has led to encroachment by floral species associated with disturbance, however this is not considered to be severe; • The ecological service provision by the seep wetland was assessed to be intermediate due to services such as sediment trapping, nitrate assimilation and erosion control; and • The seep covers a very small footprint (0.40 ha) and was not observed to have diversity of habitat available, as a result it was considered limited in terms of habitat provision for biodiversity support. However, the ecoservice provision of the system is largely seasonal and is strongly influence by presence of surface water within the wetland. Thus, the degree and extent of modification is deemed sufficient to categorise these systems as 'modified' (in terms of the IFC definition).

7 LEGISLATIVE REQUIREMENTS, NATIONAL AND PROVINCIAL GUIDELINES PERTAINING TO THE APPLICATION OF BUFFER ZONES

According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone. However, in summary, it is considered to be "a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another". Buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on water resources arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015). It should be noted, however, that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

The definition and motivation for a regulated zone of activity for the protection of the freshwater ecosystems can be summarised as follows:

Table 11: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use License Application in terms of the National Water Act, 1998 (Act No. 36 of 1998).	**Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No.36 of 1998)** In accordance with GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998), a regulated area of a watercourse in terms of water uses as listed in Section 21(c) and 21(i) is defined as: • the outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; • in the absence of a determined 1 in 100-year flood line or riparian area the area within **100 m from the edge of a watercourse** where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a **500 m radius from the delineated boundary** (extent) of any wetland or pan in terms of this regulation.
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA Regulations (2014), as amended must be taken into consideration if any activities (for example,	**Activity 12** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA regulations, 2014 (as amended) states that: *The development of:* *(xii) Infrastructure or structures with a physical footprint of 100 square meters or more;*

Regulatory authorisation required	Zone of applicability
access roads) are to take place within the applicable zone of regulation. This must be determined by the EAP in consultation with the relevant authorities.	*Where such development occurs—* *a) Within a watercourse;* *b) In front of a development setback; or* *c) If no development setback has been adopted, within **32 meters of a watercourse**, measured from the edge of a watercourse.*

In terms of GN509 of the National Water Act, 1998 (Act No. 36 of 1998), a 100 m zone of regulation is applicable to any riparian area, in the absence of a modelled 1:100-year floodline, and a 500 m zone of regulation in line with GN509 of the National Water Act, 1998 (Act No. 36 of 1998) is also applicable to any wetland identified within the investigation area.

A 32 m zone of regulation in accordance with the National Environmental Management Act, 1998 (Act No. 107 of 1998) is also applicable to all freshwater ecosystems. It is however acknowledged that linear developments (such as powerlines) may need to traverse the delineated freshwater ecosystems and therefore cannot be entirely excluded from the applicable zones of regulation. Thus, it is essential that strict implementation of well-developed, cogent mitigation measures takes place, to prevent unnecessary impacts on the affected drainage systems particularly during construction. Additionally, the mitigation hierarchy must be followed, and impacts which cannot be practicably avoided, minimised or rehabilitated may need to be offset.

The respective zones of regulation as stipulated above are depicted in the figures 18 below.

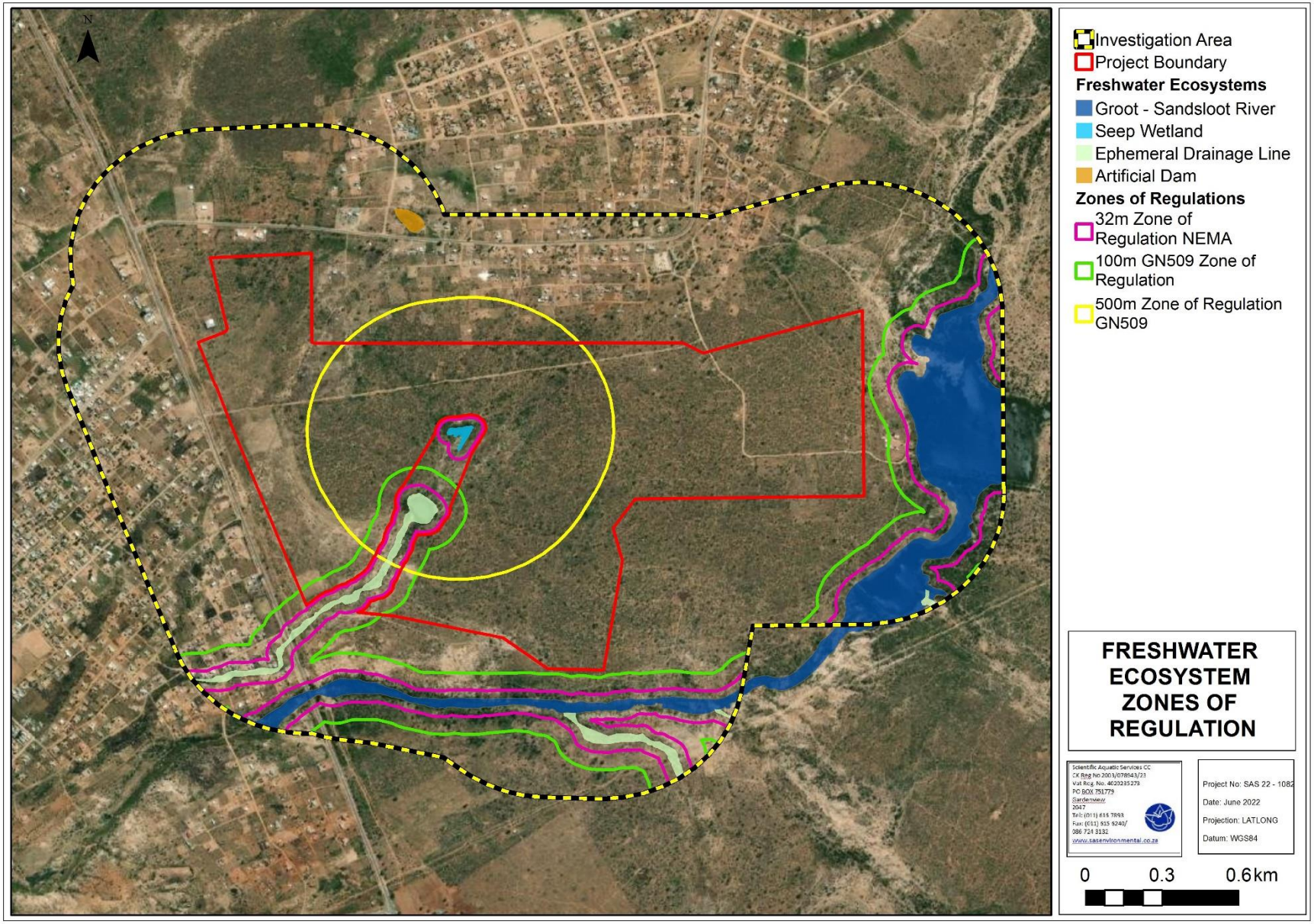


Figure 18: Conceptual presentation of the zones of regulation in terms of NEMA and GN509 of 2016 as it relates to the NWA in relation to the delineated freshwater ecosystems.

8 IMPACT ASSESSMENT

Identified impacts are described in terms of the nature of the impact, receptor sensitivity and the significance of the predicted environmental change (before and after mitigation). The assessment of the identified impacts is based on determining the following aspect: impact intensity, duration, extent, consequence, probability and impact reversibility. The impact rating system considers the confidence level that can be placed on the successful implementation of mitigation.

According to SMEC (2022), the stormwater management plan as part of the development was designed to ensure that requirements from the relevant authorities are met, and these include specifically, designing a stormwater management to prevent off-site migration of contaminated stormwater/increased soil erosion, ensuring implementation of the appropriate design measures to allow surface and subsurface movement of water along drainage lines, to not impede natural surface and subsurface flows. In addition, ensuring that the drainage in the landscape promotes the dissipation of stormwater run-off.

8.1 Impact Ratings and Discussion

There are four key ecological impacts on freshwater ecosystems that are anticipated:

- Changes to the freshwater ecosystems leading to the loss of habitat;
- Modification of hydrological function and water quality of the freshwater ecosystems;
- Changes to the freshwater geomorphological processes and sedimentation; and
- Impacts on the freshwater ecosystems leading to the loss of biota.

Various activities and development aspects may lead to these impacts, however, these impacts can be adequately minimized or avoided provided the mitigation measures provided in this report are implemented and adhered to. The following tables serve to summarise the findings of the assessment undertaken with reference to the perceived impacts stemming from the current layout of the proposed Mogalakwena Solar PV.

IMPACT 1: LOSS OF WETLAND HABITAT AND ECOLOGICAL INTEGRITY

Table 12: Activities register leading to the loss of wetland habitat.

Construction	Operation and Maintenance
Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing).	Operation of the PV facility and associated PV infrastructure.
Removal of vegetation within the development footprint and associated disturbances to soil, and access to the site.	Potential maintenance of the PV facility and associated PV infrastructure.
Earth works involving removal of topsoil and creation of soil stockpiles	Potentially ineffective rehabilitation which may lead to disturbed landscapes vulnerable to erosion.

Construction	Operation and Maintenance
Altered runoff patterns, leading to increased erosion and sedimentation of the episodic drainage line.	-

Table 13: Aspects of the loss of wetland habitat.

Construction	Operation and Maintenance
Potential incision and erosion of freshwater ecosystems as a result of the formation of preferential flow paths and artificial areas with concentrated flow.	Potential incision and erosion of freshwater ecosystems as a result of the formation of preferential flow paths and artificial areas with concentrated flow.
Increased sediment loads reporting to the freshwater ecosystems from disturbed areas.	Increased soil erosion as a result of desiccated freshwater environments.

IMPACT 2: MODIFICATION OF WETLAND HYDROLOGICAL FUNCTION

Table 14: Activities register leading to impact on hydrology and water quality.

Construction	Operation and Maintenance
Site preparation (vegetation clearing) prior to construction activities	Operation of the PV facility and associated PV infrastructure.
Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing);	Potential maintenance of the PV facility and associated PV infrastructure.
Construction of the proposed substations and associated support tower infrastructure.	-
Stockpiling of removed soil and vegetation;	-

Table 15: Aspects of modification of wetland hydrological function and water quality.

Construction	Operation and Maintenance
Potential smothering of freshwater habitat from stockpiled sediment and vegetation and increased potential for AIP proliferation resulting in decreased habitat for biota.	Disturbance to soil and ongoing erosion as a result of periodic maintenance activities.
Loss of wetland hydrological connectivity due to groundwater clearing.	Altered water quality (if surface water is present) as a result of increased availability of pollutants.
-	Increase in runoff which will result in changes if pattern of flows and timing of water in the landscape especially during rainfall events.

IMPACT 3: CHANGES TO THE WETLAND GEOMORPHOLOGICAL PROCESSES (SEDIMENT BALANCE, EROSION AND SEDIMENTATION)

Table 16: Activities register leading to changes to the wetlands geomorphological processes and sedimentation.

Construction	Operation and Maintenance
Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing);	Operation of the PV facility and associated PV infrastructure.
Removal of vegetation within the development footprint and associated disturbances to soil, and access to the site.	Potential maintenance of the PV facility and associated PV infrastructure.
Earth works involving removal of topsoil and creation of soil stockpiles	Ineffective small-scale rehabilitation which may lead to disturbed landscapes vulnerable to erosion.
Altered runoff patterns, leading to increased erosion and sedimentation of the episodic drainage line.	-

Table 17: Aspects of changes to the wetland geomorphological processes.

Construction	Operation and Maintenance
Potential incision and erosion of freshwater environment as a result of the formation of preferential flow paths and artificial areas with concentrated flow.	Potential incision and erosion of wetlands as a result of the formation of preferential flow paths and artificial areas with concentrated flow.
Increased sediment loads reporting to freshwater areas from disturbed areas.	Increased soil erosion as a result of desiccated freshwater areas.

IMPACT 4: IMPACT ON WETLAND BIOTA

Table 18: Activities register leading to the loss of wetland biota.

Construction	Operation and Maintenance
Physical disturbance including trampling, ploughing and tilling of soil (heavy machinery and manual clearing);	Operation of the PV facility and associated PV infrastructure.
Removal of vegetation within the development footprint and associated disturbances to soil, and access to the site.	Potential maintenance of the PV facility and associated PV infrastructure.
Earth works involving removal of topsoil and creation of soil stockpiles	Potentially ineffective rehabilitation which may lead to disturbed landscapes vulnerable to erosion.

Table 19: Aspects of the loss of wetland habitat.

Construction	Operation and Maintenance
Loss of indigenous and sensitive freshwater vegetation.	Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment.
Potential loss of recharge affecting freshwater vegetation with a specific requirement of wetland recharge.	Potential incision and erosion of freshwater areas as a result of the formation of preferential flow paths and artificial areas with concentrated flow.
Earthworks in the vicinity of wetland and riparian areas leading to disturbance of habitat.	Increased soil erosion as a result of desiccated freshwater environments.

Table 20: Summary of the impact assessment conducted for the proposed Mogalakwena PV infrastructure.

Ref:	Project phase	Impact	Without mitigation						With mitigation					
			Nature	Duration	Extent	Intensity	Probability	Significance	Nature	Duration	Extent	Intensity	Probability	Significance
1	Construction	Removal of vegetation within the development footprint and associated disturbances to soil resulting in loss of freshwater habitat.	Negative	Short term	Local	Moderate	Certain / definite	Minor - Negative	Negative	Brief	Limited	Low	Unlikely	Negligible - negative
2	Construction	Potential Modification of hydrological function and water quality of the freshwater ecosystems	Negative	Short term	Local	Moderate	Certain / definite	Minor - Negative	Negative	Short term	Limited	Very low	Unlikely	Negligible - negative
3	Construction	Changes to the freshwater geomorphological processes and sedimentation	Negative	Short term	Local	Moderate	Certain / definite	Minor - Negative	Negative	Brief	Limited	Very low	Unlikely	Negligible - negative
4	Construction	Impacts on the freshwater ecosystems leading to the loss of biota.	Negative	Short term	Local	Moderate	Certain / definite	Minor - Negative	Negative	Brief	Very limited	Negligible	Rare / improbable	Negligible - negative
5	Operation	Removal of vegetation within the development footprint and associated disturbances to soil resulting in loss of freshwater habitat.	Negative	Brief	Limited	Very low	Rare / improbable	Negligible - negative	Negative	Immediate	Very limited	Negligible	Highly unlikely / none	Negligible - negative
6	Operation	Modification of hydrological function and water quality of the freshwater ecosystems	Negative	Short term	Limited	Very low	Rare / improbable	Negligible - negative	Negative	Short term	Very limited	Negligible	Highly unlikely / none	Negligible - negative
7	Operation	Changes to the freshwater geomorphological processes and sedimentation	Negative	Brief	Limited	Negligible	Rare / improbable	Negligible - negative	Negative	Brief	Very limited	Negligible	Highly unlikely / none	Negligible - negative
8	Operation	Impacts on the freshwater ecosystems leading to the loss of biota.	Negative	Brief	Limited	Very low	Certain / definite	Minor - negative	Negative	Immediate	Very limited	Very low	Highly unlikely / none	Negligible - negative

Based on the outcome of the impact assessment, most of the activities associated with the construction and operation of the proposed Mogalakwena PV infrastructure, without mitigations pose a low to medium risk significance to the integrity of the identified freshwater ecosystems which include the Seep wetland, Groot-Sandsloot and EDL's identified to be associated with the proposed Mogalakwena PV infrastructure.

Following the mitigation hierarchy as advocated by the Department of Environmental Affairs (DEA) *et al* (2013), i.e. the impacts would first be avoided, minimised if avoidance is not feasible. The layout has been optimised to avoid the freshwater systems, as such reducing any potential direct impacts to the freshwater ecosystems.

In terms of the layout of the solar PV in relation to the floodlines of the Groot-Sandsloot River, according to the hydrological report (SMEC 2022), the modelling results showed that the solar PV plant is positioned well clear of the floodlines and that there is no flood risk. This is not only important for the ecological functioning of the system but also more important for the protection of the infrastructure. Additional important mitigation measures which must be considered as part of the project and particularly the in the design of the Stormwater Management Plan include the following:

- The construction activities nearest to the freshwater ecosystems must be undertaken during the drier winter months when surface flow is absent to very low within the freshwater ecosystems, this will ensure that impacts to the hydrological and geomorphological regime, and surface water quality of the are potentially reduced to low. Should it be necessary to conduct construction activities throughout the year, it must be ensured that all stormwater management controls be implemented prior to the commencement of the activities;
- It must be ensured that no channels and no outlets associated with the stormwater plan are located within the delineated boundary of the freshwater ecosystems. Authorisation must be obtained from the relevant authorities for stormwater infrastructure proposed within the 32 m boundary of the freshwater systems;
- At the proposed discharge points, it must be ensured that energy dissipating structures and structures encouraging diffused flows are included to reduce the overall risk of erosion, especially given the nature of the soils in the Mogalakwena area;
- In the design of the stormwater management plan, it must be ensured that no concrete is used, and the channels must be natural and well vegetated. According to a study on the assessment of hydrologic impacts of solar panels, it was stated that addition of solar panels over a grassy field does not have much of an effect on the volume of

runoff, the peak discharge, nor the time to peak while gravel and pavement increased runoff volume significantly Cook and McCuen (2013). Given these findings it must be ensured that as much indigenous vegetation is used as part of the stormwater management plan to mitigate for any potential changes in runoff volume within the development footprint; and

- In addition, consideration for additional stormwater outlets must be done, particularly where volume released from a single outlet has the potential to increase the risk of soil erosion to the freshwater ecosystems.

Additional “good practice” mitigation measures applicable to a project of this nature are provided in Appendix D of this report.

8.2 Cumulative Impacts

Cumulative impacts are activities and their associated impacts on the past, present and foreseeable future, both spatially and temporally, considered together with the impacts identified in Section 5.1 above. Freshwater ecosystems within the region are under continued threat due to growing mining intensification in the surrounding landscape along with the impacts of population growth.

Direct and indirect impacts identified on freshwater ecosystems include an increase mining activity, expansion of communal areas (linked to increased livestock grazing) which have resulted in proliferation of alien and invasive species in the area due to regular disturbance of soil and removal of indigenous vegetation. Anticipated cumulative impacts associated with the project include increase in runoff which will result in changes if pattern of flows and timing of water in the landscape especially during rainfall events. As such, it is recommended that stormwater generated within the proposed Mogalakwena PV facility and associated infrastructure (substations) must be suitably managed according to a site-specific stormwater management plan. No water may be directly released from the proposed PV facility into the surrounding freshwater ecosystems but must rather be suitably managed and released diffusely into the landscape. As far as possible engineering techniques should be used to achieve this.

9 CONCLUSION

During the field assessment, no freshwater ecosystems were identified within the project boundary, however various freshwater ecosystems were identified within the investigation

area and assessed as part of the study. These were identified as follows. These were identified as follows:

- The Groot-Sandsloot River is located along the southern edge of the investigation area;
- A single seep wetland located east of the N11 highway within the investigation area; and
- Various ephemeral drainage lines (EDLs) associated with the Groot-Sandsloot River are located within the investigation area.

The results of the ecological assessment is summarised in Table 21 below.

Table 21: Summary of results of the field assessment as discussed in Section 4.

Freshwater Ecosystem	Present Ecological State (PES) / Ecostatus	Ecoservices	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Category / Recommended Management Objective / Best Attainable State
Groot-Sandsloot River	Category C (Moderately Modified)	Intermediate	Moderate	REC Category: C/D BAS Category: C RMO: Maintain
Ephemeral Drainage Lines	Category C (Moderately Modified)	Intermediate	Moderate	REC Category: C BAS Category: C RMO: Maintain
Seep Wetland	Category C (Moderately Modified)	Intermediate	Moderate	REC Category: C BAS Category: C RMO: Maintain
Extent of modification	**Low** The assessed freshwater ecosystems (Seep wetland, Groot-Sandsloot and EDLs) will not directly be traversed by the proposed Mogalakwena PV infrastructure. The layout has been optimised to avoid the freshwater systems, as such reducing any potential impacts to these systems, therefore the extent of modification is considered low. In terms of the layout of the solar PV in relation to the floodlines of the Groot-Sandsloot River, according to the hydrological report (SMEC 2022), the modelling results showed that the solar PV plant is positioned well clear of the floodlines and that there is no flood risk to the infrastructure.			

A stormwater management plan was designed to ensure that requirements from the relevant authorities are met, and these include specifically, designing a stormwater management plan to prevent off-site migration of contaminated stormwater/increased soil erosion, ensuring implementation of the appropriate design measures to allow surface and subsurface movement of water along drainage lines, to not impede natural surface and subsurface flows. Important mitigation measures which must be considered as part of the design of the stormwater management plan include the following:

- It must be ensured that no channels and no outlets associated with the stormwater plan are located within the delineated boundary of the freshwater ecosystems.

Authorisation must be obtained from the relevant authorities for stormwater infrastructure proposed within the 32 m boundary of the freshwater systems;

- At the proposed discharge points, it must be ensured that energy dissipating structures and structures encouraging diffused flows are included to reduce the overall risk of erosion, especially given the nature of the soils in the Mogalakwena area;
- In the design of the stormwater management plan, it must be ensured that no concrete is used, and the channels must be natural and well vegetated. According to a study on the assessment of hydrologic impacts of solar panels, it was stated that addition of solar panels over a grassy field does not have much of an effect on the volume of runoff, the peak discharge, nor the time to peak while gravel and pavement increased runoff volume significantly (Cook and McCuen 2013). Given these findings it must be ensured that as much indigenous vegetation is used as part of the stormwater management plan to mitigate for any potential changes in runoff volume within the proposed development footprint; and
- In addition, consideration for additional stormwater outlets must be done, particularly where volume released from a single outlet has the potential to increase the risk of soil erosion to the freshwater ecosystems.

Provided that site-specific mitigation measures are implemented during all phases of the project, with specific mention of ensuring that the construction activities for the proposed solar PV avoid indirect impacts on the freshwater ecosystems, and that inspections of all stormwater infrastructure are done routinely as recommended in the hydrological report (SMEC 2022) during the operational phase of the solar PV, the risk significance can be considered a limited.

Given that the current layout which was optimised significantly to avoid traversing or encroaching into these freshwater ecosystems, the overall impact significance for the seep wetland, Groot-Sandsloot River and the EDLs was assessed to be between ‘Minor – Negative’ to ‘Negligible – Negative’ with recommended mitigations applied. It is the opinion of the specialist that the proposed Mogalakwena solar PV infrastructure poses a low-risk significance to the ecological integrity of the identified freshwater ecosystems, and with adherence to the suggested mitigation measures the project can be considered.

REFERENCES

Department of Water Affairs and Forestry (DWAF). 2008. *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas,* prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. X. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2005. *Final draft: A practical field procedure for identification and delineation of wetlands and Riparian areas.*

Department of Water and Sanitation (DWS). 2014. *A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: C2 Compiled by RQIS-RDM: Online available: https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx*

Kleynhans C.J., Thirion C. and Moolman J. 2005. *A Level 1 Ecoregion Classification System for South Africa, Lesotho and Swaziland.* Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria

Kleynhans C.J., Thirion C., Moolman J, Gaulana L. 2007. *A Level II River Ecoregion Classification System for South Africa, Lesotho and Swaziland.* Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria

Kotze D.C., Marneweck G.C., Batchelor, A.L., Lindley D.S. and Collins N.B. 2009*. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands.* WRC Report No TT 339/08, Water Research Commission, Pretoria.

National Environmental Management Act (NEMA) 107 of 1998

National Water Act (NWA) 36 of 1998.

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D., Koopman V., Goodman P. and Goge C. 2008. *WET-Health: A technique for rapidly assessing wetland health.* WRC Report No. TT 340/08. Water Research Commission, Pretoria.

Nel, JL, Driver, A., Strydom W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J, Nienaber, S., Van Deventer, H., Swartz, E. & Smith-Adao, L.B. 2011. *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources.* Water Research Commission Report No. TT 500/11, Water Research Commission, Pretoria.

NFEPA: Driver, A., Nel, J.L., Snaddon, K., Murruy, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J. and Funke, N. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Water Research Commission. Report No. 1801/1/11. Online available: http://bgis.sanbi.org/nfepa/project.asp

Ollis, D.J., Snaddon, C.D., Job, N.M. & Mbona, N. 2013. *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems.* SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Rossouw, L., Avenant, M. F., Seaman, M. T., King, J. m., Barker, C. H., du Preez, P. J., Pelser, A. J., Roos, J. C., van Staden, J. J., van Tonder, G. J., and Watson, M. 2005. *Environmental Water Requirements in Non-Perennial Systems.* WRC Report 1414/1/05. Water Research Commission. Pretoria.

Rountree, M.W. and Kotze, D.C. 2013. Appendix A3: Ecological Importance and Sensitivity Assessment. In: Rountree, M. W., Malan, H.L., and Weston, B.C. Eds. *Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0)*. WRC Report No. 1788/1/12. Pretoria. STS 210042.

Scientific Aquatic Services. 2021. Freshwater Ecosystem and Aquatic Ecological Assessment As Part of the Environmental Authorisation Process For The Proposed Solar Photovoltaic (PV) Plant Associated With The Anglo-Mogalakwena Mine Near Mokopane, Limpopo Province. Report Reference: SAS 202186

Scientific Terrestrial Services. 2021. Terrestrial Biodiversity Assessment As Part of the Environmental Authorisation Process for the Proposed PV Solar Plant Near Mokopane as Part The Environmental Assessment Phase, Limpopo Province. Report Reference: STS 210042.

SMEC South Africa. Design report: Mogalakwena PV Hydrological Study. Prepared for EDF Renewables. 06 May 2022.

Van Deventer, H.; Smith-Adao, L.; Mbona, N.; Petersen, C.; Skowno, A.; Collins, N.B.; Grenfell, M.; Job, N.; Lötter, M.; Ollis, D.; Scherman, P.; Sieben, E.; Snaddon, K. 2018. *South African Inventory of Inland Aquatic Ecosystems. South African National Biodiversity Institute, Pretoria. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847*.

Van Deventer, H., Smith-Adao, L., Collins, N.B., Grenfell, M., Grundling, A., Grundling, P-L., Impson, D., Job, N., Lötter, M., Ollis, D., Petersen, C., Scherman, P., Sieben, E., Snaddon, K., Tererai, F. & Van der Colff, D. 2019. *South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria.* http://hdl.handle.net/20.500.12143/6230.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. *2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 November 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number* http://hdl.handle.net/20.500.12143/5847.

APPENDIX A – Terms of Use and Indemnity

INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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APPENDIX B – Legislation

LEGISLATIVE REQUIREMENTS

The Constitution of the Republic of South Africa, 1996	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
National Environmental Management Act (NEMA) (Act No. 107 of 1998)	The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
The National Water Act (NWA) (Act No. 36 of 1998)	The National Water Act (NWA) (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
National Environmental Management: Biodiversity Act (2004) (Act 10 of 2004) (NEMBA)	**Ecosystems that are threatened or in need of protection** (1) (a) The Minister may, by notice in the Gazette, publish a national list of ecosystems that are threatened and in need of protection. *(b)* An MEC for environmental affairs in a province may, by notice in *the Gazette,* publish a provincial list of ecosystems in the province that are threatened and in need of protection. (2) The following categories of ecosystems may be listed in terms of subsection (1): *(a)* critically endangered ecosystems, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation; *(b)* endangered ecosystems, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems; (c) vulnerable ecosystems, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and *(d)* protected ecosystems, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed in terms of paragraphs *(a), (b)* or (c).
Government Notice 598 Alien and Invasive Species Regulations (2014), including the Government Notice 864 Alien Invasive Species List as published in the Government Gazette 40166 of 2016, as it relates	NEMBA is administered by the Department of Environmental Affairs and aims to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA. This act in terms of alien and invasive species aims to: ➢ Prevent the unauthorized introduction and spread of alien and invasive species to ecosystems and habitats where they do not naturally occur, ➢ Manage and control alien and invasive species, to prevent or minimize harm to the environment and biodiversity; and ➢ Eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

to the National Environmental Management Biodiversity Act, 2004 (Act No 10 of 2004)	Alien species are defined, in terms of the NEMBA as: (a) A species that is not an indigenous species; or (b) An indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention. Categories according to NEMBA (Alien and Invasive Species Regulations, 2017): ➢ **Category 1a:** Invasive species that require compulsory control; ➢ **Category 1b:** Invasive species that require control by means of an invasive species management programme; ➢ **Category 2:** Commercially used plants that may be grown in demarcated areas, provided that there is a permit and that steps are taken to prevent their spread; and ➢ **Category 3:** Ornamentally used plants that may no longer be planted.
Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA (Act 36 of 1998)	In accordance with Regulation GN509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: a) The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; b) In the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or c) A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix; iv) Conduct river and stormwater management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.
National Environmental Management: Waste Act, No 59 of 2008 (NEMWA)	NEMWA, which reforms the law regulating waste management in order to protect the health and the environment by providing reasonable measures for the prevention of pollution; provides for national norms and standards for regulating the management of waste by all spheres of government, and provides for the licensing and control of waste management activities.

APPENDIX C – Method of Assessment

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the watercourses present or in close proximity of the project boundary are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 National Freshwater Ecosystem Priority Areas (NFEPA, 2011)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWA, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present in the vicinity of or within the project boundary.

2. Classification System for Wetlands and other Aquatic Ecosystems in South Africa

The watercourses encountered within the project boundary were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013), hereafter referred to as the "Classification System". A summary of Levels 1 to 4 of the classification system are presented in Table C1 and C2, below.

Table C1: Proposed classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table C2: Hydrogeomorphic (HGM) Unit for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
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
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

From the Classification System, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[6] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

[6] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There is a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) group's vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the National Freshwater Ecosystem Priority Areas (NFEPA) project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

Level 3: Landscape Setting

At Level 3 of the Classification System, for Inland Systems, a distinction is made between four Landscape Units (Table C1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System (Table C2), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2009).

3. WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever-changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing to promote their conservation and wise management.

Level of Evaluation
Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Framework for the Assessment
A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

Units of Assessment
Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems above.

Quantification of Present State of a wetland
The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of the impact of individual activities and then separately assessing the *intensity* of the impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores, and Present State categories are provided in the table below.

Table C3: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D

Impact category	Description	Impact score range	Present State category
Serious	The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognisable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been completely modified with an almost complete loss of natural habitat and biota.	8-10	F

Assessing the Anticipated Trajectory of Change
As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (table below).

Table C4: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Overall health of the wetland
Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

4. Watercourse Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[7] The assessment of the ecosystem services supplied by the identified watercourses was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;

[7] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the watercourses. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the watercourses.

Table C5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

5. Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purposed of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,* 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of socio-cultural benefits, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C6) of the wetland system being assessed.

Table C6: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High	>2 and <=3	B

EIS Category	Range of Mean	Recommended Ecological Management Class
Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.		
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

6. Recommended Management Objective (RMO) and Recommended Ecological Category (REC) Determination

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure" (DWA, 1999).

The RMO (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the watercourse (sections above), with the objective of either maintaining, or improving the ecological integrity of the watercourse in order to ensure continued ecological functionality.

Table C7: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

PES			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
	A	Pristine	A Maintain	A Maintain	A Maintain	A Maintain
	B	Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good	A Improve	B/C Improve	C Maintain	C Maintain
	D	Fair	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Poor	D* Improve	E/F* Improve	E/F* Maintain	E/F* Maintain

***PES Categories E and F are considered ecologically unnacceptable (Malan and Day, 2012) and therefore, should a watercourse fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A watercourse may receive the same class for the REC as the PES if the watercourse is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the watercourse.

Table C8: Description of Recommended Ecological Category (REC) classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

7. General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C8 below.

Table C9: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.* 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
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.	0 - 19

8. The Riparian Vegetation Response Assessment Index (VEGRAI)

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results (Kleynhans *et al.*, 2007a). Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Riparian vegetation is described in the National Water Act (NWA; Act 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soil, 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 land areas.

Table C10: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

9. Freshwater ecosystem delineation

The freshwater ecosystem delineation took place according to the method presented in the “Updated manual for the identification and delineation of wetland and riparian resources” published by DWAF in 2008. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

According to the DWA (2005) like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands. The delineation process requires that the following be taken into account:

- topography associated with the watercourse;
- vegetation; and
- alluvial soils and deposited material.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005).

AQUATIC ECOLOGICAL METHOD OF ASSESSMENT

The sections below describe the methodology used to assess the aquatic ecological integrity of the sites selected based on water quality, instream and riparian habitat condition and biological impacts and integrity.

Visual Assessment

Each site was investigated in order to identify visible impacts on the site, with specific reference to impacts from surrounding activities. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system, were identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area; and
- Other life forms reliant on aquatic ecosystems.

Physico Chemical Water Quality Data

On-site testing of biota specific water quality parameters including pH, Electrical Conductivity (EC), dissolved oxygen concentration (DO) and temperature. The results aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF 1996 vol. 7) as well as the Reserve Determination of Water Resources for the Catchments of the Mokolo, Matlabas, Crocodile West and Marico River catchment, Department of Water and Sanitation (DWS 2017). This publication provided updated classes and resource quality objectives of water resources for the Crocodile catchment. Although the guideline water quality values pertain to temporal comparisons, it will also be applied to spatial comparisons for the purpose of this report, as no suitable alternative is currently available.

General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C8 below.

Table C11: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.* 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
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.	0 - 19

Habitat for aquatic macro-invertebrates

The Integrated Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. However, according to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores with regard to the suitability of habitat at sampling sites for aquatic macroinvertebrates (Ollis *et al*., 2006). Furthermore, the performance of the IHAS seems to vary between geomorphologic zones and between biotope groups (Ollis *et al*., 2006). It has, however; become clear that IHAS requires further validation and testing, although the basic data remains of value (Thirion, 2007).

Table C12: IHAS Scores and their corresponding description of overall condition (quality and quantity) of available aquatic macroinvertebrate habitat (McMillan, 1998)

IHAS Score (%)	Description
>75	Excellent
65 – 74	Good
55 – 64	Adequate / Fair
<55	Poor

Aquatic Macro-Invertebrates: South African Scoring System version 5 (SASS5)
Aquatic Macro-invertebrates were sampled using the qualitative kick sampling method called SASS5 (South African Scoring System version 5) (Dickens and Graham, 2002). The SASS5 method has been specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter (1998). The assessment was undertaken according to the protocol as defined by Dickens & Graham (2002). All work was undertaken by an accredited SASS5 practitioner.

The SASS5 method was designed to incorporate all available biotypes at a given site and to provide an indication of the integrity of the of the aquatic macro-invertebrate community through recording the presence of various macro-invertebrate families at each site, as well as consideration of abundance of various populations, community diversity and community sensitivity. Each taxon is allocated a score according to its level of tolerance to river health degradation (Dallas, 1997).

This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net, with a pore size of 1000 micron mounted on a 300 mm square frame, over the churned-up area several times. In stony bottomed flowing water biotopes (rapids, riffles, runs, etc.) the net downstream of the assessor and the area immediately upstream of the net is disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net was also swept under the edge of marginal and aquatic vegetation to cover from 1-2 meters. Identification of the organisms was made to family level (Thirion *et al*., 1995; Davies & Day, 1998; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation, it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score, in conjunction with a low habitat score, can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score, together with a high habitat score, would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

Macro-invertebrate Response Assessment Index (MIRAI)

The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly, habitat preferences and requirements for each taxa present should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result, expected and actual patterns can be evaluated to achieve an Eco status Category rating.

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index has been applied to the sites following methodology described by Thirion (2007).

Aquatic macro-invertebrates expected at each point were derived both from previous studies of rivers near the area as well as habitat, flow and water parameters (Thirion, 2007).

APPENDIX D – Risk Assessment Methodology

CRITERIA	CATEGORY	DESCRIPTION
Project phase	Construction	
	Operation	
	Decommissioning	
Mitigatability	Low	Mitigation does not exist; or mitigation will slightly reduce the significance of impacts
	Medium	Mitigation exists and will notably reduce significance of impacts
	High	Mitigation exists and will considerably reduce the significance of impacts
Nature	Positive	
	Negative	
Duration	Immediate	Impact will self-remedy immediately
	Brief	Impact will not last longer than 1 year
	Short term	impact will last between 1 and 5 years
	Medium term	Impact will last between 5 and 10 years
	Long term	Impact will last between 10 and 15 years
	On-going	Impact will last between 15 and 20 years
	Permanent	Impact may be permanent, or in excess of 20 years
Extent	Very limited	Limited to specific isolated parts of the site
	Limited	Limited to the site and its immediate surroundings
	Local	Extending across the site and to nearby settlements
	Municipal area	Impacts felt at a municipal level
	Regional	Impacts felt at a regional / provincial level
	National	Impacts felt at a national level
	International	Impacts felt at an international level
Intensity	Negligible	Natural and/ or social functions and/ or processes are negligibly altered
	Very low	Natural and/ or social functions and/ or processes are slightly altered
	Low	Natural and/ or social functions and/ or processes are somewhat altered
	Moderate	Natural and/ or social functions and/ or processes are moderately altered
	High	Natural and/ or social functions and/ or processes are notably altered
	Very high	Natural and/ or social functions and/ or processes are majorly altered
	Extremely high	Natural and/ or social functions and/ or processes are severely altered
Probability	Highly unlikely / none	Expected never to happen
	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
	Probable	The impact has occurred here or elsewhere and could therefore occur
	Likely	The impact may occur
	Almost certain / Highly probable	It is most likely that the impact will occur
	Certain / definite	There are sound scientific reasons to expect that the impact will definitely occur
Confidence	Low	Judgement is based on intuition
	Medium	Determination is based on common sense and general knowledge
	High	Substantive supportive data exists to verify the assessment
Reversibility	Low	The affected environment will not be able to recover from the impact - permanently modified
	Medium	The affected environment will only recover from the impact with significant intervention
	High	The affected environmental will be able to recover from the impact
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce
	Medium	The resource is damaged irreparably but is represented elsewhere
	High	The resource is irreparably damaged and is not represented elsewhere
Significance	Negligible	
	Minor	
	Moderate	
	Major	

Significance:	negative	positive
Negligible	Negligible - negative	Negligible - positive
Minor	Minor - negative	Minor - positive
Moderate	Moderate - negative	Moderate - positive
Major	Major - negative	Major - positive

APPENDIX E – Results of Field Investigation

PRESENT ECOLOGICAL STATE (PES) AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table E1: Presentation of the results of the Ecoservices assessment applied to the delineated freshwater ecosystems.

Ecosystem service	Groot Sandsloot	EDL's	Seep Wetland
Flood attenuation	1.9	1.8	1.7
Streamflow regulation	1.4	1.2	1.4
Sediment trapping	2.8	2.4	1.6
Phosphate assimilation	2.4	2.3	1.8
Nitrate assimilation	2.1	2.3	1.8
Toxicant assimilation	2.6	2.4	1.7
Erosion control	2.3	1.6	1.8
Carbon Storage	1.3	1.0	0.3
Biodiversity maintenance	2.2	1.8	1.5
Water Supply	2.5	1.2	0.6
Harvestable resources	1.8	1.4	1.2
Cultivated foods	1.4	1.4	1.2
Cultural value	1.0	1.0	1.0
Tourism and recreation	1.5	0.3	0.1
Education and research	0.3	0.8	0.5
SUM	**27.4**	**22.7**	**18.1**
Average score	**1.8**	**1.5**	**1,2**

Table E2: Presentation of the results of the results of the EIS for the Groot Sandsloot and EDLs.

	EDL	Groot Sandsloot
Ecological Importance and Sensitivity		
Biodiversity support	A (average)	(average)
	0,67	2,00
Presence of Red Data species	0	1
Populations of unique species	1	2
Migration/breeding/feeding sites	1	3
Landscape scale	B (average)	(average)
	1,40	1,80
Protection status of the wetland	0	0
Protection status of the vegetation type	3	3
Regional context of the ecological integrity	2	3
Size and rarity of the wetland type/s present	1	1
Diversity of habitat types	1	2
Sensitivity of the wetland	C (average)	(average)
	1,00	1,67
Sensitivity to changes in floods	2	2
Sensitivity to changes in low flows/dry season	0	1
Sensitivity to changes in water quality	1	2
ECOLOGICAL IMPORTANCE & SENSITIVITY	**(max of A,B or C)**	*(average of A, B or C)*
Fill in highest score:	**B**	**A**

Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.				
Hydro-Functional Importance			Score (0-4)	Score (0-4)
Regulating & supporting benefits	**Flood attenuation**		2	4
	Streamflow regulation		2	4
	Water Quality Enhancement	***Sediment trapping***	2	4
		Phosphate assimilation	2	4
		Nitrate assimilation	2	4
		Toxicant assimilation	2	4
		Erosion control	1	4
	Carbon storage		1	4
HYDRO-FUNCTIONAL IMPORTANCE			2	2
Direct Human Benefits			Score (0-4)	Score (0-4)
Subsistence benefits	***Water for human use***		1	2
	Harvestable resources		1	1
	Cultivated foods		1	4
Cultural benefits	***Cultural heritage***		1	4
	Tourism and recreation		0	4
	Education and research		0	4
DIRECT HUMAN BENEFITS			0,67	1,33

Table E3: Presentation of the results of the VEGRAI applied to the Groot Sandsloot River.

LEVEL 3 ASSESSMENT					
METRIC GROUP	CALCULATED RATING	WEIGHTED RATING	CONFIDENCE	RANK	% WEIGHT
MARGINAL	60,0	37,5	3,0	1,0	100,0
NON MARGINAL	66,7	25,0	0,0	2,0	60,0
	2,0				160,0
LEVEL 3 VEGRAI (%)				62,5	
VEGRAI EC				**C**	
AVERAGE CONFIDENCE				1,5	

Table E4: Presentation of the results of the VEGRAI applied to the EDLs.

LEVEL 3 ASSESSMENT					
METRIC GROUP	CALCULATED RATING	WEIGHTED RATING	CONFIDENCE	RANK	% WEIGHT
MARGINAL	72,6	45,4	2,0	1,0	100,0
NON MARGINAL	69,6	26,1	0,0	2,0	60,0
	2,0				160,0
LEVEL 3 VEGRAI (%)				71,5	
VEGRAI EC				**C**	
AVERAGE CONFIDENCE				1,0	

Table E5: Presentation of the results of the IHI applied to the Groot Sandsloot River.

	MRU
INSTREAM IHI	
Base Flows	0,5
Zero Flows	0,0
Floods	1,0
HYDROLOGY RATING	**0,6**
pH	1,0
Salts	1,0
Nutrients	3,0
Water Temperature	1,0
Water clarity	2,0
Oxygen	4,0
Toxics	4,0
PC RATING	**1,5**
Sediment	2,0
Benthic Growth	2,0
BED RATING	**2,0**
Marginal	2,0
Non-marginal	1,0
BANK RATING	**1,6**
Longitudinal Connectivity	1,5
Lateral Connectivity	1,5
CONNECTIVITY RATING	**1,5**
INSTREAM IHI %	**72,7**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**2,6**

	MRU
RIPARIAN IHI	
Base Flows	0,5
Zero Flows	0,0
Moderate Floods	1,5
Large Floods	1,5
HYDROLOGY RATING	**1,0**
Substrate Exposure (marginal)	2,0
Substrate Exposure (non-marginal)	2,0
Invasive Alien Vegetation (marginal)	2,0
Invasive Alien Vegetation (non-marginal)	2,0
Erosion (marginal)	2,0
Erosion (non-marginal)	2,0
Physico-Chemical (marginal)	2,0
Physico-Chemical (non-marginal)	1,0
Marginal	2,0
Non-marginal	2,0
BANK STRUCTURE RATING	**2,0**
Longitudinal Connectivity	1,5
Lateral Connectivity	1,0
CONNECTIVITY RATING	**1,3**
RIPARIAN IHI %	**69,4**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**2,0**

Table E6: Presentation of the results of the IHI applied to the EDLs.

	MRU
INSTREAM IHI	
Base Flows	
Zero Flows	
Floods	
HYDROLOGY RATING	**#VALUE!**
pH	
Salts	
Nutrients	
Water Temperature	
Water clarity	
Oxygen	
Toxics	
PC RATING	
Sediment	
Benthic Growth	
BED RATING	
Marginal	
Non-marginal	
BANK RATING	
Longitudinal Connectivity	
Lateral Connectivity	
CONNECTIVITY RATING	
INSTREAM IHI %	**100,0**
INSTREAM IHI EC	**A**
INSTREAM CONFIDENCE	**#DIV/0!**

	MRU
RIPARIAN IHI	
Base Flows	0,0
Zero Flows	1,0
Moderate Floods	1,0
Large Floods	1,0
HYDROLOGY RATING	**0,7**
Substrate Exposure (marginal)	2,0
Substrate Exposure (non-marginal)	1,5
Invasive Alien Vegetation (marginal)	0,5
Invasive Alien Vegetation (non-marginal)	1,0
Erosion (marginal)	2,0
Erosion (non-marginal)	1,5
Physico-Chemical (marginal)	1,0
Physico-Chemical (non-marginal)	1,0
Marginal	2,0
Non-marginal	1,5
BANK STRUCTURE RATING	**1,9**
Longitudinal Connectivity	2,5
Lateral Connectivity	1,5
CONNECTIVITY RATING	**2,2**
RIPARIAN IHI %	**68,6**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**2,0**

Table E7: Presentation of the results of the PES of the seep wetland.

HGM Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation		Overall Score
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	
Seep	0,96	100	3,5	-1	1	-1	2,1	-1	2,38
Wetland			C		B		C		C

APPENDIX F – Impact Analysis and Mitigation Measures

General construction management and good housekeeping practices

Latent and general impacts which may affect the freshwater ecosystem ecology and biodiversity, will include any activities which take place in close proximity to the proposed servitude that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the freshwater ecosystem identified in this report:

Development footprint

- All development footprint areas should remain as small as possible and should only encroach into the freshwater ecosystem considered absolutely essential;
- The boundaries of footprint areas, including contractor laydown areas, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes should avoid freshwater ecosystem areas and be restricted to existing roads along the tarred access road which traverses the freshwater ecosystem;
- Appropriate sanitary facilities must be provided for the life of the repair and maintenance phase and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage;
- No fires should be permitted in or near the construction area; and
- Ensuring that an adequate number of waste and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed areas. Whilst not considered severe at this time, the vegetation component within the freshwater ecosystem environment is already transformed. However, alien invasive species are opportunistic, and where disturbances do occur, they will promulgate; therefore, these species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Removal of the alien and weed species encountered within the freshwater ecosystem must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) and Section 28 of the National Environmental Management Act, 1998 (Act No. 107 of 1998); and
- Species specific and area specific eradication recommendations:
    - Footprint areas should be kept as small as possible when removing alien plant species; and
    - No vehicles should be allowed to drive through designated sensitive freshwater ecosystems areas during the eradication of alien and weed species.

Soils

- Sheet runoff from compacted areas should be slowed down by the strategic placement of berms;
- It is considered ideal that activities occur within the current season (low rainfall) to minimise impacts of sedimentation;
- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soils;
- Temporary stockpiling of excavated material from trenches can be retained alongside trenches, as required for backfilling. Any soil to be stockpiled for longer than a month should be moved to a designated stockpile area, as approved by the Environmental Control Officer (ECO);
- All soils compacted during the repair and maintenance phase should be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence should be implemented to prevent erosion and incision.

Rehabilitation

- Construction rubble must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed work area should be removed.

APPENDIX G – Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)
Amanda Mileson	Advanced Diploma: Nature Conservation (UNISA)
Leandra Jonker	MSc Aquatic Health (University of Johannesburg)
Nqobile Lushozi	MSc (Geoinformatics) (Stellenbosch University)

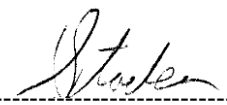
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Physical address:	29 Arterial Road West, Oriel		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	Stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Natural Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health Practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



Signature of the Specialist

I, Amanda Mileson, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

Signature of the Specialist

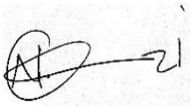
I, Leandra Jonker, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

Signature of the Specialist

I, Nqobile Lushozi, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct.



Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland assessment short course Rhodes University	2016
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013

Short Courses

Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF AMANDA MILESON

PERSONAL DETAILS

Position in Company	Ecologist: Wetland Ecology
Joined SAS Environmental Group of Companies	2013

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Wetland Society (SAWS)
Member of the Gauteng Wetland Forum (GWF)

EDUCATION

Qualifications

N. Dip Nature Conservation (UNISA)	2017
Advanced Diploma: Nature Conservation (UNISA)	2020

Short Courses

Wetland Management: Introduction and Delineation (University of the Free State)	2018
Tools for Wetland Assessment (Rhodes University)	2017
Wetland Rehabilitation (University of the Free State)	2015

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape
Africa – Zimbabwe, Zambia

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater EcoService and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant Species Plan
- Freshwater Offset Plan

Biodiversity Assessments

- Ecological Scan
- Biodiversity Offset Plan

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF LEANDRA JONKER

PERSONAL DETAILS

Position in Company	Aquatic Ecologist
Joined SAS Environmental Group of Companies	2012

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Southern African Society of Aquatic Scientists

EDUCATION

Qualifications

MSc Aquatic Health (University of Johannesburg)	2015
BSc Environmental Management (Hons) (University of South Africa)	2011
BSc Botany and Zoology (North-West University)	2009

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Free State

KEY SPECIALIST DISCIPLINES

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA, IHI & RHAM)
- Aquatic Macro-Invertebrate Community Integrity Assessments (SASS5 & MIRAI)
- Fish Community Integrity Assessments (FRAI)
- Fish Health Assessments
- Diatom Community Assessments
- Riparian Vegetation Integrity Assessments (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Sediment Chemical Analysis
- Riverine Rehabilitation Plans

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF NQOBILE LUSHOZI

PERSONAL DETAILS

Position in Company	Junior Freshwater Ecologist Wetland and Aquatic Ecology
Joined SAS Environmental Group of Companies	April 2019

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the International Affiliation for Impact Assessments (IAIAsa) South Africa
Member of the South African Wetland Society (SAWS)

EDUCATION

Qualifications

MSc Geoinformatics (Cum laude) (Stellenbosch University)	2019
BSc (Hons) Environmental Sciences (University of KwaZulu-Natal)	2015
BSc Environmental Sciences (University of KwaZulu-Natal)	2014

Short courses

Tools for Wetland Assessment (Rhodes University)	2020
Grass Identification Course (Africa Land-Use Training)	2021

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Northern Cape, Free State

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans

Aquatic Ecological Assessment and Water Quality Studies

- Toxicological Analysis
- Surface and groundwater quality Monitoring
- Screening Test
- Mass and salt balance determination