QUANTUM 1 SOLAR ENERGY FACILITY

(PORTION 265 VLAKPLAATS 160-IQ, GAUTENG).

Surface Water Ecosystems Ecological, Delineation and Impact Surveys

Aquatic Biodiversity Compliance Statement

Prepared for:

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DECLARATION

PROJECT:

QUANTUM 1 SOLAR ENERGY FACILITY AND BATTERY ENERGY STORAGE SOLUTION PROJECT (PTN 265 VLAKPLAATS 160-IQ), MOGALE CITY, GAUTENG PROVINCE: SURFACE WATER ECOSYSTEMS ECOLOGICAL REPORT.

CLIENT: SAVANNAH ENVIRONMENTAL (PTY) LTD

This report has been prepared according to the requirements of the Environmental Impact Assessment Regulations (GNR 982) in Government Gazette 38282 of 4 December 2014 (and amended in 2017), Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998, when applying for environmental authorisation (GN 320, published in the Government Gazette no. 43110, 20 March 2020), and DWAF (2008) Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas. We (the undersigned) declare the findings of this report free from influence and/or prejudice.

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DISCLAIMER, ASSUMPTIONS AND LIMITATIONS

The findings of the survey provided within this report, together with the results and general observations, and the conclusions and recommendations provided upon completion of the survey are based on the best scientific and professional knowledge of the field specialists. This is also dependent on the data and resources available at the time. The report is based on survey and assessment techniques that are limited by time and budgetary constraints relevant to the type and level of investigation undertaken as well as the characteristics of the site. These limitations do not affect the outcome of the findings of the survey nor the ratings of the impact significance.

The Client, in accepting the report, acknowledges the limitations outlined above.

ABBREVIATIONS, ACRONYMS AND DEFINITIONS

TERM	EXPLANATION
Development area	The Development Area is that identified area (located within the Project Site) of ~94.1479 ha demarcated within the Affected properties for consideration in the EIA process where the Quantum 1 Solar PV Facility and associated infrastructure is planned to be located.
Development footprint	The development footprint is the defined area (located within the development area) where the PV array and other associated infrastructure for the Quantum 1 Solar PV Facility and associated infrastructure is planned to be constructed. This is the actual footprint of the facility, and the area which would be disturbed and is 19.99 ha.
DFFE	Department of Forestry, Fisheries and the Environment.
DHSWS	Department of Human Settlements, Water and Sanitation.
DWAF	Department of Water and Forestry. An outdated an unofficial name for the present DHSWS but which remains relevant for literature and policy referrals.
DWS	Department of Water and Sanitation. An outdated an unofficial name for the present DHSWS but which remains relevant for literature and policy referrals.
ECO	Environmental Control Officer. A suitably qualified person appointed to oversee the construction procedures to ensure environmental compliance (also sometimes referred to as the Environmental Compliance Officer).
EIA	Environmental Impact Assessment.
Facultative wetland species	Floral species that occur in wetlands or the outer skirts of wetland units where soils are seasonally saturated or waterlogged.
Ferrolysis	A chemical process that occurs within hydromorphic soils associated with wetland conditions where the cyclic precipitation and dissolution of iron (and other minerals) within the soils due to oxidation induced by a seasonally fluctuating water table induces metal nodule formation. This is useful as an indication of wetland conditions.
FRAI	Fish Response Assessment Index
GDARD	Gauteng Department of Agriculture and Rural Development
GIS	Geographic Information System.
GPS	Global Positioning System.
HGM unit	Hydrogeomorphic unit. A referral to the classified type of wetland unit that is dependent on topographical, geomorphological and hydrological characteristics.
Hydromorphic	Refers to soils that show the physical and chemical indications of being waterlogged for a prolonged period within a year (i.e., wetland soils).
Hydrophytic	Floral species specifically adapted to grow within water inundated (saturated) soils or water
Hypoxic	A state of oxygen deprivation.
IHI	Index of Habitat Integrity
I&AP	Interested and Affected Party.
MIRAI	Macro-invertebrate Response Assessment Index
NFEPA	National Freshwater Ecosystem Priority Areas. A national inventory and description of the surface water ecosystem units of South Africa.
PES	Present Ecological State. A term used to describe the overall ecological condition of the ecological feature described
Pioneer species	A floral species that is typically the first to colonize a disturbed area as part of the plant succession process. Characteristically hardy to sustain harsh environmental conditions, it then provides more favourable conditions for other floral species to establish.
Project	Project includes the PV facility and all the associated infrastructures.
Project Site/Area	The Project Site/Area is the area with an extent of approx. 94.1479ha, within which the Quantum 1 Solar PV Facility development footprint will be located.
PV	Photovoltaic.
RAM	Risk Assessment Matrix
SANBI	South African National Biodiversity Institute.
SASS5	South African Scoring System (version 5) for aquatic macro-invertebrates.
SFI	Soil Form Indicator. In confirming wetland conditions, chemical processes within the soil within 500 mm of the surface are identified and utilised to confirm the occurrence of a wetland unit.
SWE	Surface Water Ecosystems.
SWI	Soil Wetness Indicator. In confirming the potential occurrence of a wetland unit, the degree of soil wetness to a depth of 500 mm is used as one of the confirmation indicators of wetland conditions.
TUI	Terrain Unit Indicator. In confirming the potential occurrence of a wetland unit, the terrain (valley bottom, depression, etc.) provides an indication of where topographical features could support wetland conditions and is often the first step to delineating a wetland unit.
VEGRAI	(Riparian) Vegetation Response Assessment Index
VI	Vegetation Indicator. Wetland soils, depending on their period of prolonged saturation, support a particular floral species community structure. Due to facultative adaptation to levels of soil saturation, floral species within wetland soils tend to only occur within particular zones of the wetland (i.e., temporary, seasonal or permanent zones). The identification of the zones and the floral species communities associated with each is a useful tool when delineating the boundaries of a wetland unit.
Wetland-IHI	Wetland Index of Habitat Integrity.

EXECUTIVE SUMMARY

Introduction & Background

A photovoltaic (PV) solar energy facility and associated infrastructure (Quantum 1 Solar Energy Facility) has been proposed for Portion 265 (a portion of portion 19) of the Farm Vlakplaats 160-IQ, located in Tarlton, Gauteng. Enviross was requested to undertake the surface water ecosystems ecological and delineation surveys for the project area and to rate the overall impacts to the ecological features associated with the proposed photovoltaic solar development. This report details the findings of the field survey undertaken during the last week of May 2023.

Methods & Materials

Desktop Survey

Prior to the field survey, the desktop survey was undertaken to gather relevant ecological processes data for the survey area. Sources included available online data, Geographic Information Systems (GIS) databases, aerial imagery, and topographical maps. Biodiversity data was sourced from available online sources, as well as publications, field guides, and the databases developed by Enviross from field surveys undertaken within the vicinity.

Field Survey

Wetland delineations were undertaken according to methods outlined in the Department of Water Affairs and Forestry (DWAF) *Updated Manual* for *the Identification and Delineation of Wetlands and Riparian Areas, 2008*. These guidelines make use of four indicators of wetland habitats that enable the identification of a wetland. This does not necessarily mean that all four indicators are utilised, but rather that there are four indicators available to be utilised. Aspects such as severely degraded vegetation structures often lead to this indicator not being utilised. In this case, more emphasis is then placed on the other indicators. The four available indicators commonly used are:

- Terrain Unit Indicators (TUI)
- Soil Wetness Indicators (SWI)
- Soil Form Indicators (SFI)
- Vegetation Unit Indicators (VUI)

Consultation of various available mapping (1:50,000 topographical maps, databases), aerial photographs and catchment reviews formed part of reiterative data collection for the survey. The field survey concentrated on identifying the various wetland indicators by making use of samples taken with a soil auger, the digging of inspection pits, wetland floral species identification and the confirmation of topographical features that would support wetland formation and the observations of any saturated soils and surface water.

The outer edges of the temporary zones of the wetlands were then identified and mapped using a handheld GPS unit. These data sets were then transformed into GIS shapefiles that can be incorporated into the construction and layout plans of the proposed development activities.

Wetland ecological integrity was assessed by making use of the Wetland Index of Habitat Integrity (WETLAND-IHI) (DWAF, 2007) as well as the Wetland EcoServices (Kotze, *et al.,* 2007) models. The DWS Risk Assessment Matrix was also applied to the wetlands according to the layout plan that was proposed by the Proponent.

Aquatic ecological surveys were undertaken to evaluate the watercourse as an aquatic habitat unit to supplement the ecological data. The aquatic macro-invertebrate community integrity was undertaken using the standard and DWS-endorsed SASS5 protocols (Dickens & Graham, 2002) (Appendix C). The fish community structure ecological integrity was surveyed using a battery pack electrofishing device throughout the length of the watercourse associated with the project area. The overall poor biological results did not justify the application of the full EcoStatus protocols and therefore the data thus gained was regarded as supplementary. *In situ* water quality parameters were taken at the time of the survey using a handheld multiparameter water quality meter.

Impact significance ratings were then applied to pertinent ecological features that are then a function of evaluating the expected impacts associated with a development of this nature and how that would be expected to impact the habitat units that it is associated

with. Screening of the impacts of existing infrastructure and the identification of current pressures and drivers of ecological change within the local catchment area forms part of this process.

Results & Discussions

The desktop review indicated the land use within the area to be dominated by agriculture (active cultivation) with a growing population due to an expanding informal residential area located near to the project site. There is a wastewater treatment works located upstream of the site that releases processed effluent into the watercourse that runs through the southern section of the site. The survey property is currently being utilised as an active chicken farm enterprise. The wetland unit has suffered varying degrees of transformation and ecological degradation due to both local and catchment pressures and drivers of ecological change.

The Screening Tool Assessment and Site Verification showed that the actual proposed development footprint falls within an area classified as Low ecological sensitivity, with only the watercourse and associated wetland zones that associate with the southern boundary area of the larger property being assigned a Very high ecological sensitivity. The proposed development activities therefore only associate with the area zoned as being of Low ecological sensitivity.

The general Present Ecological State (PES) of the wetland unit associated with the site calculated to represent a D ecological category. The watercourse was also evaluated as an aquatic system, which resulted in an E/F ecological category for the SASS5 survey. Only one individual of an alien fish species was sampled, which then also translates to an E/F category for fish. The *in-situ* water quality results showed that all the parameters tested for remained within acceptable limits excepting for a low oxygen level that could be regarded as unsustainable to supporting a diversity of aquatic biota.

The application of the DWS Risk Assessment Matrix indicated that an overall low risk to the wetland unit is assumed for any activities associated with the proposed development. This is largely due to the infrastructure footprint being located some distance from the wetland area. The impacting features that were identified, however, could be lowered with the implementation of proposed mitigation measures. The overall impact significance of the proposed development activities to surface water ecosystems within the area is insignificant.

Conclusions & Recommendations

Following the field survey of the proposed development area, the following conclusions can be made, and salient recommendations can be proposed to aid in the conservation of the overall ecological integrity of the surface water ecosystems within the region:

- Wetland habitat units were noted to be associated with the proposed development. The units were delineated and are presented, together with the proposed development layout, in Figure 8.
- The wetland unit is classified as a well-developed channelled and valley-bottom unit that is linearly and laterally connected to seep zones and a floodplain-type habitat unit.
- The wetland unit has been subject to varying levels of impacts through historical and present land use, with impoundments, water quality degradation, and exotic vegetation inundation having been identified as the most prominent drivers of ecological change.
- The PES of the wetland unit calculated at 50.1% (D category). The EIS for the unit calculated to 1.8 (C category).
- The watercourse was also assessed as an aquatic habitat unit, which showed an overall E/F ecological rating according to the status of the aquatic macro-invertebrates and fish community structures.
- The impact significance of the potential impacting features to the surface water ecosystems were shown to be low to insignificant due to the distance of the proposed infrastructure from the surface water ecosystem units. All impacts were also shown to be further reduced with the implementation of the proposed mitigation measures.
- Erosion control measures and avoidance of indiscriminate habitat destruction outside of the ultimate construction footprint are regarded as the most pertinent mitigation measures.
- It is recommended that the developer manage the riparian zones of the watercourse for exotic vegetation and the currently unabated dumping of rubble that takes place within that area.
- The overall ecological impact significance of the proposed development activities is expected to be insignificant. Therefore, no justifiable reasons for opposing the development can be offered.

It should be noted that, to conserve the ecological structures within the region, a holistic habitat conservation approach should be adopted. This includes keeping general habitat destruction and construction footprints to an absolute minimum within the terrestrial

habitat as well. Conserving the habitat units will ultimately conserve the species communities that depend on it for survival. This can only be achieved by the efforts of the contractor during the various processes of the construction phase.

It is the opinion of the specialist that the proposed development of the Quantum 1 Solar Energy Facility (in the locality and spatial extent as indicated at the time of the assessment) can be favourably considered for authorisation as the survey results indicated that it would not impose any significant impacts to the surface water ecosystems within the area provided that the recommended mitigation measures are adhered to.

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1. INTRODUCTION

1.1. Background & Project Description

South Africa Mainstream Renewable Power Developments (Pty) Ltd (hereafter referred to as "Mainstream") is proposing the construction and operation of a solar photovoltaic (PV) facility and associated infrastructure on Portion 285 (a portion of portion 19) of the Farm Vlakplaats 160, located approximately 7.2km west of Krugersdorp, within the Mogale City Local Municipality in the West Rand District Municipality in the Gauteng Province. The facility will have a contracted capacity of up to 10MW and will be known as Quantum 1 Solar Energy Facility.

A preferred development area with an extent of ~94.1479ha has been identified by South Africa Mainstream Renewable Power Developments (Pty) Ltd as technically suitable for the development of the Quantum 1 Solar Energy Facility. The facility will comprise the following infrastructure:

- Solar PV array comprising solar modules.
- Mounting System Technology
- Inverters and transformers.
- Low voltage cabling between the PV modules to the inverters.
- Overhead power lines
- Onsite substation, switching substation and laydown areas.
- Battery Energy Storage System (BESS) and associated infrastructure.
- Internal access roads.
- Fence around the project development areas.

A summary of the details and dimensions of the planned infrastructure associated with the project is provided in Table 1.

Table 1: Details of typical infrastructure required for the 10MW Quantum 1 SEF.

Component	Description / Dimensions
District Municipality	West Rand District Municipality
Local Municipality	Mogale City Local Municipality
Ward Number (s)	Ward 30
Nearest town(s)	Krugersdorp (7.2km east)
Farm name(s) and number(s) of properties affected by the PV Facility, incl SG 21 Digit Code (s)	Portion 265 (a portion of portion 19) of the Farm Vlakplaats 160 (T0IQ00000000016000265)
Current zoning	Agriculture
Site Coordinates (centre of development area)	26° 4'8.17"S, 27°38'55.89"E
Total extent of the Affected Properties, also referred to as the project site[1]	~94.1479ha
Total extent of the Development area[2]	~94.1479 ha
Total extent of the Development footprint[3]	19.99Ha
Contracted capacity of the PV facility	10 MW
PV panels	Height: up to 5m from ground level (installed)
Power line capacity	11 kV
Power line servitude width	Up to 18 m

[1] The project site is that identified area within which the development area and development footprint are located. The project site is ~94.1479ha in extent and only consist of one affected property.

[2] The development area is that identified area where the 10MW PV facility is planned to be located. This area has been selected as a practicable option for the facility, considering technical preference and constraints. The development area is ~94.1479ha in extent.

[3] The development footprint is the defined area (located within the development area) where the PV panel array and other associated infrastructure for the Quantum 1 Solar Energy Facility is planned to be constructed. This is the actual footprint of the facility, and the area which would be disturbed. (19.99ha)

Component	Description / Dimensions
Grid connection	To be evacuated from the onsite substation via 11 kV Monopole or lattice structure pylons to the Eskom Tarlton 132/44/11 kV substation located on the same land parcel as the proposed PV facility. This will form part of a separate EA process.
On-site Facility Substation, and O&M buildings	Located within the development area. Approximately 1.5 ha in extent.
Battery Energy Storage System (BESS)	The BESS area will form part of the 1.5 ha allocated for other infrastructure.
Access roads and internal roads	Existing roads will be used as far as possible. There are existing gravel roads that can be utilized for site access (width of up to 6 m). Upgrading of existing roads or new roads may be required.

The Quantum 1 SEF is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to submit a bid in terms of a regulated power purchase procurement process (e.g., REIPPPP) with the aim of evacuating the generated power into the national grid or obtaining a commercial PPA (Power Purchase Agreement). This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP) with the Quantum 1 SEF set to inject up to 10MW (peak AC power) into the national grid.

From a regional perspective, the area within the West Rand District Municipality identified for the project is considered favourable for the development of a commercial PV facility due to the low environmental sensitivity of the identified site, excellent solar resource, and availability of land on which the development can take place. There is also potential for evacuating the power to the national grid via a direct grid connection at the Eskom Tarlton 132/44/11kV substation which is located within the proposed site. The development areais also in proximity to large electricity users which opens opportunities for commercial PPAs (Behind the meter connection Or Wheeling to a 3rd party off-taker).

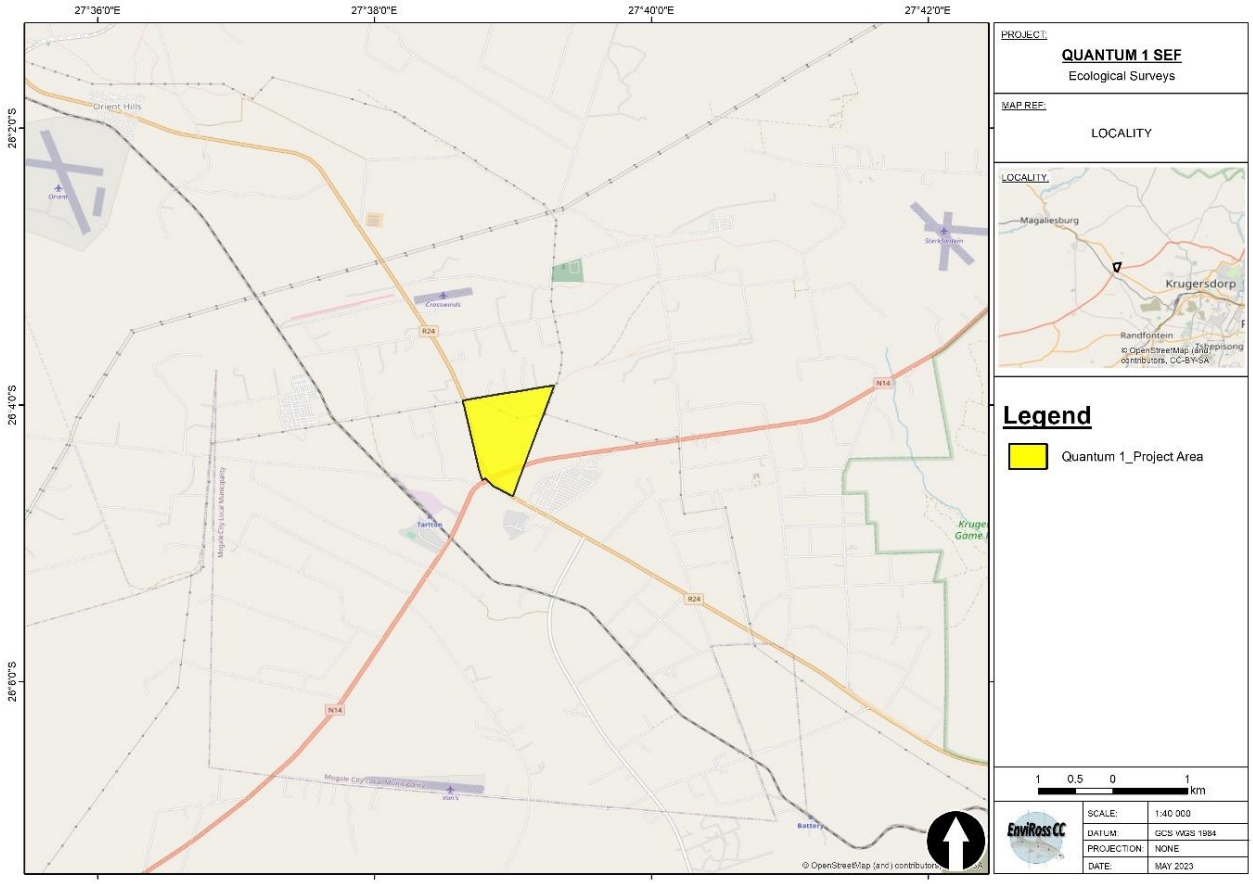


Figure 1: Locality of the survey area.

EnviRoss was commissioned to undertake a surface water ecosystems delineation and ecological functionality survey for the project area. This was done to ascertain the overall ecological value of the habitat units, and to offer mitigation measures to

abate negative ecological impacts emanating from the proposed development activities. The locality of the site is presented in Figure 1. This report details the findings of the surface water ecosystems survey that reflects the findings of the field survey undertaken during the last week of May 2023. Survey was completed within one day. Assessments of this nature are not dependent on seasonality and therefore can be completed at any time during the year.

1.2. Scope of Work

The Scope of Work for the ecological survey encompasses the following aspects:

- Desktop survey, making use of available GIS databases, aerial imagery, and catchment data, to gain an understanding of the regional land use, the pressures and drivers of ecological change, catchment condition and to establish areas of focus,
- Field survey to ground truth the information gathered during the desktop review. This includes accounts of the dominant floral species for the area and the habitat availability and condition to support biodiversity (with emphasis on species of conservational significance and species that would be dependent on surface water habitat units),
- An impact assessment of the proposed development activities through the various phases of the construction and rehabilitation process, and,
- To make recommendations to allow for reduction of the overall ecological impacts emanating from the proposed development.

1.3. Assumptions & Limitations

The following conclusions to the overall perceived impacts have been based on a desktop survey that was reiterated by ground-truthing through a single field survey of the area encompassing the proposed development. Due to this, the species and community structures that are mentioned within the report allude to the assessment of overall ecological health and functionality of the survey area or for the purposes of rating the significance of the ecological impacts and to allow for the objective presentation of the significance of the ecological impacts and the level of practical mitigation. Floral species accounts therefore do not represent a comprehensive account of the species that occur within the scope of the project area.

1.4. Aims & Objectives

The objective of this report is to indicate the present ecological state of the habitat units encompassed within the development impact zones and to highlight the ecologically sensitive and relevant areas to be avoided, if possible, by the proposed development activities. Mitigation measures are provided for abating the overall significance of the impacts associated with the proposed development activities where those impacts are determined to be unavoidable through alternative infrastructure layout planning. This information can then be utilised as supporting documentation for the design and construction teams of the proposed development activities.

1.5. Applicable Legislature

Legislation pertaining to environmental resources, the use and conservation thereof, is regulated by a multitude of inter-disciplinary laws. Only the pertinent laws (Acts) are discussed below.

Conservation of wetland habitat units and resources is protected by a myriad of legislature, including the Constitution of South Africa Act 108 of 1996, which states that everyone has a right to an environment that is not harmful or detrimental to their health and which is sustainable for future generations. Further to this, South Africa uses environmental-specific legal frameworks based on principles found in the National Environmental Management Act 107 of 1998 (NEMA). Section 28 (1) states that any person who causes or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing, or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

The National Water Act 36 of 1998 (NWA), which is the main water regulation statute of South Africa, defines what is meant as a "water use" as activities that require authorisation. Sections most applicable to developments impinging upon or within wetland boundaries are section 21(c) *impeding or diverting the flow of water in a watercourse,* and 21(i) *altering the bed, banks, course, or characteristics of a watercourse*. As per definition, this means any change affecting the resource quality within the riparian habitat or 1:100 year floodline, whichever is the greater distance.

The application of a Risk Assessment Matrix (RAM) pertaining to wetland habitat units has also become mandatory as per Government Gazette 39458, Notice 1180 of 2015 (27 Nov 2015), wherein the severity of the risk to the habitat unit is categorised and rated.

The designation of regulatory conservation buffer zones is also done in accordance with legislature. The extent of the buffer zone, however, is largely determined by the present ecological condition of the habitat unit, the ecological sensitivity of the unit and the impact severity of the development activity. It is largely the industry norm to stipulate a buffer zone of 30 m from the outer limits of the temporary zone of a wetland unit or the riparian zones of a watercourse. Wetland and aquatic habitat that is particularly ecologically sensitive or support species that are regarded as being particularly sensitive to disturbances and/or are of conservational significance often warrants the designation of larger buffer zones.

Under the NWA, a water resource includes a watercourse, surface water, estuary, or aquifer. A *watercourse* is defined as (inter alia):

- a river or spring,
- a natural channel in which water flows regularly or intermittently,
- a wetland, lake, or dam into which, or from which, water flows.

In this context it is important to note that reference to a watercourse includes, where relevant, its bed and banks (to within the 1:100 year floodline or outer limit of the riparian edge or temporary zones of a wetland, whichever is the greatest).

Protection of a water resource, as defined in the NWA entails:

- Maintenance of the quality of the water resource to the extent that the water use may be used in a sustainable way,
- Prevention of degradation of the water resource,
- The rehabilitation of the water resource.

The NEMA is the principal legislation governing Environmental Impact Assessment (EIA), under the authority of the Department of Forestry, Fisheries, and the Environment (DFFE), and is applicable to both water resources and terrestrial habitat units. The NEMA makes provisions for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of the State, and to provide for matters connected therewith. Section 2 of the NEMA establishes a set of principles which apply to the activities of all organs of state that may significantly affect the environment. These include the following:

- Development must be sustainable,
- Pollution must be avoided or minimised and remedied,
- Waste must be avoided or minimised, reused or recycled,
- Negative impacts must be minimised and positively enhanced; and responsibility for the environmental health and safety consequences of a policy, project, product, or service exists throughout its entire life cycle.

The National Environmental Management: Biodiversity Act 10 of 2004 (NEM:BA) (G-26436) operates in conjunction with the National Environmental Management: Protected Areas Act 57 of 2003 (NEM:PA) and amendment No 15 of 2009 (G32404). Both Acts emerge from the recommendations of the White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (1998) and were originally conceived of as one Act.

Within the framework of the NEMA, to provide for:

- The management and conservation of biological diversity within the Republic and of the components of such biological diversity,
- The use of indigenous biological resources in a sustainable manner,

- The fair and equitable sharing among stakeholders of benefits arising from bio-prospecting involving indigenous biological resources,
- To give effect to ratified international agreements relating to biodiversity which are binding on the Republic,
- To provide for co-operative governance in biodiversity management and conservation; and to provide for a South African National Biodiversity Institute (SANBI) to assist in achieving the objectives of the Act.

The NEMBA provides specifically for the issuing of permits. Before issuing a permit, the issuing authority may in writing require the applicant to furnish it, at the applicant's expense, with such independent risk assessment or expert evidence as the issuing authority may determine. Regulations may be made pertaining to various matters regulated by the NEMBA, offences and penalties are provided for, and consultation processes are prescribed. Should Red Data species be directly affected by the proposed project, then the necessary permits will be required to be applied for. A list of the protected species that fall under the auspice of the NEMBA was published within the Government Gazette No 30568, under Government Notice No R 1187 issued on 14 December 2007.

Regulations stipulated by the DFFE require the submission of a report that is generated by the National Environmental Screening Tool in terms of section 24(5)(h) of the NEMA and regulation 16(1)(b)(v) of the EIA regulations, 2014, as amended, forms part of the initial desktop review process. This screening tool assessment stipulates the sensitivity zoning of various ecological (and physical) themes applicable to the site. The level of detail required for each associated ecological specialist assessment is dependent on the level of sensitivity rating that has been zoned for each theme associated with the site. This feature is detailed under sections 2.1.1. and 3.1.

2. MATERIALS & METHODS

2.1. Desktop Review

The purpose of the desktop review process is to provide an overview of the associated ecological processes, the ecological descriptors and habitat units, and the important ecological and conservational features that have been identified at both the national and provincial level that are relevant to the project area. Review of the applicable resources pertaining to ecological aspects of the project area allows for a planned and targeted field survey that then allows for ground truthing of the pertinent areas identified through the desktop review process. A desktop review also very often provides a starting point for the infield wetland delineation process, especially in areas where wetland units tend to be more cryptic due to aspects such as thick vegetation, relatively undeveloped wetland units and other factors, which could lead to wetland units being missed by field consultants at the ground level.

2.1.1. Environmental Screening Tool Assessment

Regulations stipulated by the DFFE require the submission of a report that is generated by the National Environmental Screening Tool in terms of section 24(5)(h) of the NEMA and regulation 16(1)(b)(v) of the EIA regulations, 2014, as amended, forms part of the initial desktop review process. The survey area as well as a 500 m buffer zone was subject to the screening assessment to determine the level of sensitivity for the various themes and therefore provides an indication of the level of detail that is required during the analysis of the various ecological themes associated with the project area. The screening tool is an online resource that is available at https://screening.environment.gov.za/screeningtool.

2.1.2. Literature and Data Sources

Data at the provincial level are provided within the Gauteng Department of Agriculture and Rural Development (GDARD) Conservation Plan version 3.3 (GDARD, 2014) and the accompanying GIS spatial dataset. These data identify those areas of ecological significance from the region that provide varying levels of biodiversity support and therefore require focused attention for the aspects identified to be associated with the project area.

As well-established wetland units typically support unique vegetation units, the identification of the vegetation units and associated characteristics in terms of climatic data, topographical features, general geological and soil characteristics, defining floral species identified as being diagnostic of the vegetation unit, conservation status of the vegetation unit, and other relevant data are considered important. Most of these data were sourced from SANBI (2006), together with the accompanying GIS spatial datasets (updated in 2012) that indicate the extent of the vegetation units at the national level. These datasets are scaled at the national level and therefore, although indicative of the expectations of the wetland units and types associated with a project area, cannot be used as an accurate account of the extent of the wetland units associated with a project area.

The most recent as well as historical aerial imagery from Google Earth ® Pro was utilised to evaluate the project area. Digital 1:50,000 topographical maps and topographical mapping GIS spatial datasets (Chief Directorate Surveys and Mapping, Department of Land Affairs) and GIS datasets from ongoing GIS dataset development within EnviRoss. Spatial resources pertaining to surface water ecosystems were sourced through the National Freshwater Ecosystem Priority Areas (NFEPA) mapping datasets (Nel *et al*, 2011). Again, the spatial references of surface water ecosystem units that are indicated within the NFEPA datasets are mapped at the national level and are indicative of site characteristics expectations rather than accurate accounts of the extent of all surface water units within the project area.

Faunal and floral species identification was supported by various printed field guides, digital field guides and other taxa-specific resources, as well as experience and knowledge of the field consultants undertaking the surveys. The conservation status of relevant species was obtained through www.redlist.sanbi.org, and published red data books and conservation assessments of specific taxa. Species accounts were typically limited to those indicative of, and which would be supported by, surface water ecosystems within the scope of the project area.

2.2. Wetland Delineation Methods

Following on from the desktop review process where a general impression of the project area can be ascertained, a ground-truthing field survey to identify all surface water ecosystem units associated with the project area and to determine the extent of those units is performed. This procedure is undertaken according to the *DWAF Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas* (DWAF, 2008).

According to these guidelines, the wetland delineation procedure considers the following attributes to determine the outer boundaries of each unit:

- Terrain Unit Indicator – helps to identify those parts of the landscape where wetlands are more likely to occur,
- Soil Form Indicator – identifies the hydromorphic soil forms and the chemical processes that are associated with prolonged and frequent saturation and associated anoxia and ferrolysis.
- Soil Wetness Indicator – identifies the morphological "signatures" developed in the soil profile resulting from prolonged and frequent saturation, and,
- Vegetation Indicator – identifies hydrophilic vegetation associated with frequently saturated soils.

> According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps several centuries) (DWAF, 2008).

2.2.1. Terrain Unit Indicator (TUI)

The TUI takes into consideration the topography of the area to determine those areas most likely to support a wetland (DWAF, 2008). These include depressions and channels where water would be most likely to accumulate. This is done with the aid of topographical maps, aerial photographs, and engineering and contour data (if available, these are most often used as they offer the highest degree of detail needed to accurately delineate the valley-bottom and depression features that would be

conducive to supporting wetland features). Seepage zones are also very often characterised by depressions, the identification of which aids in determining the presence of a wetland from a topographical perspective.

2.2.2. Soil Form Indicator (SFI)

The SFI considers the identification of hydromorphic soils that display unique characteristics resulting from prolonged and repeated saturation. This ongoing saturation leads to the soil eventually becoming anaerobic and therefore a change in the chemical characteristics of the soil. Certain soil components, such as iron and manganese, which are insoluble under aerobic conditions, become soluble when the soil becomes anaerobic, and can thus be leached out of the soil profile. Iron is one of the most abundant elements in soils and is responsible for the red and brown colours of many soils. Once most of the iron has been dissolved out of the soil because of the prolonged anaerobic conditions, the soil matrix is left a greyish, greenish, or bluish colour, and is said to be “gleyed”. A fluctuating water table, common in wetlands that are seasonally or temporarily saturated, results in alternation between aerobic and anaerobic conditions in the soil. Aerobic conditions in the soil leads to the iron returning to an insoluble state and being deposited in the form of patches or mottles within the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Thus, soil that is gleyed and has many mottles may be interpreted as indicating a zone that is seasonally or temporarily saturated (DWAF, 2008).

Soil samples are taken periodically in a line running perpendicular to the permanent water zone (or other obvious signs of wetland conditions) until the outer limits of this zone are identified. This normally coincides with a particular contour level, but transformations and modifications to the landscape often lead to the zone limits not conforming to this theory. Soil samples are taken using a Dutch-type soil auger to a depth of 500 mm. The soil sample is then examined for indications of soils particular to the characteristics described above. Sample pits are also dug periodically as a more thorough and therefore more reliable means of confirming the presence or absence of hydromorphic soil characteristics. These get dug using a garden spade and the profiles thus created are examined for hydromorphic processes within the soil.

2.2.3. Soil Wetness Indicator (SWI)

In practise, this indicator is used as the primary indicator, but can be rendered unreliable during heavy rainfall periods. The colour of various soil components is also often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix. Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils, and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils, until they disappear altogether in dry soils (DWAF, 2008). This indicator is also identified by taking a soil sample using a Dutch-type soil auger, or by digging a hole to examine the soil profile to a depth of 500 mm. The soil sample (or vertical profile) is then examined for indications of soils displaying the above-mentioned characteristics.

2.2.4. Vegetation Indicator (VI)

Vegetation is a key component of the wetland definition in the NWA. However, using vegetation as a primary indicator requires undisturbed conditions and expert knowledge (DWAF, 2008). As a result of this, greater emphasis is often placed on the SWI and SFI. Nonetheless, plant community structure analyses are still viewed as helpful guides to finding the boundaries of wetlands. Plant communities undergo distinct changes in species composition along the wetness gradient from the centre of the wetland to the edge, and into adjacent terrestrial areas. This change in species composition provides valuable clues for determining the wetland boundary, and wetness zones. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicator species (DWAF, 2008). In wetlands that have undergone extensive transformation through landscaping, the vegetation unit indicators can potentially be absent.

2.3. Wetland Hydrogeomorphic Forms Associated with the Project Area

Once the wetland units applicable to the project area have been identified and the boundaries of the units delineated, the different units are classified according to their different hydrogeomorphic forms. This was done according to the nomenclature presented in Ollis *et al* (2013).

2.4. Assessing the Present Ecological State (PES) of the wetland habitat units

The survey site falls within an area historically utilised for agriculture, with a commercial and industrial component. More recently, the residential (semiformal and informal) sector is also expanding within the area, creating more intense pressures and drivers of ecological change within the area. These pressures tend to manifest within the surface water habitat units. Evaluating the ecological integrity of the surface water ecosystems very often provides for an indication of the status of the catchment area.

2.4.1. Wetland Index of Habitat Integrity (WETLAND-IHI)

The WETLAND-IHI (Wetland Index of Habitat Integrity) is a wetland habitat assessment tool that was utilised to establish the overall PES of the various wetland habitat units associated with the proposed development area. The WETLAND-IHI was developed as a tool for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI was developed to allow the NAEHMP to include *floodplain and channelled valley bottom wetland types* to be assessed and the monitoring data incorporated into the national monitoring programme (DWA, 2007). The WETLAND-IHI has been applied to each wetland habitat unit associated with the project area and the results of each zone have been presented separately. The output scores of the WETLAND-IHI model are presented in the standard DHSWS A-F ecological categories (Table 2) and provide a score of the Present Ecological State (PES) of the habitat integrity of the wetland system being examined.

Table 2: Description of the A-F ecological categories (after Kleynhans, 1996; 1999) *from DWA, 2007.*

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

The model is composed of four modules (shown in Figure 2). The *Hydrology, Geomorphology* and *Water Quality* modules all assess the contemporary *driving processes* behind the wetland formation and maintenance. The *Vegetation Alteration* module provides an indication of the intensity of human land-use activities on the wetland surface itself and how these have modified the condition of the wetland. The integration of the scores from these four modules provides an overall PES score for the wetland system being examined (DWA, 2007).

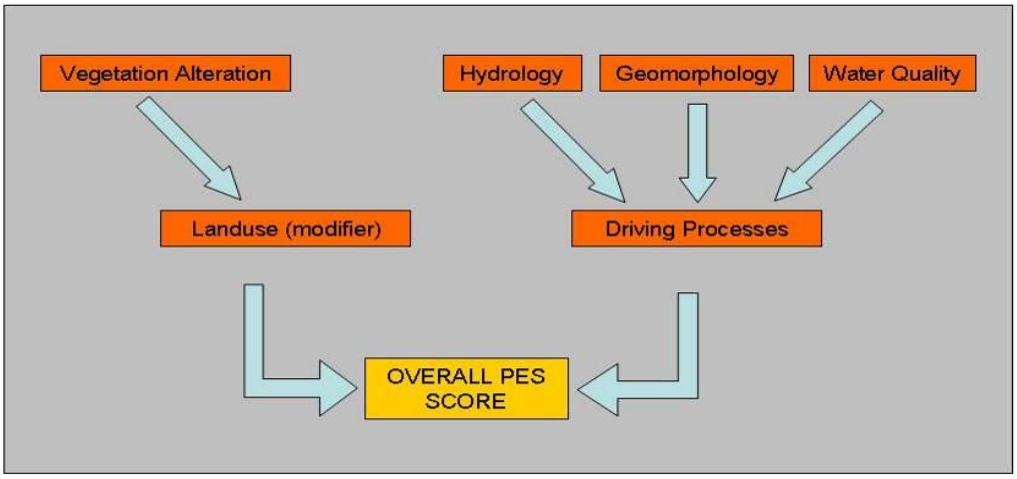


Figure 2: The four modules of the WETLAND-IHI model, and their relationship to the overall PES score, which is derived from them (from DWA, 2007).

Further observations of general ecological integrity at each site during the routine surveys will also be reported on. These points include:

- Erosion trends,
- Degree of siltation at downstream points,
- Unnecessary vegetation removal,
- Other general impacts on the aquatic system (dumping of rubble, litter, etc),
- Impacts of surrounding land use, including encroachment, restriction on the natural movement of water, etc.

2.4.2. WET-Ecoservices

WET-Ecoservices (Kotze *et al*, 2007) was used to assess the goods and services that individual the wetlands within each zone provide. This is taken as a combination of both ecological services and provision of services and resources to users. Through a series of scoring matrices for 15 different goods and service characteristics of a particular wetland, a rating score (out of 4) is provided. This is then compared to the class categories presented in Table 3.

Table 3: Ecological importance and sensitivity categories (*adapted from* WCS, 2007), with an interpretation of the median values and categories.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Ecological 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. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and ≤4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and ≤3	B
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. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and ≤2	C

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Ecological Class
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. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1	D

2.5. DHSWS Risk Assessment Matrix

The DHSWS developed a risk-based analysis matrix (published in Government Gazette 39458, Notice 1180 of 2015, 27 Nov 2015) that stipulates that a Risk Assessment Matrix be applied to water users in terms of the NWA, which then allows for the categorisation of the severity of the ecological risks pertaining to proposed developments associated with wetland habitat units. Based on the outcome of the Risk Assessment Matrix, *Low* risk activities will be generally authorised with conditions, while activities that are rated as *moderate* to *high* risk will be required to go through a Water Use Licence Application (WULA) Process.

Table 4: Ratings of the risk and associated management descriptions used for the DHSWS Risk Assessment Matrix.

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

Water use activities that are authorised in terms of the GA will still need to be registered with the DHSWS. The Risk Assessment Matrix has been used in the assessment of the risk posed to the wetland ecosystems for the proposed development to better quantify the risk to the resource. The categories (and interpretations of the scores) are assigned to the final ratings based on the ratings analysis (Table 4).

The Risk Assessment Matrix was applied as a generic impact rating according to the typical impacts associated with a development of this nature.

2.6. Aquatic Habitat Quality

The watercourse associated with the site has associated wetland features that surround it and provide a supportive function, but the watercourse tends to function as an aquatic habitat feature. Survey methods aimed at determining the ecological integrity of aquatic habitat units were then also applied to the watercourse.

2.6.1. Aquatic macro-invertebrates

The SASS5 protocols (Dickens & Graham, 2002) to ascertain the ecological health of the stream pertaining to the aquatic macro-invertebrates was undertaken. The SASS5 collection protocols are a standardised procedure that requires accreditation from the DWS. These protocols are presented in Appendix C.

2.6.2. Fish community structures

Electrofishing throughout the reach of the stream associated with the site was undertaken as the only fish collection technique, using a SUM 1200V battery backpack electrofisher. This was regarded as adequate for the scale of the stream associated with the site. Overall poor results meant that application of the full aquatic integrity indices was not warrant (i.e., the full EcoStatus models for the various themes).

2.6.3. *In situ* water quality

The water quality parameters tested for *in situ* at the site included pH, electroconductivity (EC), total dissolved solids (TDS), oxygen saturation (%), oxygen content (mg/ℓ), salinity, and temperature, using a Hannah hand-held multiparameter water quality meter (model HI9828). Although not a comprehensive analysis of the water quality within the stream, the parameters tested for aid in the interpretation of the biological results obtained during the survey.

3. RESULTS & DISCUSSIONS

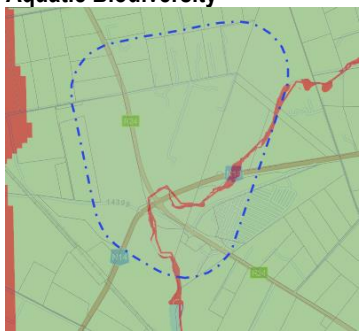
3.1. Environmental Screening Tool Assessment & Site Verification

As part of the desktop review process, regulations stipulated by the DFFE require that a report generated by the national web-based environmental screening tool in terms of section 24(5)(h) of the NEMA and regulation 16(1)(b)(v) of the EIA regulations, 2014, as amended, be submitted. The survey area as well as a 1 km buffer zone was subject to the screening assessment to determine the level of analysis for the site for various themes. All ecological themes associated with this survey are included as there is an interplay between the surface water ecosystems and aspects of the plant and animal themes that are supported by them. The designated sensitivity of each theme and notes associated with each are presented in Table 5.

From the results of the screening tool analysis, the aquatic biodiversity theme pertaining to the site is rated as overall green (*low*). A *very high* rating is allocated to the aquatic and wetland unit that runs along the southern boundary area of the site. The sensitivity rating designated to a site from the Screening Tool analysis dictates the protocols and requirements that are required from the relevant specialist surveys. These requirements and the associated protocols that were followed are presented in Table 5. It should be noted that the specialist assessment provides a ground-truthing of the sensitivity designations and therefore the outcomes of the specialist assessment following on from the field survey do not always correlate to the sensitivity analysis provided by the Screening Tool. A synopsis of whether the ground-truthing assessment agrees within the sensitivity analysis is also indicated in Table 5.

An assessment of the Procedures and Protocols outlined in GN320 indicated that an Aquatic Biodiversity Compliance Statement would suffice as the surface water ecosystems impact assessment. This report is therefore structured to comply with the regulations. A summary of the regulations and the sections pertaining to each of the requirements are presented in Appendix A, Table 11.

Table 5: The results of the DFFE screening tool analysis for the survey area, including a 500 m buffer zone.

Theme	Screening Tool Classification	Required survey protocols (for features relevant to the proposed development site)	Survey Observations and References
Aquatic biodiversity	**Aquatic Biodiversity**  Red (very high sensitivity) Strategic water source area FEPA Quinary catchment Green (low sensitivity)	Green (low) areas: Drafting of a compliance statement that indicates confirmation of the classification of the area and that the proposed development (with mitigation strategies in place) will have a limited impact on the aquatic biodiversity theme, and which will also be rendered insignificant within two years following the completion of the project. Red (very high) areas: Specialist surveys indicating the PES/EIS ratings of the relevant catchment areas. Confirmation of the integration of the interdependent ecological processes and how the proposed development will impact on these processes. Identification of any alternatives for the proposed development that will result in a low impact significance (if applicable). Identification of whether the proposed development will allow for the maintenance of the priority aquatic ecosystems in their current state, and whether the development will allow for maintenance of the resource quality objectives. Identification of how the proposed development will impact on fixed and dynamic processes associated with the habitat units (i.e., changes in flooding regimes, changes to the geomorphological dynamics of the system,	Green (low) areas: The site survey reiterated that these areas were of low sensitivity for aquatic biodiversity due to current land use and the characteristics of the surface water ecosystems. No surface water ecosystems other than the watercourse indicated occur within the scope of the proposed development site. The nature of the proposed development will conform to remaining outside of the conservation buffer zones and will have mitigation measures in place to protect the aquatic habitat. Impact significance is therefore considered to be low. Red (very high) areas: Specialist surveys were undertaken to determine the PES/EIS ratings of the habitat units. The surface water habitat unit was defined as a valley-bottom wetland unit but had enough of an aquatic habitat component to warrant further assessment using the standard aquatic assessment protocols. The habitat unit was delineated according to current guidelines and conservation buffer zones have been indicated. The proponent will conform to the stipulated buffer zones. A proposed infrastructure layout was presented by the Proponent following the initial outcomes of the delineation procedures. The infrastructure footprint will be located within the northern half of the property and will not physically impact on the surface water ecosystem habitat units nor the associated conservation buffer zones. No alternative layouts were therefore presented. The proposed development will not further disrupt any ecological processes than what is already imposed by the existing roadway and other surrounding land uses. The proposed development will allow for maintenance of the priority aquatic ecosystems in their current state and will allow for the maintenance of the resource quality objectives. Mitigation measures include the management of exotic vegetation that currently encroaches within the riparian zones and the controlling of informal dumping that currently takes place within the riparian zones. If undertaken, this will ultimately improve on the ecological functionality of the unit.

3.2. GDARD Conservation Plan

The Gauteng Department of Agriculture and Rural Development (GDARD) developed a conservation plan that outlines a spatial assessment that indicates the conservation significance of areas to both the aquatic and terrestrial features at the provincial level. Pertaining to surface water ecosystems, the spatial dataset provides an indication of the surface water ecosystem habitat units and associated buffer zones that are on record. The plan indicates that a river buffer zone and associated ecological support area (ESA) is applicable to the southern area of the site, which is then continuous with an open grassland zone that runs northwards along the eastern boundary of the site (i.e., terrestrial habitat continuity). An ESA refers to an ecological unit that supports ecological functioning, such as a greenbelt zone that supports migration movement of species, provides green zones and refugia for various species, conservation buffer zones, etc. An ESA is not necessarily a natural area that has retained high ecological integrity, but an area that still performs an ecological function. In this case, the ESA indicates a migratory corridor and a terrestrial conservation buffer zone that is coupled to watercourses throughout the province. The GDARD C-Plan ecological units identified that are associated with the property are presented in (Figure 3). The watercourse and associated wetland zones that occur along the southern boundary areas of the site are justifiably zoned as a CBA. Applicable conservation buffer zones have been designated to this habitat unit that should be adhered to during the layout planning of the proposed development. The proposed development site is underlain by dolomite, which is a geological feature known to be particularly associated with groundwater of good quantity and quality. Development features that pose a potential threat to groundwater quality are generally not supported by authorities. A PV solar facility is not regarded as a development type that would pose a threat to groundwater quality and quantity.

3.3. Catchment Area Descriptions & Characterisations

The survey area falls within the Limpopo (A) Primary catchment and the Crocodile (west) Marico water management area. The project area falls within the A21D quaternary catchment, which is drained toward the northeast by the Rietspruit and later the Bloubankspruit, which is the main watercourse that drains the catchment area to confluence with the Crocodile (west) River in the adjacent quaternary catchment. The Crocodile (west) River continues northwards to confluence with the Marico River. This confluence forms the Limpopo River, which then runs eastwards, forming the international border between South Africa and Zimbabwe. The Limpopo River continues eastwards through Mozambique to drain into the Indian Ocean.

The major watercourses within the region tend to be classified within the PES C (moderately transformed) categories (Nel *et al*, 2011) (Figure 4) but the continued transformation and degradation of habitat within this catchment area has seen a general lowering of the overall PES of watercourses (pers obs). The quaternary catchment of A21D supports a growing population, much of which is regarded as informal, which is placing increased pressure on the surface water resources and the ecological integrity of those resources. The catchment area also includes mining (aged tailings facilities), formal farming (active cultivation mostly for vegetable production) and the watercourse receives all the processed sewerage effluent of the Randfontein Wastewater Treatment Works. Exotic vegetation associated with all the watercourses throughout the catchment area is also particularly problematic.

The sub-quaternary catchment associated with the site (1185) has a catchment PES classification of a D, with *moderate* ecological importance and a *high* ecological sensitivity (DWS, 2014). There are wetland units and a river system within the area.

The dominant vegetation unit associated with the project area is Carletonville Dolomite Grassland, which forms part of the Dry Highveld Grassland bioregion within the Grassland biome. Established wetland units within the region support an azonal freshwater wetlands vegetation type typically found embedded within the Highveld grasslands, namely Eastern Temperate Freshwater Wetlands and Highveld Alluvial Vegetation (riverine/riparian vegetation) of the Freshwater Wetlands biome. Carletonville Dolomite Grassland, as a vegetation unit, is regarded as conservationally *Least Concern* (SANBI, 2022), with the main drivers being identified as transformation of the unit to accommodate urbanisation and the lack of substantial areas representing primary vegetation features within protected areas (SANBI, 2006), whereas Eastern Temperate Freshwater Wetlands vegetation unit is considered to be threatened (SANBI, 2022).

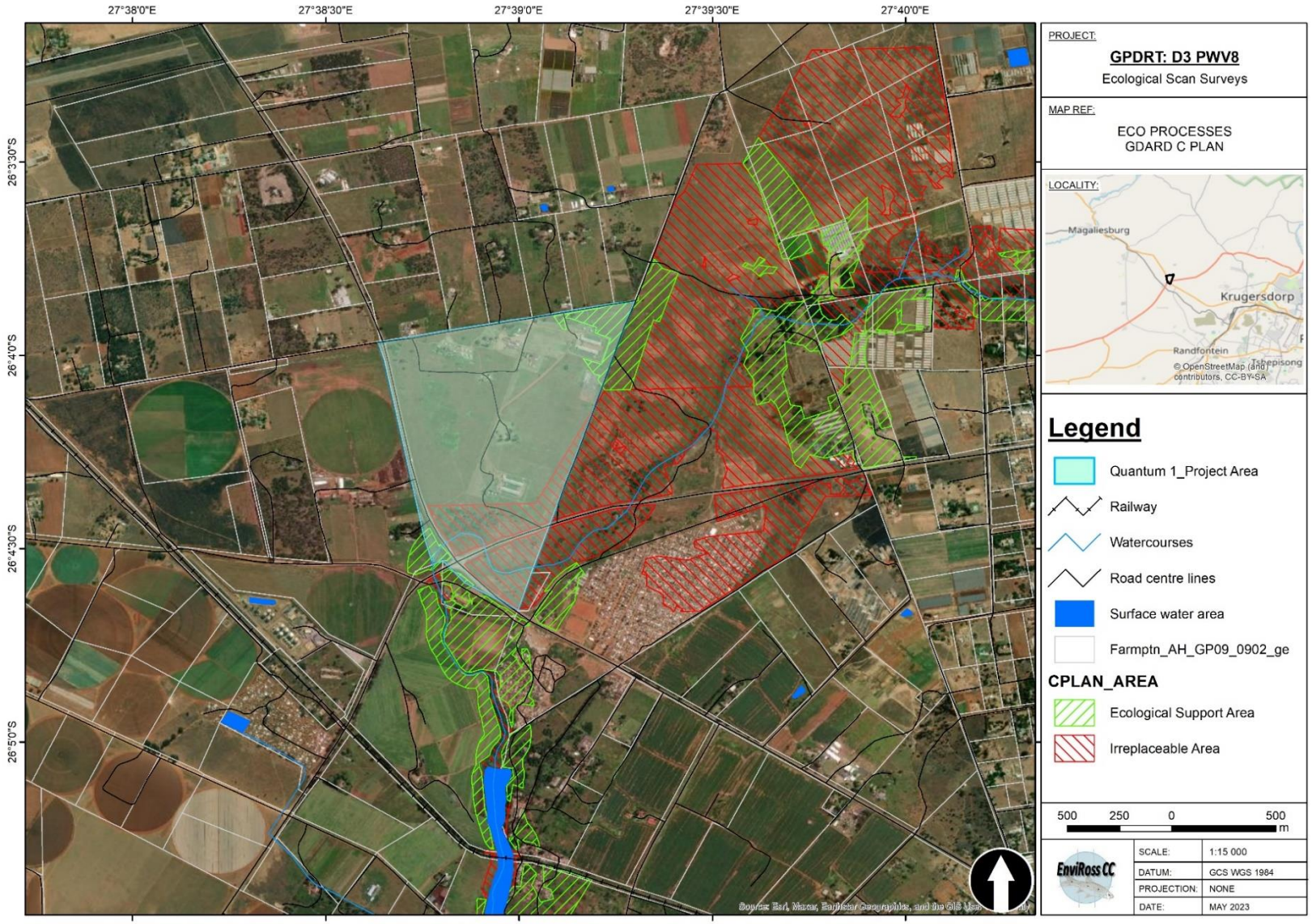


Figure 3: The GDARD C-Plan and details of the local land use applicable to the project area.

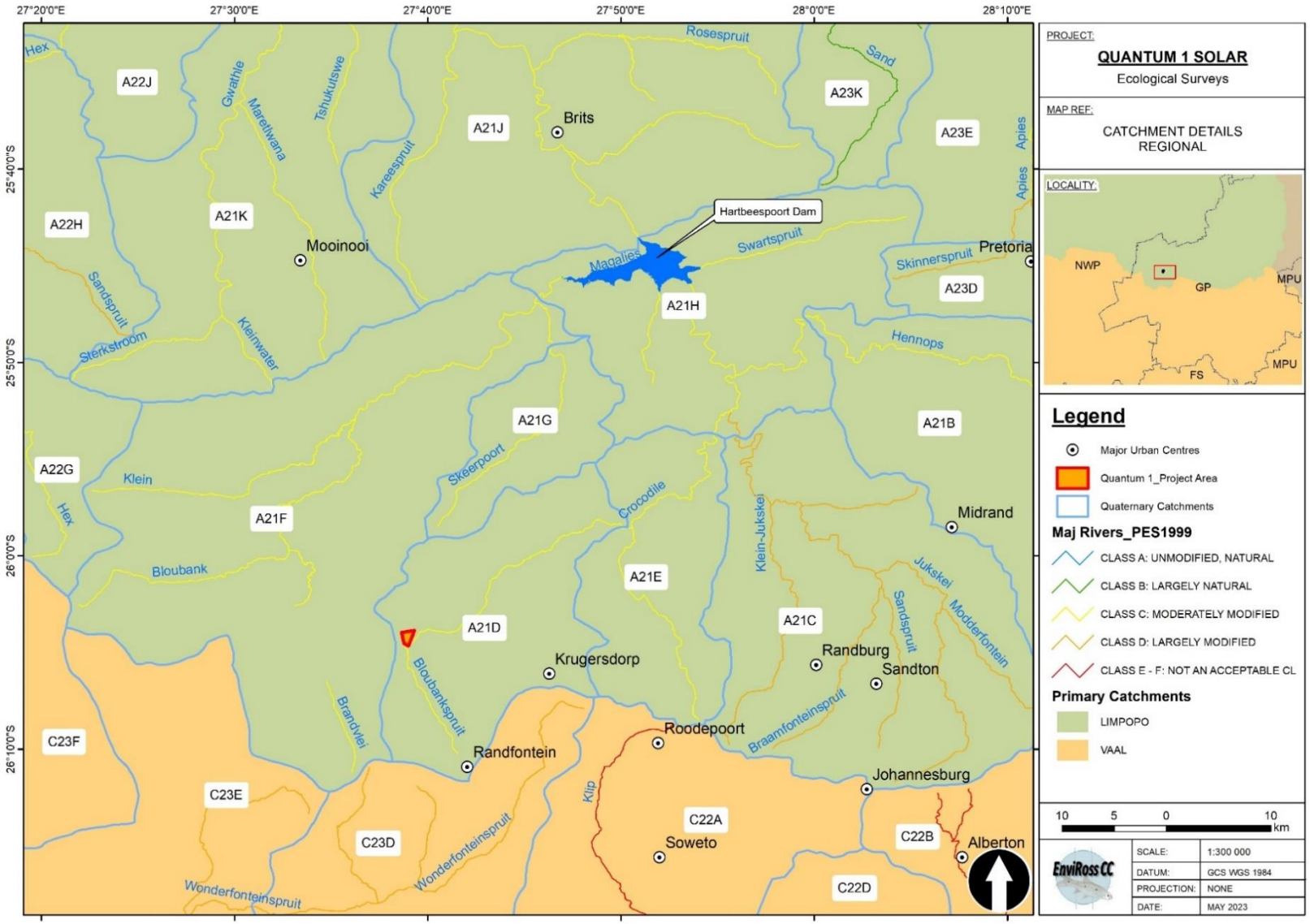


Figure 4: Regional catchment details, showing the major rivers and their relative PES categories within the region.

3.4. Site Description & Characterisation

The project area includes an existing chicken farm, with two chicken houses (rearing facilities). The property also includes administrative buildings, workshop and farming storage facilities, and staff quarters. The existing Tarlton Substation is located on the eastern boundary of the property. Most of the property stretching from the central sections toward the southern area is dominated by grassland. Most of the grassland areas are transformed, with a high inclusion of exotic annual weeds. Natural grassland has a patchy occurrence throughout the property. There is a watercourse (Rietspruit) that enters the property in the southwest corner and exits it again at the southeast corner. Surface water ecosystems associated with the property area are limited to this southern section and are associated with the N14 and R24 roadways – both of which are main arterial routes that carry a high volume of traffic. A cattle feedlot is located immediately upstream of the project site, on the western side of the R24. There is also an informal residential area located to the nearby south and southeast of the site. The project site can be regarded as being ecologically isolated due to the formal tarred roads along the south and western boundaries, gravel roads and ecologically transformed areas to the north, and the formal roads and land use features of the south-eastern areas.

The watercourse would naturally have been a seasonal valley-bottom system with associated hillslope seepage zones. The surrounding roads have induced changes in geomorphic and hydrological functionality of the unit, with the occurrence of a floodplain-type habitat being formed under high baseflow conditions. Unnaturally high and relatively constant baseflow volumes are induced by the water-borne processed effluent from the Randfontein WWTWs. The watercourse is dominated on its northern outer riparian zones by exotic vegetation, which is presumably from soil disturbances induced by the historical farming practices that occurred on the site to the adjacent north. This area is still utilised for informal dumping of rubble, building materials, and some domestic and garden refuse, which is presumably from the residents from the surrounding area that opportunistically utilise this site for that purpose. Besides annual exotic weeds such as *Tagetes minuta*, exotic trees dominate the zone, with *Acacia baileyana*, *Acacia dealbata*, *Acacia decurrens*, *Opuntia ficus-indica* and *Solanum mauritianum* being dominant. Various views of the project area are presented in Figure 5.

The culvert at the R24 road crossing where the watercourse enters the project site.

A general view of the watercourse and wetland features associated with the project site.

The watercourse associated with the site. An upstream view showing the dominance of exotic trees on the left bank.

Besides the generally transformed nature of the vegetation within the wetland areas, it still provided good ground cover.

The floodplain-type wetland unit associated with the watercourse.

The area of the watercourse that provided a positive connection to the floodplain-type area.

The sample zone of the watercourse did provide a diversity of habitat types, making for the expectation of a relatively high level of aquatic biodiversity to be present.

The outer limits of the riparian area are subject to a variety of pressures and drivers of ecological change.

Figure 5: Various views of the project area.

3.5. Delineation of Wetland Units

It is important to note that not all the four wetland indicators will necessarily be present for all wetland units. Disturbance factors and landscaping often lead to the vegetation indicators being largely transformed and unreliable. Landscaping also often diverts surface water flow that often dries certain areas of the wetlands, leading to the loss of the soil wetness indicators. Landscaping may also lead to alteration of the soil profiles. This is particularly true for the project area that has residual impacts associated with the construction of the nearby major roads that required the importing of materials to establish suitable foundations for the roads within the wetland habitat. The combination of all four of the unit indicators should therefore be taken into consideration, as well as a certain degree of "intuitive rationalisation" gained through experience, when assessing the existence and interaction of wetland zones. Soil auguring and digging of sample pits to gain an understanding of the soil processes and wetland forms and functions are utilised as reference points, and then analysis of aerial imagery is used in many cases when analysing wetland drainage and flow patterns, especially for projects that span over a relatively large area.

3.5.1. Terrain Unit Indicator

The TUI (taken from topographical maps, GIS data and visual observations at the site) indicated that the terrain is topographically conducive to supporting wetlands. The natural terrain unit indicator is influenced by historical development and any other activities that alter the natural topographical features of the site – the degree of which is dictated by the type of development (impoundments, earthen embankments, excavations, etc.). The terrain unit has been modified by the historical establishment of the major roads that are closely associated with the survey site. The northern banks of the watercourse have also been modified through historical agricultural activities where the open grasslands to the north seemingly needed to be levelled at one stage, which necessitated the undertaking of earthworks in that area. This was seemingly done within the relatively distant past. The site disturbances may, however, have been the reason for the dominance of exotic vegetation within that area at present. The terrain unit indicator was, however, supported in that the wetland units occurred (and were confined to) a valley bottom within the landscape.

3.5.2. Soil Form Indicator

Soil form indicators pertaining to ferrolytic processes within the soil profiles are an indication of seasonal (cyclic) soil inundation with water. Wet soils therefore do not necessarily indicate wetland conditions as this may just be the result of localised surface water runoff and collection within a low point within the landscape. Areas where wetland-dependent biodiversity is supported by surface water sources (i.e., stormwater runoff) would not necessarily be supported by soil forms induced through ferrolytic processes. The development of indicators of ferrolysis within the soil profiles (i.e., mottling) takes a prolonged period of cyclic levels of inundation to develop and would not occur within areas where supplementation of the water source has occurred only recently.

The established wetland units showed prominent soil form indicators and therefore the SFI was used as one of the primary indicators when delineating the wetland zones within these areas. Figure 6 presents a view of the SFI indicators typical of a seasonal-temporary interface zone. The rust-red colours that indicate ferrolytic processes within the soils can be seen. This is a typical indication of hydromorphic soils that develop due to being periodically and cyclically inundated.

Figure 6: Results of soil profile inspections within the wetland units of the survey area. Soil form indicators were clearly present in association with areas associated with natural wetland units.

3.5.3. Soil Wetness Indicator

The soil wetness indicator was one of the secondary wetland confirmation indicators during the field survey. The wetland unit and watercourse are confined to a valley bottom with a combination of associated side seepage zones and flood terraces. The SWI was expected to be well developed, especially as the watercourse is thought to receive an unnaturally high level of water feeding into it from the upstream-located WWTWs. The watercourse also enters the survey area through a culvert and exits the site again via a culvert beneath the roads. This scenario tends to induce localised flooding, spreading the flow of water across the valley bottom area. The SWI was supported, however, but was not thought to reliably indicate the outer limits of the wetland zones.

3.5.4. Vegetation Indicator

Wetlands tend to be transitional in nature and therefore a gradual transition of soils, inundation and vegetation structures can be observed from the terrestrial areas, temporary, seasonal and into the permanent zones of a unit. The ability to identify and differentiate wetland floral species as being obligate wetland species, facultative wetland species, facultative species and facultative dryland species is important in discerning the occurrence of wetland conditions.

Wetland-dependent (hydrophytic) vegetation has a floral species community structure that is dominated by species specifically adapted to inhabiting soils of varying degrees of waterlogging, and which can flourish in oxygen-poor (hypoxic) soils. Various species are adapted to survive under varying periods of prolonged water saturated soils and therefore form distinct communities. This is largely true for undisturbed floral community structures associated with wetlands. The outer limits of the various wetland zones can therefore very often be determined by the changes in floral community structures. This unit indicator was found to be useful in indicating the outer boundaries of the wetlands, but there were areas where alien vegetation had encroached to within the wetland zones, which then nullified the use of the VI as a viable indicator within these areas. The exotic grass species, namely Kikuyu (*Pennisetum clandestinum*) is a highly invasive and opportunistic species that was common along the banks of the watercourse. This species had displaced much of the natural wetland indicator floral species.

Figure 7: Although a high level of transformation of the vegetation had taken place, vegetation zoning was still supported as an indicator of wetland conditions, with *Imperata cylindrica* indicating a temporary-seasonal zone interface.

Although the vegetation structures were ecologically transformed and much of the riparian vegetation was dominated by exotic species, wetland indicator species were still present, the identification of which allowed for the VI being a viable indicator of wetland conditions. When the wetland vegetation has suffered transformation, it is also rather the growth form and vigour of the individual plants that gets utilised for zonation purposes rather than the identification of the presence of obligate wetland species. In such cases, other indicators were also used to reiterate the extent of the wetland zoning. The dominant floral species that were considered useful in delineating wetland zonation are presented in Table 6.

Table 6: The dominant floral species noted within the wetland zones that were utilised for delineation purposes.

Species	Common name	Zonation indicator
Agrostis lachnantha	Bent grass	Seasonal zone
Andropogon appendiculatus	Vlei bluestem	Seasonal zone
Arudinella nepalensis	River grass	Seasonal zone
Imperata cylindrica	Cotton wool grass	Seasonal zone
Setaria sphacelata	Common bristle grass	Seasonal/temporary zone
Persicaria senegalensis	Snakeroot	Seasonal/permanent zone
Pycreus macranthus	"biessie"	Seasonal zone
Juncus dregeanus	"biessie"	Seasonal zone

3.6. Delineation Mapping

A handheld GPS (Model: *Garmin Montana 680*) was used to mark the outer edges of the various wetland zones. This information was then used together with aerial imagery overlays to generate digital shapefiles and maps of the various wetland zones.

The wetland unit associated with the site was delineated and designated conservation buffer zones extending 30 m from the outer limits of the unit. This is indicated in Figure 8. The applicable digital shapefiles accompany this report.

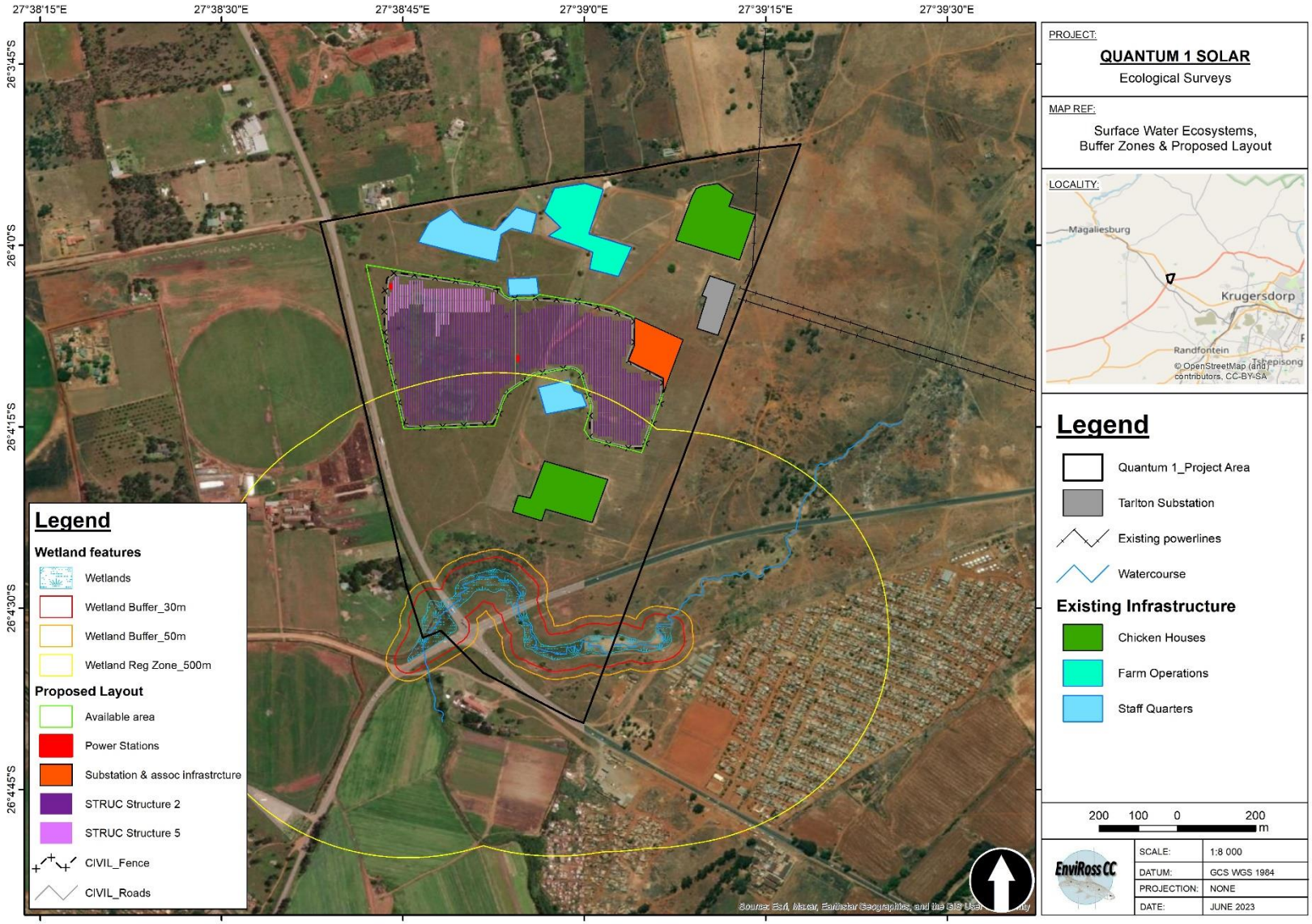


Figure 8: Delineation of all the areas that displayed wetland features associated with the survey property.

3.7. Wetland Hydrogeomorphic Forms Associated with the Project Area

A wetland is defined as land that 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, under normal circumstances, supports or would support vegetation typically adapted to life in saturated soil (NWA). The identification of a wetland therefore requires a combination of factors, including hydrological (water drainage and movement), geomorphological (soil types, characteristics, and inundation) as well as vegetation (identification of hydrophytic species and communities).

The wetland units associated with the project area are dominated by a channelled valley-bottom with associated floodplain and seep zones connected to the channel. The watercourse is supplied with supplementary water volume and therefore baseflow through the watercourse is unnaturally high and not subject to the levels of cyclic variation that would be typical of seasonality. Instead, it remains relatively stable throughout the year. The active watercourse therefore is transformed into a largely aquatic environment. Flood frequency and amplitude would have also increased due to the hard and impermeable surfaces within the catchment area that induces runoff rather than infiltration, which aggravates erosion and incision of the banks. There are floodplain terraces and seep zones associated with the watercourse.

3.8. Assessing the Present Ecological State (PES) of the wetland habitat units

The Wetland Index of Habitat Integrity (Wetland-IHI) (DWAF, 2007) is a tool that was utilised to determine the PES of the various wetland units identified throughout the project area. The WETLAND IHI is specifically aimed at channelled valley-bottom wetland units and therefore it required a level of adaptation to represent the wetland unit located on the site.

3.8.1. Wetland-IHI

The Wetland-IHI scores are presented in Table 7. The overall ecological integrity of the wetlands within the project area could be regarded as falling within a D (Largely modified) category.

Table 7: Results from the WETLAND-IHI for the wetlands associated with the proposed development area.

Wetland unit	Vegetation	Hydrology	Geomorphology	Water quality	Overall PES
Wetland unit 1	52.4% (D)	36.9% (E)	58.0% (C/D)	59.7% (C/D)	50.1% (D)

The wetland unit associated with the site suffers the effects of the historical and present land use as well as the urbanising transformation of the catchment area. The greatest driver of ecological change is the hydrology component. The watercourse receives a significant volume of water from the Randfontein WWTWs that has altered its seasonality, flooding regimes and elevated baseflows. Elevated flows have resulted in the incision of the channel, which aggravates erosional features. vegetation structure. Vegetation alteration within the wetland zones sees the dominance of exotic species as well as the displacement of vegetation due to artificially induced inundation, which is most prolific along the northern banks of the stream. Geomorphological functioning (sediment movement) is impacted by the increase in sediment delivery to the system from within the catchment where active cultivation destabilises soils and removes the protective vegetation cover. Sediment is then readily transported through the channel by the relatively high velocity of the water, only being deposited within impoundments, where the channel expands, or deposited within floodplain-type habitats during flood events. The water quality associated with the wetland unit is impacted by urban runoff features that carry toxins toward the watercourse. Agrochemical usage within the catchment area includes pesticides, herbicides, and various fertilisers that all impact on the water quality of the system. Sewerage effluents as well as contamination from untreated sewerage from derelict and over-capacitated sewer infrastructure also impacts on the water quality within the system. The overall PES of the wetland unit was calculated at 50.1% (D PES category) indicating that the wetland unit is not regarded as a particularly ecologically sensitive wetland feature, but it plays an important supporting role to important aquatic habitats located further downstream.

3.8.2. Ecological Importance & Sensitivity (EIS)

The EIS was undertaken according to the methods outlined in WET-EcoServices (Kotze *et al*, 2007). The EIS protocol tends to rate the services to the various sectors provided by the wetland units and utilises these results to designate an importance rating. The summary rating for the EIS is presented in Table 8.

Table 8: The results of the WET-Ecoservices index to determine the EIS of the wetland unit.

Wetland functional features	Wetland unit 1 (Score /4)
Flood attenuation: The undulated channel, floodplain-type habitat and flood terraces associated with a wetland area that has retained high vegetation cover provides for relatively good flood attenuation. The capacity of this is, however, limited in the greater regional context.	1.3
Streamflow regulation: Groundwater interaction is present within the unit but provides a limited source of baseflow.	2.8
Sediment trapping: Linear wetland units do trap sediments if their overall ecological integrity has been retained to a functional level. Valley-bottom wetland units with a structured vegetation component provide a valuable sediment trapping function, which is enhanced if flood terraces and floodplain-type habitat is associated with the unit.	2.5
Phosphate trapping: Wetland vegetation can trap and process phosphates to remove it from the environment. This is particularly relevant to valley-bottom units. The wetland unit associated with the site has a well-defined channel and therefore retention time within the wetland unit is limited, which limits the capacity of the unit to remove contaminants from the water. Sewerage contamination and agrochemicals would be considered a main source of phosphates within the system.	2.1
Nitrate removal: Similarly, wetland vegetation can trap and process nitrates to remove it from the environment. This is particularly relevant to valley-bottom units. Agrochemicals and sewerage contamination would be considered a main source of nitrates within the system.	2.0
Toxicant removal: Wetland vegetation can trap and process toxicants to remove it from the environment. This is particularly relevant to valley-bottom units. Sewerage contamination, runoff from commercial, industrial, and mining sectors, as well as roadway runoff would be considered a main source of toxicants within the system.	2.5
Erosion control: The wetland unit does retain good vegetation cover and therefore provides erosion control at the local level. The defined and generally incised channel promotes the efficient movement of water through the system, which limits the ability of the watercourse to provide a significant contribution to erosion control.	1.7
Carbon storage: Wetland units store a relatively high level of carbon, but this has limited relevant to wetland units associated with the project area.	2.3
Maintenance of biodiversity: Wetlands provide habitat for a high level of biodiversity. This is, however, has limited relevance to the wetland unit associated with the site due to the relative ecological isolation imposed by the major roads associated with the site.	1.3
Water supply for human use: The wetlands within the project area do not supply resources that support local communities and therefore this feature is of limited significance.	2.1
Natural resources: The wetlands within the project area do not supply resources that support local communities and therefore this tends to be of limited significance.	1.4
Cultivated foods: The wetlands within the project area do not supply resources that support local communities and therefore this tends to be of limited significance.	0.6
Cultural significance: The wetlands within the project area do not hold cultural value to local communities and therefore this is of limited significance.	0.0
Tourism and recreation: This has limited relevance to the wetland units associated with the project area.	0.4
Education and research:	0.5

Wetland functional features	Wetland unit 1 (Score /4)
This is of limited value as the wetland units associated with the project area do not form part of significant wetland types and therefore tends not to be the focus of any research or education.	
Threats: The land use within the project area is being transformed to accommodate a growing residential and commercial sector, which will lead to encroachment along the periphery of the wetland units and buffer zones. High-impact land uses have the potential to pose a threat to the ongoing ecological functioning of wetland units within the area.	3.0
Opportunities: The wetland associated with the project site is spatially limited and the nature of the present land use (chicken farming) and the proposed development (a PV solar development) are not generally open to the public. Opportunities to enhance the wetland usage and ecological integrity is therefore limited. Management of the present pressures and drivers of ecological change could present an opportunity to enhance the ecological functionality of the wetland unit, however.	1.0
Runoff intensity from the wetland unit's catchment: Stormwater runoff from road networks and an increase in urbanisation of the catchment area conveys significant volumes of water toward the wetland units.	1.75
Alteration of sediment regime: Active development, construction and cultivation within the project area tends to mobilise sediments.	4.0
Alteration of nutrient/toxicant regime: Increased population density within the catchment area will lead to the inevitable pressure on water-borne sewerage systems, increase in roads and other supporting infrastructure. Infrastructure failures and roadway runoff are typical sources of nutrient enrichment and toxicants that impact on the wetlands.	3.0
Rating	1.8

These results indicate that the wetland systems are currently supplying a *Moderately low (C)* ecological service. This should, however, not be misinterpreted. The Ecoservices model places a large emphasis on the use of the wetland units to sustain surrounding residents in terms of resource harvesting, providing for agriculture, etc and therefore tends to be more applicable to the rural sector. This is indicated in the results that show an overall low direct dependency of people on the wetland units. It does, however, show high ratings of wetland functional components, such as maintenance of water quality and quantity management. The overall importance of the wetland units should therefore be interpreted with this factor taken into consideration.

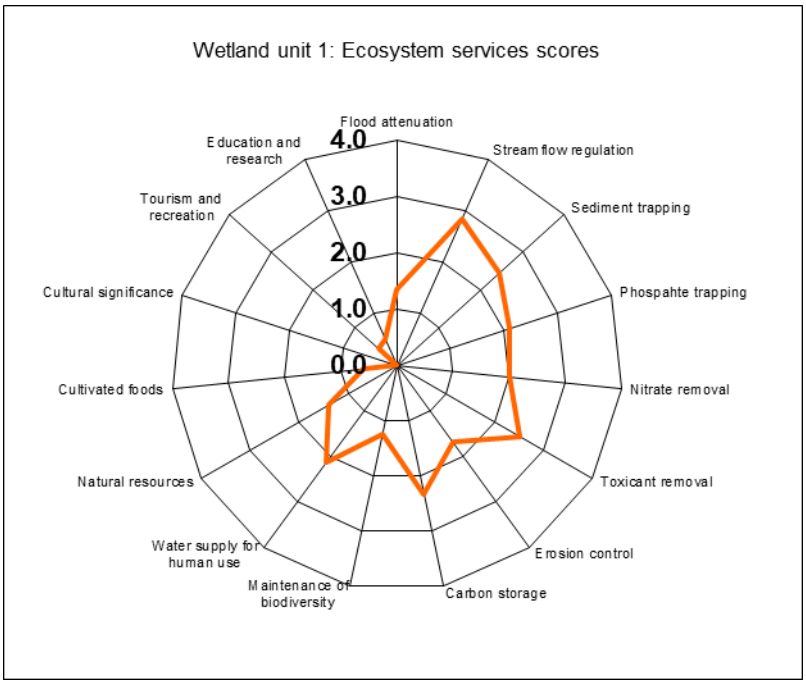


Figure 9: Scoring of the various aspects of ecological services provided for by the wetland habitat unit present within the project area.

The various input features and how they scored for the wetland unit are presented in Figure 9, which provides a visual representation of which features (services) that are performed by the wetlands are currently scoring the highest, and which ones are ranked lower. The ecological services supplied by the wetlands are rated as the relative highest. The wetland functionality elements associated with water quality and quantity management, erosion control, and biodiversity support tend to rank the highest. Features of lesser significance tend to be those elements that include the dependency of the rural sector on the resources offered by the wetland units and cultural significance of the wetland units. It should be noted, however, that the overall ecological functionality of a wetland is dependent on a balanced interplay between the various features and one feature tends to be dependent on another.

3.9. DHSWS Risk Assessment Matrix

The wetland unit associated to the project area has been delineated and the appropriate conservation buffer zones have been designated to the unit (Figure 8). A preliminary layout plan has been provided by the Proponent as an indication of the proposed infrastructure locality, spatial extent, and layout of the various elements. It has been shown that the infrastructure footprint will not impact on the wetland unit, nor will it impact on the conservation buffers. The proposed layout does, however, fall within the 500 m regulatory zone, which makes the application of the Risk Assessment Matrix (RAM) relevant to the proposed development. Because activities that take place further afield than the extent of the buffer zones can often lead to impacts to the wetland unit, the RAM is inclusive of the risks that these activities may impose.

The level of risk to a wetland unit posed by a development is largely determined by the proximity of the development activities to the wetland. In this instance, the overall risk to the wetland unit is considered low as the layout planning has taken the occurrence and extent of the wetland units into consideration. There is still the potential for the proposed development activities to impact on the wetland unit associated with the site, albeit of minor significance. Those potential impacting features that fall within the terrestrial zones (but which are within the 500 m regulatory zone) will have an insignificant impact, with the significant risk ratings calculating to 35 (Low significance) (Table 9).

Mitigation measures that were outlined within the RAM are all achievable with relatively little effort and cost to the project.

Table 9: Summary of the Risk Assessment Matrix pertaining to activities that are to take place within the terrestrial zones but within the 500 m regulatory buffer associated with the wetland units.

SUMMARY OF RAM RATINGS & DESCRIPTIONS				
Activity #1 Construction activities within terrestrial areas but which fall within the 500 m regulatory zones				
Phase	**Construction**			
Aspect	Construction activities leading to altered physical habitat, vegetation structures, hydrological and geomorphological functioning of the nearby wetland units.			
Impact	Increased sediment runoff following soil disturbances.			
Ratings		**Control measures**		
Flow regime	1	Construction footprint to remain as localised as possible. Limit soil disturbance impacts as much as possible. Reinstatement of soils that are properly landscaped to negate erosive forces and altered surface hydrology. Stormwater management and sediment control within road reserves and other hard surface areas should be in place. Water used to wash PV panels must be managed as part of the stormwater management plan that is designed to separate clean (water that can be released into the environment) from dirty (water that is contaminated and requires further processing before being released into the environment) water if found to be necessary. The contamination of water through the cleaning process is not thought to pose a risk unless detergents are used.		
Physico-chemical (Water quality)	2			
Habitat (Geomorphology + Vegetation)	2			
Biota	1			
SEVERITY	**1.5**			
Spatial scale	1			
Duration	1			
CONSEQUENCE	**3.5**			
Frequency of Activity	1			
Frequency of Impact	2			
Legal Issues	5			
Detection	2			
LIKELIHOOD	**10**	Confidence Level	95%	
SIGNIFICANCE	**35**	Borderline LOW Moderate rating classes	No	
RISK RATING	LOW	PES & EIS of watercourse	No change	

Activity #2 Fuel spillages from vehicles and/or equipment.				
Phase	**Construction**			
Aspect	Fuel/oil spillages from vehicles and/or equipment will lead to soil contamination and pollution of the water impacting on biodiversity.			
Impact	Hydrocarbon contamination of a natural waterbody has negative impacts on the biodiversity.			
Ratings		**Control measures**		
Flow regime	1	Construction vehicles and equipment on site must be routinely serviced and monitored for any fluid leaks. If fluid leaks are detected, contaminated soils must be immediately removed and disposed of at a registered disposal facility. Refuelling of vehicles and equipment must be undertaken only within designated and authorised areas where suitable protection measures are in place to abate the impacts of potential spillages. Fuel storage must be adequately bunded to ameliorate the impact on the environment through tank/equipment failures. This is an impact that can have profound impacts to the aquatic environment if it does occur. Avoidance of this impact can be readily achieved through simple mitigation measures.		
Physico-chemical (Water quality)	2			
Habitat (Geomorphology + Vegetation)	2			
Biota	1			
SEVERITY	**1.5**			
Spatial scale	1			
Duration	1			
CONSEQUENCE	**3.5**			
Frequency of Activity	1			
Frequency of Impact	2			
Legal Issues	5			
Detection	2			
LIKELIHOOD	**10**	Confidence Level	95%	
SIGNIFICANCE	**35**	Borderline LOW Moderate rating classes	No	
RISK RATING	LOW	PES & EIS of watercourse	No change	

3.10. Aquatic habitat integrity

As the watercourse associated with the wetland unit could be regarded as an aquatic habitat, standard aquatic monitoring protocols were also applied to determine the ecological integrity of the system.

3.10.1. Aquatic macro-invertebrates

The standard SASS5 protocols were used at the site to collect and identify the aquatic macro-invertebrates at the site as an indication of ecological health. It is a scoring system that rates the relative sensitivity of each taxon (mostly at the family level of invertebrates) to water quality degradation. Each taxon is provided with a sensitivity rating out of 15. The organisms are collected according to a standardised method and identified. The sensitivity ratings of those taxa that have been collected and identified are added together, which provides the SASS score for the site. This is then divided by the number of taxa that have been collected, which provides the average score per taxon (ASPT) for the site. For the site, the SASS score was calculated at 24, with 8 taxa being recorded. This provided an ASPT of 3. As noted above, the sensitivity rating scale is out of a possible 15, so an average sensitivity rating for the site of 3 is regarded as low. Interpretation of this score would indicate that the site falls within the E/F (Critically modified) ecological integrity class. The completed SASS5 score sheet is presented in Appendix D.

The habitat types (biotopes) were regarded as being relatively good and therefore was enough diversity of habitat to support the expectation of a relatively higher SASS score. As this was not the case, it is assumed that the water quality at the site is the limiting factor. The *in-situ* water quality parameters measured at the site (see Section 3.10.3.) showed an unsustainably low oxygen content within this water, which, together with the presumed contamination by agro-chemicals (amongst other factors) would provide a justification for this.

3.10.2. Fish community structures

The only fish captured during the survey was an alien species, namely Common carp (*Cyprinus carpio*). This result does not warrant the application of the full FRAI model. The results of the fish survey would automatically classify the PES of the fish

community structures within an F rating. The habitat availability for fish within the river reach that was sampled was suitable for potentially supporting a variety of Cichlidae (*Tilapia sparrmanii* and *Pseudocrenilabrus philander*), Mochokidae (*Chiloglanis pretoriae*) and Cyprinidae (*Enteromius anoplus, Labeobarbus polylepis* and *Labeobarbus marequensis*). None of these species were sampled, however.

Figure 10: Only one individual of the alien exotic Common carp (*Cyprinus carpio*) was sampled during the fish survey. The individual appeared to be in good health.

Again, it is thought that the overall water quality is the limiting factor that has influenced the occurrence of fish within the river reach. *Cyprinus carpio* is regarded as a species that is tolerant to water quality degradation. The presence of this species would not have an overly significant influence on the distribution of the indigenous species known from the system as it is not a predatory species, and it was not found in any significant numbers. This reiterates the assumption that poor water quality is the limiting factor that influences the occurrence of a greater diversity of fish species within the area. Another factor to consider is the high level of artificial impoundments found along the watercourse that inhibits migratory movement of fish. This would mean that indigenous fish are not able to recruit into the upper reaches of the system from downstream sources.

3.10.3. *In situ* water quality

In situ water quality parameters were tested at two sites within the survey area using a Hanna Instruments ® handheld multiparameter water quality meter (model HI9828) and compared to the target water quality guideline ranges indicated in DWAF (1996). The results are presented in Table 10.

All water quality parameters tested for fell in line with expected values for streams of similar characteristics within the catchment area excepting for the oxygen content. Guideline values for aquatic ecosystems (DWAF, 1996) indicate that an oxygen content of greater than 5 mg/ℓ is required to sustain viable aquatic life and that values lower than this would present limitations to species sensitive to low oxygen conditions. The recorded value of 3.85 mg/ℓ represents an "unacceptable" value for sustaining aquatic life (DWAF, 2006). A suspected reason for low oxygen conditions is the high biological oxygen demand of nutrient rich water resulting from sewerage contamination or runoff from the upstream-located cattle feedlot. A low oxygen content may also be due to chemical contamination, but this is less likely.

Table 10: Results of the *in-situ* water quality readings taken at the time of the survey.

Site	Temp (°C)	pH	Dissolved O_2 (DO) (mg/ℓ)	O_2 saturation (%)	TDS (ppm)	EC (µS/cm)	Salinity
Survey site	12.12	7.61	3.85	43.3	179	359	0.17
Guideline Values	Should not fluctuate by more than 2 °C or 10% of the normal daily cycle	Between 6 and 8, and should not exceed 0.5 pH units or 5% of the natural pH range for a given system at any given time	>5 mg/ℓ	>60%	TDS of <1000 ppm or not fluctuate by more than 15% of the normal range of a system within a 24hr cycle.		

The operation of a solar PV project utilises water for periodic cleaning of the solar panels. Detergents are generally not required so the only contamination of water would result from the dust accumulation on the panels. Other sources of surface water contamination may result from poor on site sewerage management, amongst other smaller sources. The risk to surface water contamination resulting from the operation of the development are generally insignificant.

4. SENSITIVITY MAPPING

Areas regarded as being of high ecological sensitivity within the survey property coincide with the wetland areas and the associated conservation buffer zones. These zones are indicated in Section 3.6., Figure 8.

5. PREFERRED ALTERNATIVES

A single proposed infrastructure layout was provided at the time of the assessment. This is indicated in the wetland delineation map (Section 3.6., Figure 8), which shows that the proposed infrastructure falls some distance from the surface water ecosystems associated with the project area. No alterative infrastructure layouts are considered necessary.

6. SIGNIFICANCE RATINGS OF PERCEIVED ENVIRONMENTAL IMPACTS

This section provides for an elaboration of ecological impacts and recommended mitigation measures that are indicated within the impact analysis. It is noted that the potential impacts to the surface water ecosystems tend to all be indirect impacts due to the distance of the infrastructure footprint from the wetland and watercourse that were identified at the property. Many of the impacts and the associated mitigation measures are applicable to terrestrial habitat areas. These have been included here as these all contribute to catchment management, which ultimately also impacts on the surface water ecosystems within the project area.

6.1. Outline of the development process and expected impacting features pertaining to surface water ecosystems

The stripping of vegetation followed by landscaping and earthworks to establish an area that is suited to facilitate the development will result in soil disturbances. As vegetation currently acts to stabilise the soils within the footprint area, destabilisation of the soils through vegetation removal will subject them to dispersal and cause them to be susceptible to erosion, especially during rainfall events. Watercourses and wetland zones typically represent the lowest points within the landscape, which makes them particularly susceptible to physical smothering (by sediments that are transported from disturbed areas) and physicho-chemical alteration of the water resource (increase in turbidity, increase in dissolved salts, possible contamination, etc.). Soil erosion, therefore, although a terrestrial-based impacting feature, could have profound impacts on the nearby aquatic resources within the area.

6.2. Impact Analysis

The impact significance was calculated by taking the following aspects into consideration:

- The **nature** of the impact,
- The **extent** of the area that the impact will affect,
- The **duration** of the expected impact,
- The **magnitude** of the impact, and
- The **probability** of the impact occurring.

The impacts pertaining to the construction and the operations phase are considered for the analysis. The full methodology for the scoring criteria of the various components is presented in Appendix B.

6.2.1. Construction Phase

6.2.1.1. Destruction of ecologically sensitive habitat

Impact:
Destruction of sensitive habitat within areas designated as high ecological sensitivity.

Nature:

Indirect Impact
Wetland units are located some distance from the proposed development footprint area and therefore any impacts to the wetland areas would be an indirect feature. The significance of this is therefore limited.
Soil erosion will affect any unprotected soils that have suffered disturbances, including unprotected stockpiles of stored topsoil.
Stormwater drainage features will also induce erosion impacts.
Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of sediment into the general environment and surrounding watercourses.

	Without mitigation	**With mitigation**
Extent	Local (2)	Site (1)
Duration	Short (2)	Very short (1)
Magnitude	Slight (4)	Minor (2)
Probability	Improbable (2)	Very improbable (1)
Significance	Low (16)	Low (4)
Status (positive or negative)	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation:

The ecologically sensitive features have been delineated and mapped.
Conservation buffer zones have also been designated to these areas.
Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services). This will ensure the limiting of soil disturbances that could result in erosion that could see sediment being transported toward the wetland areas.
Erosion must be strictly controlled through the utilization of silt traps, silt fencing, etc. This is especially pertinent within areas of steeper gradients.
Topsoil stockpiles should be protected from erosion through the utilization of silt traps, silt fencing, etc.
Areas currently suffering from the effects of soil erosion should be stabilised and rehabilitated as part of the development strategy.

Cumulative impacts:
Surface water ecosystems within the area have suffered a high level of transformation due to physical alteration and the residual impacts associated with unmitigated historical impacts pertaining to development features and land use within the adjacent wetland and riparian zones with little to no regard for conservation buffer zones.

Residual Risks:
Little to no residual risks will remain given the application of the mitigation measures described above.

6.2.1.2. Impacts to water quality

Impact:
Impacts to water quality within surface water ecosystems.

Nature:

Indirect Impact
Impacts to water quality include accidental fuel/oil spills from poorly maintained equipment, accidents, or container failure, and poorly managed and/or non- bunded fuelling stations.
Water quality impacts will also occur because of unabated soil erosion.

	Without mitigation	**With mitigation**
Extent	Local (2)	Site (1)
Duration	Short (2)	Very short (1)

Magnitude	Slight (4)	Minor (2)
Probability	Improbable (2)	Very improbable (1)
Significance	Low (16)	Low (4)
Status (positive or negative)	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: No fuel to be stored at or near watercourses or waterbodies; Equipment to be properly maintained and serviced; Fuel storage and pump areas to be bunded to avoid accidental leakage; No refuelling should be done within the riparian zones (exceptions are made for stationery motors i.e. pumps); Accidental spills must be reported and cleaned immediately. Contaminated soils must be removed and disposed of at a registered disposal site. Soil erosion must be managed as an ongoing concern throughout the development process.		
Cumulative impacts: Surface water ecosystems within the catchment area have suffered a high level of water quality degradation through contamination from various point and diffuse pollution sources. Active catchment management is limited and therefore surface water ecosystems continue to be subject to unregulated contamination.		
Residual Risks: Little to no residual risks will remain given the application of the mitigation measures described above.		

6.2.2. Operations Phase

6.2.2.1. Soil erosion

Impact: Soil erosion. **Nature:** *Indirect Impact* Soil erosion will impact any unprotected soils that have suffered disturbances, including unprotected stockpiles of stored topsoil. Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of sediment into the general environment and surrounding watercourses. Poor stormwater management will induce erosion.		
	Without mitigation	**With mitigation**
Extent	Local (2)	Site (1)
Duration	Short (2)	Very short (1)
Magnitude	Slight (4)	Minor (2)
Probability	Improbable (2)	Very improbable (1)
Significance	Low (16)	Low (4)
Status (positive or negative)	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Mitigation: Erosion must be strictly controlled through the utilization of silt traps, silt fencing, etc. This is especially pertinent within areas of steeper gradients. Topsoil stockpiles should be protected from erosion through the utilization of silt traps, silt fencing, etc. Stormwater management must be regarded as an ongoing concern and outfall structures must be designed to include energy dissipating features. Flood attenuation should be considered through the establishment of an attenuation pond that would allow for controlled release of the stormwater into the wetland unit.		
Cumulative impacts: Surface water ecosystems within the catchment area have suffered a high level of smothering due to unabated soil erosion originating from within the catchment areas. Disturbance of soils within the catchment area is a significant contributor to this impact. Active catchment management is limited and therefore surface water ecosystems continue to be subject to unregulated sedimentation and smothering.		
Residual Risks: Little to no residual risks will remain given the application of the mitigation measures described above.		

6.2.2.2. Impacts to water quality

Impact:
Impacts to water quality within surface water ecosystems.

Nature:
Indirect Impact
Impacts to water quality include accidental fuel/oil spills from poorly maintained equipment, accidents, or container failure, and poorly managed and/or non- bunded fuelling stations.
Water quality impacts could also occur because of unabated soil erosion.
Herbicides used on the PV site for routine vegetation management could be transported to the aquatic environment, where it will impact on aquatic biota.

	Without mitigation	**With mitigation**
Extent	Local (2)	Site (1)
Duration	Short (2)	Very short (1)
Magnitude	Slight (4)	Minor (2)
Probability	Improbable (2)	Very improbable (1)
Significance	Low (16)	Low (4)
Status (positive or negative)	Negative	Negative
Reversibility	Medium	High
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes

Mitigation:
No fuel to be stored at or near watercourses or waterbodies; Equipment to be properly maintained and serviced; Fuel storage and pump areas to be bunded to avoid accidental leakage; No refuelling should be done within the riparian zones (exceptions are made for stationery motors i.e. pumps);
Accidental spills must be reported and cleaned immediately. Contaminated soils must be removed and disposed of at a registered disposal site.
Soil erosion must be managed as an ongoing concern throughout the development process.
Herbicide usage at the site must be strictly controlled and regulated, with adequate training provided to application staff. Herbicides to be stored in an appropriate lockable place to avoid use by uninformed and untrained personnel. Herbicide application should only be done when no rain is forecast for the area. It is preferable to avoid windy days. Only registered herbicides to be used. Manufacturer's dosage directions (concentration and application frequency) are to be strictly adhered to. Over-application and higher than necessary concentrations will increase the risk to the aquatic environment. Manual weed control should be encouraged over the use of herbicides.

Cumulative impacts:
Surface water ecosystems within the catchment area have suffered a high level of water quality degradation through contamination from various point and diffuse pollution sources. Active catchment management is limited and therefore surface water ecosystems continue to be subject to unregulated contamination.
Existing usage of agrochemicals within the catchment area is currently high, which is considered a major driver of ecological change to the water quality associated with surface water ecosystems.

Residual Risks:
Little to no residual risks will remain given the application of the mitigation measures described above.
The risks to the aquatic environment pertaining to herbicide usage at the site are minimal if mitigation measures are adhered to.

6.3. Cumulative Impacts

Assessment of the cumulative impacts allows for an evaluation of those impacts expected to be induced by the proposed development activities in the regional context and the significance of additional impacts on the ecological resources. The following tables provide an indication of the significance of the cumulative impacts for those impacts perceived to be imposed by the proposed development activities.

6.3.1. Cumulative destruction of ecologically sensitive habitat

Nature:
Additional sources of contamination that will impact the water quality of the surface water ecosystems within the region.

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Site (1)	Regional (3)

Duration	Very short (1)	Permanent (5)
Magnitude	Zero (0)	Minor (2)
Probability	Very improbable (1)	Very improbable (1)
Significance	**Low (2)**	**Low (10)**
Status (positive or negative)	Negative	Negative
Reversibility	High	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Confidence of findings	High	

Mitigation:

The ecologically sensitive features have been delineated and mapped.
Conservation buffer zones have also been designated to these areas.
Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services). This will ensure the limiting of soil disturbances that could result in erosion that could see sediment being transported toward the wetland areas.
Erosion must be strictly controlled through the utilization of silt traps, silt fencing, etc. This is especially pertinent within areas of steeper gradients.
Topsoil stockpiles should be protected from erosion through the utilization of silt traps, silt fencing, etc.
Areas currently suffering from the effects of soil erosion should be stabilised and rehabilitated as part of the development strategy.

6.3.2. Cumulative impacts to water quality

Nature:
Additional sources of contamination that will impact the water quality of the surface water ecosystems within the region.

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	Site (1)	Regional (3)
Duration	Very short (1)	Permanent (5)
Magnitude	Zero (0)	Moderate (6)
Probability	Very improbable (1)	Very improbable (1)
Significance	**Low (2)**	**Low (14)**
Status (positive or negative)	Negative	Negative
Reversibility	High	Low
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes	Yes
Confidence in findings	High	

Mitigation:
No fuel to be stored at or near watercourses or waterbodies; Equipment to be properly maintained and serviced; Fuel storage and pump areas to be bunded to avoid accidental leakage; No refuelling should be done within the riparian zones (exceptions are made for stationery motors i.e., pumps).
Accidental spills must be reported and cleaned immediately. Contaminated soils must be removed and disposed of at a registered disposal site.
Soil erosion must be managed as an ongoing concern throughout the development process.
Herbicide usage at the site must be strictly controlled and regulated, with adequate training provided to application staff. Herbicides to be stored in an appropriate lockable place to avoid use by uninformed and untrained personnel. Herbicide application should only be done when no rain is forecast for the area. It is preferable to avoid windy days. Only registered herbicides to be used. Manufacturer's dosage directions (concentration and application frequency) are to be strictly adhered to. Over-application and higher than necessary concentrations will increase the risk to the aquatic environment. Manual weed control should be encouraged over the use of herbicides.

The impacts imposed by the proposed development activities to the existing impacts pertaining to destruction of ecologically sensitive habitat (surface water ecosystem habitat) and impacts to water quality within the catchment area are regarded as being minimal. These aspects already suffer considerable degradation at the regional context, which limits the significance of the contribution of the proposed development activities to the cumulative impacts within the regional context.

7. MITIGATION MEASURES FOR INCLUSION IN THE ENVIROMENTAL MANAGEMENT PROGRAMME FOR SURFACE WATER ECOSYSTEMS

An Environmental Management Programme (EMP) is a detailed account of the mitigation measures and the management of the implementation of those mitigation measures throughout the progression of the various phases of the project to ensure maximum effectivity. The following table provides for the aspects pertaining to the surface water ecosystems.

OBJECTIVE: The objective of the of this EMP is to provide an account of the perceived impacting features imposed by the proposed development activities pertaining to the conservation of the surface water habitat units associated with the site and within the regional context and to provide the necessary mitigation measures to abate these perceived impacts to conserve (or improve on) the ecological processes that they presently provide.

Project component/s	Construction phase that entails vegetation stripping that will disturb soils and lead to potential mobilisation of silt and sediment that could reach the wetland and watercourse within the southern area of the project site, impacting on the ecological integrity of the unit. This could potentially impact on physical habitat integrity and water quality. Herbicide usage to control vegetation throughout the site could impact on the aquatic system should it be transported via stormwater runoff and/or spray drift.
Potential Impact	The potential of the impact is regarded as being low-medium whereas the probability of this occurring is considered very low due to the distance between the construction footprint area and the wetland/watercourse and associated conservation buffer zone.
Activity/risk source	Indiscriminate destruction of habitat and/or disregard of areas delineated as being ecologically sensitive features.
Mitigation: Target/Objective	To negate the impacts to the present ecological state of the surface water ecosystems within the area in totality.

Mitigation: Action/control	**Responsibility**	**Timeframe**
Limit the extent of the vegetation stripping within the construction footprint to limit the impact of sedimentation of the surface water habitat units caused through erosion. The delineated area of the surface water ecosystems and associated conservation buffer zones must be regarded as out of bounds to contractors and equipment. Equipment and vehicles to be serviced and regularly inspected for fluid leaks to limit the impact of hydrocarbon contamination of soils and potential contamination of the surface waters. No dumping of any kind to take place within the delineated wetland zones and associated conservation buffers. If no viable alternative to herbicidal usage can be implemented, then herbicides must be applied according to manufacturer's guidelines, on quiet/windless/minimal windy days, and never during rain or when rainfall is forecast.	Contractor, Operations Manager & ECO	Ongoing throughout all phases of the proposed development activities.

Performance indicator	Routine visual inspections to observe active sediment deposition and/or erosion formation. Observations of unexplained die back of riparian/wetland vegetation.
Monitoring	Recommended biennial (1x high season & 1x low season) biomonitoring of the watercourse by a suitably qualified aquatic specialist who can assess the *in-situ* water quality, riparian vegetation, aquatic macro-invertebrates (SASS5 survey) and the fish species community structures against the baseline data. A report detailing the ecological trend analysis should submitted upon completion of each survey period. The report should also include an audit of the mitigation strategies in place to abate the impacts to the surface water ecosystems and provide measures and recommendations to improve on the processes (if applicable).

8. CONCLUSIONS & RECOMMENDATIONS

Following the field survey of the proposed development area, the following conclusions can be made, and salient recommendations can be proposed to aid in the conservation of the overall ecological integrity of the surface water ecosystems within the region:

- Wetland habitat units were noted to be associated with the proposed development. The units were delineated and are presented, together with the proposed development layout, in Figure 8.
- The wetland unit is classified as a well-developed channelled and valley-bottom unit that is linearly and laterally connected to seep zones and a floodplain-type habitat unit.

- The wetland unit has been subject to varying levels of impacts through historical and present land use, with impoundments, water quality degradation, and exotic vegetation inundation having been identified as the most prominent drivers of ecological change.
- The PES of the wetland unit calculated at 50.1% (D category). The EIS for the unit calculated to 1.8 (C category).
- The watercourse was also assessed as an aquatic habitat unit, which showed an overall E/F ecological rating according to the status of the aquatic macro-invertebrates and fish community structures.
- The impact significance of the potential impacting features to the surface water ecosystems were shown to be low to insignificant due to the distance of the proposed infrastructure from the surface water ecosystem units. All impacts were also shown to be further reduced with the implementation of the proposed mitigation measures.
- Erosion control measures and avoidance of indiscriminate habitat destruction outside of the ultimate construction footprint are regarded as the most pertinent mitigation measures.
- It is recommended that the developer manage the riparian zones of the watercourse for exotic vegetation and the currently unabated dumping of rubble that takes place within that area.
- The overall ecological impact significance of the proposed development activities is expected to be insignificant. Therefore, no justifiable reasons for opposing the development can be offered.

It should be noted that, to conserve the ecological structures within the region, a holistic habitat conservation approach should be adopted. This includes keeping general habitat destruction and construction footprints to an absolute minimum within the terrestrial habitat as well. Conserving the habitat units will ultimately conserve the species communities that depend on it for survival. This can only be achieved by the efforts of the contractor during the various processes of the construction phase.

It is the opinion of the specialist that the proposed development of the Quantum 1 Solar Energy Facility and associated infrastructure (in the locality and spatial extent as indicated at the time of the assessment) can be favourably considered for authorisation as the survey results indicated that it would not impose any significant impacts to the surface water ecosystems within the area provided that the recommended mitigation measures are adhered to.

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APPENDIX A – SUMMARY OF THE SITE VERIFICATION PROTOCOLS AND PROCEDURES FOLLOWED FOR THIS ASSESSMENT ACCORDING TO REGULATIONS STIPULATED IN GN320.

Table 11: Protocol and procedural requirements pertaining to the Aquatic Biodiversity theme according to the DFFE sensitivity zoning of the area associated with the proposed development. The procedures and requirements refer to the requirements stipulated by GN 320 (gazetted 20 March 2020).

THEME: AQUATIC BIODIVERSITY				
Sensitivity	**Ref**	**Procedures and Requirements**	**Report ref**	**Comment/Action**
	1.	**General Information**		
Very High	1.1.	Submission of an **Aquatic Biodiversity Specialist Assessment**.		
	1.2.	If the information gathered from the site sensitivity verification differs from the designation of "very high" on the screening tool and it is found to be of "low" sensitivity, then an **Aquatic Biodiversity Compliance Statement must be submitted**.		
	1.3.	If any part of the proposed development footprint falls within an area of "very high" sensitivity, the assessment and reporting requirements prescribed for the "very high" sensitivity apply to the entire footprint, excluding linear activities for which impacts on aquatic biodiversity are temporary and the land in the opinion of the aquatic biodiversity specialist, based on the mitigation and remedial measures, can be returned to the current state within two years of the completion of the construction phase, in which case a compliance statement applies. In the context of this protocol, development footprint means the area on which the proposed development will take place and includes any area that will be disturbed.	✓	The proposed development footprint is located some distance from the wetland/aquatic habitat unit as well as the conservation buffer zone. Therefore, an **aquatic biodiversity compliance statement** is applicable.
Low	1.4.	Submission of an **Aquatic Biodiversity Compliance Statement.**	✓	
	1.5.	If the information gathered from the site sensitivity verification differs from the designation of "low" on the screening tool assessment, then an aquatic biodiversity specialist assessment must be conducted.	×	
Very High	**2.**	**Assessment Procedures**		
	2.1.	Specialist must be registered with the South African Council for Natural Scientific Professionals (SACNASP) with expertise in the field of aquatic sciences.		
	2.2.	The assessment must be undertaken on the preferred site and within the proposed development footprint.		
	2.3.	The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects:		
	2.3.1.	a description of the aquatic biodiversity and ecosystems on the site, including		
	a)	aquatic ecosystem types; and		
	b)	presence of aquatic species, and composition of aquatic species communities, their habitat, distribution, and movement patterns.		
	2.3.2.	the threat status of the ecosystem and species as identified by the screening tool;		
	2.3.3.	an indication of the national and provincial priority status of the aquatic ecosystem, including a description of the criteria for the given status (i.e. if the site includes a wetland or a river freshwater ecosystem priority area or sub catchment, a strategic water source area, a priority estuary, whether or not they are free-flowing rivers, wetland clusters, a critical biodiversity or ecologically sensitivity area); and		
	2.3.4.	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.); and		
	b)	the historic ecological condition (reference) as well as present ecological state of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).		
	2.4.	The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.		
	2.5.	Related to impacts, a detailed assessment of the potential impacts of the proposed development on the following aspects must be undertaken to answer the following questions:		
	2.5.1.	is the proposed development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?		
	2.5.2.	is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?		
	2.5.3.	how will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site? This must include:		
	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);		

THEME: AQUATIC BIODIVERSITY				
Sensitivity	**Ref**	**Procedures and Requirements**	**Report ref**	**Comment/Action**
	b)	will the proposed development change the sediment regime of the aquatic ecosystem and its sub-catchment (e.g. sand movement, meandering river mouth or estuary, flooding or sedimentation patterns);		
	c)	what will the extent of the modification in relation to the overall aquatic ecosystem be (e.g. 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.); and		
	d)	to what extent will the risks associated with water uses and related activities change;		
	2.5.4.	how will the proposed development impact on the functioning of the aquatic feature? This must include:		
	a)	base flows (e.g. too little or too much water in terms of characteristics and requirements of the 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 over-abstraction 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);		
	e)	fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and		
	f)	the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.);		
	2.5.5.	how will the proposed development impact on key ecosystems regulating and supporting services especially:		
	a)	flood attenuation;		
	b)	streamflow regulation		
	c)	sediment trapping		
	d)	phosphate assimilation		
	e)	nitrate assimilation;		
	f)	toxicant assimilation;		
	g)	erosion control; and		
	h)	carbon storage?		
	2.5.6.	how will the proposed 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?		
	2.6.	In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to:		
	a)	size of the estuary;		
	b)	availability of sediment;		
	c)	wave action in the mouth		
	d)	protection of the mouth		
	e)	beach slope		
	f)	volume of mean annual runoff; and		
	g)	extent of saline intrusion (especially relevant to permanently open systems).		
	2.7.	The findings of the specialist assessment must be written up in an **Aquatic Biodiversity Specialist Assessment Report** that contains, as a minimum, the following information:		
	2.7.1.	contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;		
	2.7.2.	a signed statement of independence by the specialist;		
	2.7.3.	a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;		
	2.7.4.	the methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;		
	2.7.5.	a description of the assumptions made, and any uncertainties or gaps in knowledge or data;		
	2.7.6.	the location of areas not suitable for development, which are to be avoided during construction and operation, where relevant		
	2.7.7.	additional environmental impacts expected from the proposed development;		
	2.7.8.	any direct, indirect and cumulative impacts of the proposed development on site;		
	2.7.9.	the degree to which impacts and risks can be mitigated;		
	2.7.10.	the degree to which the impacts and risks can be reversed;		
	2.7.11.	the degree to which the impacts and risks can cause loss of irreplaceable resources;		
	2.7.12.	a suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies;		
	2.7.13.	proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr);		

THEME: AQUATIC BIODIVERSITY				
Sensitivity	**Ref**	**Procedures and Requirements**	**Report ref**	**Comment/Action**
	2.7.14.	a motivation must be provided if there were development footprints identified as per paragraph 2.4 above that were identified as having a "low" aquatic biodiversity sensitivity and that were not considered appropriate;		
	2.7.15.	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; and		
	2.7.16.	any conditions to which this statement is subjected.		
	2.8.	The findings of the **Aquatic Biodiversity Specialist Assessment** must be incorporated into the Basic Assessment Report or the Environmental Impact Assessment Report including the mitigation and monitoring measures as identified, that are to be included in the EMPr.		
	2.9.	A signed copy of the assessment must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.		
Low	**3.**	**Aquatic Biodiversity Compliance Statement**		
	3.1.	The compliance statement must be prepared by a suitably qualified specialist registered with the SACNASP, with expertise in the field of aquatic sciences.	✓	Report author: Dr MJ Ross SACNASP 005072 (Aquatic & Ecological Sciences)
	3.2.	The compliance statement must:		
	3.2.1.	be applicable to the preferred site and the proposed development footprint;	✓	Locality and footprint confirmed (viz Fig 1 & Fig 8)
	3.2.2.	confirm that the site is of "low" sensitivity for aquatic biodiversity; and	✓	Section 3.8, 3.9 & 3.10
	3.2.3.	indicate whether or not the proposed development will have an impact on the aquatic features.	✓	Section 3.9 & 6
	3.3.	The compliance statement must contain, as a minimum, the following information:		
	3.3.1.	contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	✓	Pg ii CV accompanies the report as a separate addendum.
	3.3.2.	a signed statement of independence by the specialist;	✓	Declaration pg ii
	3.3.3.	a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment	✓	Section 1.1.
	3.3.4.	a baseline profile description of biodiversity and ecosystems of the site;	✓	Section 3.1 to 3.10.
	3.3.5.	the methodology used to verify the sensitivities of the aquatic biodiversity features on the site including the equipment and modelling used where relevant;	✓	Section 2
	3.3.6.	in the case of a linear activity, confirmation from the aquatic biodiversity specialist that, in their opinion, based on the mitigation and remedial measures proposed, the land can be returned to the current state within two years of completion of the construction phase;	N/A	
	3.3.7.	where required, proposed impact management outcomes or any monitoring requirements for inclusion in the EMPr;	✓	Section 3.9 & Section 6
	3.3.8.	a description of the assumptions made as well as any uncertainties or gaps in knowledge or data; and	✓	Pg iii
	3.3.9.	any conditions to which this statement is subjected.	✓	None
	3.4.	A signed copy of the compliance statement must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.		Signed declaration, pg ii

APPENDIX B – METHODOLOGY TO ASSESS THE IDENTIFIED IMPACTS

Assessment of Impacts

Direct, indirect, and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase are assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **consequences (magnitude)**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

APPENDIX C – STANDARD SASS5 METHODOLOGIES TO COLLECT AQUATIC MACRO-INVERTEBRATES

Sample Collection

A standard SASS invertebrate net (300 x 300 mm square with 1 mm gauge mesh netting) was used for the collection of the organisms. The available biotopes at each site were identified and each of the biotopes was sampled by different methods explained under the relevant sections.

The biotopes were combined into three different groups, which were sampled and assessed separately:

a) Stone (S) Biotopes:

Stones in current (SIC) or any solid object: Movable stones of at least cobble size (3 cm diameter) to approximately 20 cm in diameter, within the fast and slow flowing sections of the river. Kick-sampling is used to collect organisms in this biotope. This is done by putting the net on the bottom of the river, just downstream of the stones to be kicked, in a position where the current will carry the dislodged organisms into the net. The stones are then kicked over and against each other to dislodge the invertebrates (kick-sampling) for ± 2 minutes.

Stones out of current (SOOC): Where the river is still, such as behind a sandbank or ridge of stones or in backwaters. Collection is again done by the method of kick-sampling, but in this case the net is swept across the area sampled to catch the dislodged biota. Approximately 1 m^2 is sampled in this way.

Bedrock or other solid substrate: Bedrock includes stones greater than 30cm, which are generally immovable, including large sheets of rock, waterfalls and chutes. The surfaces are scraped with a boot or hand and the dislodged organisms collected. Sampling effort is included under SIC and SOOC above.

b) Vegetation (Veg) Biotopes:

Marginal vegetation (MV): This is the overhanging grasses, bushes, twigs and reeds growing on the edge of the stream, often emergent, both in current (MvegIC) and out of current (MvegOOC). Sampling is done by holding the net perpendicular to the vegetation (half in and half out of the water) and sweeping back and forth in the vegetation (± 2 m of vegetation).

Submerged vegetation (AQV): This vegetation is totally submerged and includes Filamentous algae and the roots of floating aquatics such as water hyacinth. It is sampled by pushing the net (under the water) against and amongst the vegetation in an area of approximately one square meter.

c) Gravel, Sand and Mud (GSM) biotopes:

Sand: This includes sandbanks within the river, small patches of sand in hollows at the side of the river or sand between the stones at the side of the river. This biotope is sampled by stirring the substrate by shuffling or scraping of the feet, which is done for half a minute, whilst the net is continuously swept over the disturbed area.

Gravel: Gravel typically consists of smaller stones (2-3 mm up to 30 mm). It is sample in a similar fashion to that of sand.

Mud: It consists of very fine particles, usually as dark-collared sediment. Mud usually settles to the bottom in still or slow flowing areas of the river. It is sample in a similar fashion to that of sand.

d) Hand picking and visual observation:

Before and after disturbing the site, approximately 1 minute of “hand-picking” for specimens that may have been missed by the sampling procedures was carried out.

APPENDIX D – COMPLETED SASS5 RECORD AND FIELD SCORING SHEET

SASS Version 5 Score Sheet

Date:	**2023/05/26**
Site Code:	**Quantum PV**
Ecoregion:	7. Highveld
Water Management Area:	Crocodile West & Marico
Quaternary Catchment:	A21D
River:	Bloubank/Rietspruit
Zonation:	Foothill stream
Site Description:	
Collector:	Mathew Ross
Grid (dd.dddd S	
E	
Datum	WGS-84
Altitude (m):	

Temp (°C):	12.1	Cond (uS/cm)	359
pH:	7.6	Clarity (cm):	50+
DO (mg/L):	3.85	Turbidity:	Medium
Flow:	Medium	Colour:	Light Brown

Biotopes sampled:	**Rating**	**Time (min)**
SIC	2	
SOOC	1	
Bedrock	1	
Aquatic Veg	1	
MVIC	3	
MVOC	3	
Gravel	1	
Sand	4	
Mud	4	
Hand picking/Visual observation	yes	

Riparian Disturbance: eg, maize

Instream Disturbance: eg. sandwinning, cattle, petrol, smell etc

Taxon		S	Veg	GSM	TOT
PORIFERA (SPONGE)	5				
COELENTERATA (CNIDARIA)	1				
TURBELLARIA (FLATWORMS)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1	A		A	B
Leeches	3			A	A
CRUSTACEA					
Amphipoda	13				
Potamonautidae* (Crabs)	3	1		1	A
Atyidae (Shrimps)	8				
Palaemonidae (Prawns)	10				
HYDRACARINA (MITES)	8				
PLECOPTERA (STONEFLIES)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA					
Baetidae 1sp	4	A		A	
Baetidae 2 sp	6		B		B
Baetidae > 2 sp	12				
Caenidae (Squaregills/Cainfles)	6				
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9				
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC	12				
Tricorythidae (Stout Crawlers)	9				
ODONATA (DRAGONFLIES & DAMSELFLIES)					
Calopterygidae ST,T	10				
Chlorocyphidae	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4				
Lestidae (Emerald Damselflies)	8				
Platycnemidae (Brook Damselflies)	10				
Protoneuridae	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters)	4				
LEPIDOPTERA					
Crambidae (Pyralidae)	12				

Taxon		S	Veg	GSM	TOT
HEMIPTERA (BUGS)					
Belostomatidae* (Giant water bugs)	3		1		1
Corixidae* (Water boatmen)	3				
Gerridae* (Pond skaters/Water striders))	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3		1		1
Notonectidae* (Backswimmers)	3		A		A
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M…veliidae* (Ripple bugs)	5				
MEGALOPTERA					
Corydalidae	8				
Sialidae	6				
TRICHOPTERA CADDISFLIES)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6				
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Helodidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae	10				
Psephenidae (Water Pennies)	10				

Taxon		S	Veg	GSM	TOT
DIPTERA (FLIES)					
Athericidae	10				
Blepharoceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2	A	A	C	C
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5				
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (SNAILS)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (BIVALVES)					
Corbiculidae	5				
Sphaeriidae (Pills clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					24
No. of Taxa					8
ASPT					3.0
Other biota:					
Comments:					