



AQUATIC BIODIVERSITY IMPACT ASSESSMENT

for the proposed

FLOOD DAMAGE REPAIRS TO THE LANGENHOVEN SUBSTATION, GEORGE, WESTERN CAPE

DATE:

5 September 2025

PREPARED FOR:

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EXECUTIVE SUMMARY

An aquatic biodiversity assessment was undertaken for the proposed flood damage repair works at the Langenhoven Substation, George, as required in terms of the National Environmental Management Act and associated specialist protocols. The study included a desktop review of regional datasets, site verification, delineation of aquatic habitat, and evaluation of present ecological state, ecological importance and sensitivity, and functional capacity of the affected watercourses.

The assessment confirmed the presence of two key aquatic features within the study area: a reach of the Camfersdrift River (LSS-HGM1) and an unchannelled valley bottom wetland (LSS-HGM2). Both systems have been modified by historic urban development, with the Camfersdrift River currently in a largely modified state (PES Category C/D) but still of high ecological importance and sensitivity due to its role as a biodiversity corridor and provider of flood attenuation services. The wetland is in a moderately modified state (PES Category C), with intact hydrological functioning and important regulatory ecosystem services, including sediment retention, water quality improvement and erosion control.

Potential impacts from the proposed repair activities were assessed and include disturbance to riparian and wetland vegetation, localised hydrological and geomorphological alteration, and temporary deterioration in water quality during construction. Cumulative pressures associated with urban expansion, invasive alien plants and stormwater runoff were also noted. With implementation of the recommended mitigation hierarchy—limiting encroachment into sensitive habitat, managing stormwater discharge, applying erosion and sediment controls, and rehabilitating disturbed areas—the significance of impacts was rated low.

Of the alternatives considered, Alternative B (flared swale outlet) was preferred, as it reduces the concentration of stormwater flows and promotes natural attenuation before discharge into the Camfersdrift River. The assessment therefore concludes that, provided the recommended mitigation and monitoring measures are strictly applied, the proposed works can proceed without causing unacceptable harm to aquatic biodiversity, and are considered acceptable from an aquatic ecosystem perspective.

Specialist Assessment Protocol Index

Report reference to Table 1 - Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity

2. Aquatic Biodiversity Specialist Assessment	
2.1. The assessment must be prepared by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP), with expertise in the field of aquatic sciences.	Debbie Fordham (119102 Ecology) Colin Fordham (400166/14 Ecology)
2.2. The assessment must be undertaken on the preferred site and within the proposed development footprint.	Section 1- Introduction 1.1 –Location & 1.2 – Project description
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;	Section 6 – Affected Environment Section 7 - Results
(a) aquatic ecosystem types; and (b) presence of aquatic species, and composition of aquatic species communities, their habitat, distribution and movement patterns;	Section 6.1 – The Drainage Network Section 7.1 – Identified habitat
2.3.2. the threat status of the ecosystem and species as identified by the screening tool;	Very High 1.4 -Screening tool results Section 6.5 – Conservation context Section 6.4 - SAIIE
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	Section 6 – Affected Environment
2.3.4. a description of the ecological importance and sensitivity of the aquatic ecosystem including:	Section 7. Delineated aquatic habitat Section 6 & 7 – Affected Environment & Results
(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	Section 6.1 – Drainage network Section 7.1 – Identified aquatic habitat

habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).	Section 6.7 –Historic land use
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.	Section 7 – Results
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?	Refer to Section 9 – Impact assessment and tables
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:	Section 8 – Identified Impacts
(a) impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); (b) 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;	Section 8.2 –Flow pattern changes 8.3 - Erosion and Sedimentation Section 8.1 – Loss of aquatic habitat Section 8.4 Water Quality impacts
2.5.4. how will the proposed development impact on the functioning of the aquatic feature? This must include:	Section 9 – Impact Significance Assessment
(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	Refer to Section 9 – Impact assessment and tables Section 8 – Identified Impacts Section 9 Impact Assessment

(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:	Section 9 – Impact Significance Assessment
(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?	Section 8 – discussion of identified impacts
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?	Section 8 and Impact Table of Section 9
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).	Not applicable
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;	Appendix 2 – Specialist curriculum vitae
2.7.2. a signed statement of independence by the specialist;	Below Declaration of Independence –Page vi
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;	4.2 – Site assessment Section 4 – Approach and methodology Section 5 – Assumptions
2.7.4. the methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;	Section 4 – Approach and methodology

SPECIALIST DECLARATION OF INDEPENDANCE

This report has been prepared as per the requirements of the Environmental Impact Assessment Regulations and the National Environmental Management Act (Act 107 of 1998), any subsequent amendments and any relevant National and / or Provincial Policies related to biodiversity assessments. This also includes the minim requirements as stipulated in the National Water Act (Act 36 of 1998), as amended in Water Use Licence Application and Appeals Regulations, 2017 Government Notice R267 in Government Gazette 40713 dated 24 March 2017, which includes the minimum requirements for an Aquatic Biodiversity Report.

Report prepared by: Debra Fordham

Reviewed by: Colin fordham



Expertise / Field of Study: Internationally certified Professional Wetland Scientist and registered SACNASP ecologist, with 10 years of working experience, specialising in aquatic ecology. Debbie holds a M.Sc. degree in Environmental Science from Rhodes University, by thesis, entitled: The geomorphic origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She is a member of scientific organisations such as the Society of Wetland Scientists (SWS), the South African Wetland Society (SAWS), and the Southern African Association of Geomorphologists (SAAG).

I, **Debbie Fordham** declare that this report has been prepared independently of any influence or prejudice as may be specified by the National Department of Environmental Affairs Fisheries and Forestry and or Department of Water and Sanitation.

Signed:...



..... Date:...5 September 2025.....

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1 INTRODUCTION

Debbie Fordham of Upstream Consulting has been appointed by Sharples Environmental Services cc, to undertake an aquatic biodiversity impact assessment for the proposed flood damage repairs to the Langenhoven Substation, George, Western Cape. The site falls within an area identified as having “Very High” aquatic sensitivity by the National Web based Environmental Screening Tool. The proposal therefore requires an aquatic specialist study to inform the NEMA environmental authorisation process.

1.1 PROJECT DESCRIPTION

The site is located centrally in George, near the Camfersdrift River and provincial hospital, and accessed off C.J. Langenhoven Street (Figure 1). The substation is located on Erf 464 and there are two project alternatives as provided by SES described below and illustrated in Figure 2.

“Alternative A

- *Construct gabion retaining structure (red polygon)*
- *Construct earth v-drain along the southern edge of the substation (green polygon)*
- *Construct trapezoidal grass swale (blue) with an outlet as close to the river as possible with energy dissipators to protect against erosion.*

Alternative B

- *Construct gabion retaining structure (red polygon)*
- *Construct earth v-drain along the southern edge of the substation (green polygon)*
- *Construct trapezoidal grass swale (blue) with a flared swale to spread the water out on the edge of the bush near the river.”*

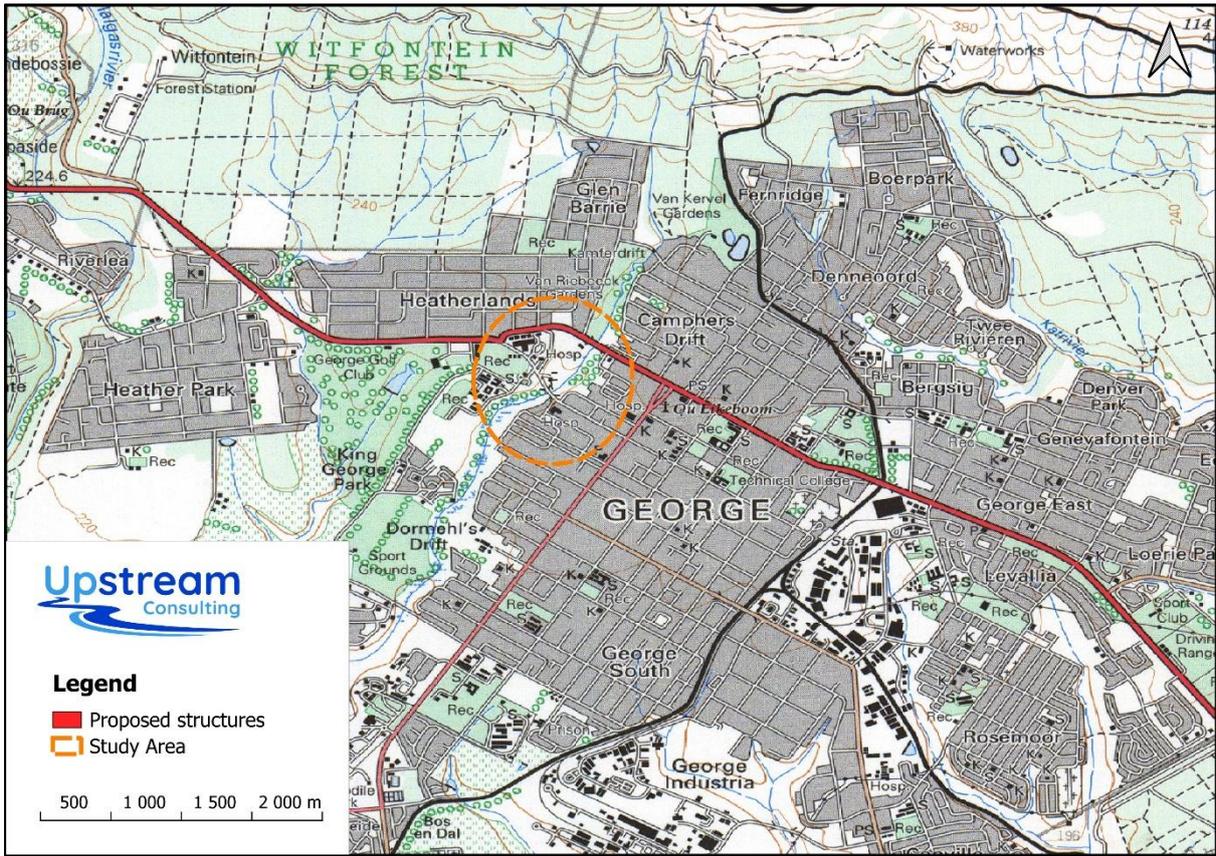


Figure 1: Locality map of the Langehoven substation in George



Figure 2: The draft site development plan provided for assessment (SES 2025)

1.2 SCREENING TOOL RESULTS

The National Web based Environmental Screening Tool was utilised for this proposal in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended, to screen the proposed site for any environmental sensitivity. The Screening Tool identifies related exclusions and/ or specific requirements including specialist studies applicable to the proposed site. The Screening Tool allows for the generating of a Screening Report referred to in Regulation 16 (1) (v) of the Environmental Impact Assessment Regulations 2014, as amended whereby a Screening Report is required to accompany any application for Environmental Authorisation. Requirements for the assessment and reporting of impacts of development on aquatic biodiversity are set out in the 'Protocol for the assessment and reporting of environmental impacts on aquatic biodiversity published in Government Notice No. 648, Government Gazette 45421, on the 10 of May 2020.

According to the Screening Report, the site has areas of “Very High” aquatic sensitivity and requires the assessment and reporting of impacts on Aquatic Biodiversity (Figure 3). The primary reasons for the score were due to the site being located in a Strategic Water Source Area and the presence rivers on site. Upstream Consulting was appointed to confirm or dispute the sensitivity rating for the aquatic biodiversity theme by undertaking an initial site sensitivity verification.

The site verification assessment was undertaken and is attached as a Site Verification Report in Appendix 3. The Very High aquatic biodiversity sensitivity rating for the site was confirmed. Therefore, the Aquatic Biodiversity Impact Assessment report was required and has been compiled in accordance with the latest NEMA Minimum Requirements and Protocol for Specialist Aquatic Biodiversity Impact Assessment (10 May 2020).

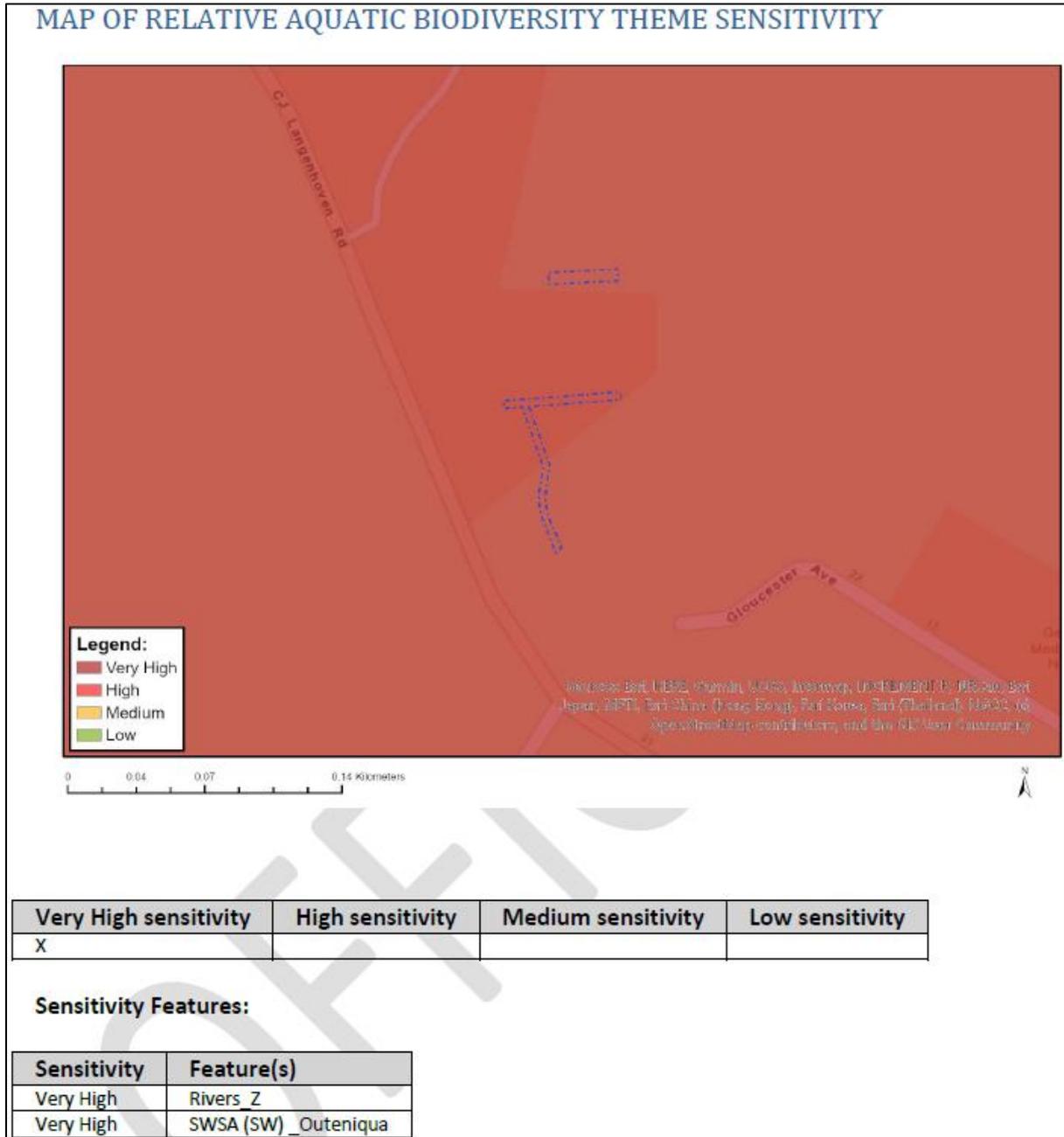


Figure 3: Aquatic biodiversity sensitivity map of the study area from the DFFE Screening Tool

2 RELEVANT LEGISLATION

The protection of water resources is essential for sustainable development and therefore many policies and plans have been developed, and legislation promulgated, to protect these sensitive ecosystems. The proposed project must abide by the relevant legislative requirements. Table 1 below shows an outline of the environmental legislation relevant to the project.

Table 1: Relevant environmental legislation

Legislation	Relevance
South African Constitution 108 of 1996	The constitution includes the right to have the environment protected
National Environmental Management Act 107 of 1998	Outlines principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state. Chapter 1(4r) states that sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Section 24 of NEMA requires that the potential impact on the environment, socio-economic conditions and cultural heritage of activities that require authorisation, must be investigated and assessed prior to implementation, and reported to the authority.
Environmental Impact Assessments Regulations	The 2014 regulations have been promulgated in terms of Chapter 5 of NEMA and were amended on 7 April 2017 in Government Notice No. R. 326. In addition, listing notices (GN 324-327) lists activities which are subject to an environmental assessment.
The National Water Act 36 of 1998	The proposed project requires water use authorisation in terms of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998, and this must be secured prior to the commencement of activities. Chapter 4 of the National Water Act addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use of water.
Conservation of Agricultural Resources Act (Act 43 of 1983)	The Conservation of Agricultural Resources Act (CARA) is to provide for the conservation of the natural agricultural resources by the maintenance of production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants.
National Environmental Management: Biodiversity Act No. 10 of 2004	This is to provide for the management and conservation of South Africa's biodiversity through the protection of species and ecosystems; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits.

3 TERMS OF REFERENCE

- Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information (including but not limited to the South African Inventory of Inland Aquatic Ecosystems (SAIIAE), vegetation, CBAs, Threatened ecosystems, any Red data book information, NFEPA data, broader catchment drainage and protected areas).
- Desktop delineation and illustration of all watercourses within and surrounding the study area utilising available site-specific data such as aerial photography, contour data and water resource data.
- Prepare a map demarcating the respective watercourses or wetland/s, within the study area. This will demonstrate, from a holistic point of view the connectivity between the site and the surrounding regions, i.e. the hydrological zone of influence while classifying the hydrogeomorphic type of the respective water courses / wetlands in relation to present land-use and their current state. The maps depicting demarcated waterbodies will be delineated to a scale of 1:10 000, following the methodology described by the DWS.
- A risk/screening assessment of the identified aquatic ecosystems to determine which ones will be impacted upon and therefore require ground truthing and detailed assessment.
- Ground truthing, identification, delineation and mapping of the aquatic ecosystems in terms of the Department of Water and Sanitation (DWA 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*.
- Classification of the identified aquatic ecosystems in accordance with the, ‘National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa’ (Ollis *et al.* 2013) and WET-Ecoservices (Kotze *et al.* 2009, 2020).
- Conduct a Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland and riparian habitats.
- Identification, prediction and description of potential impacts on aquatic habitat during the construction and operational phases of the project. Impacts are described in terms of their extent, intensity, and duration. The other aspects that must be included in the evaluation are probability, reversibility, irreplaceability, mitigation potential, and confidence in the evaluation.
- All direct, indirect, and cumulative impacts for each alternative will be rated with and without mitigation to determine the significance of the impacts.
- Recommend actions that should be taken to avoid impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas or ecological processes.
- Rehabilitation guidelines for disturbed areas associated with the proposed project and monitoring.

4 APPROACH AND METHODS

This study followed the approaches of several national guidelines with regards to wetland/riparian assessment. See Appendix 1. The following approach to the aquatic habitat assessment is undertaken:

4.1 DESKTOP ASSESSMENT METHODS

The contextualization of the study area was undertaken in terms of important biophysical characteristics and the latest available aquatic conservation planning information (i.e. existing data for coastal management lines, NFEPA identified rivers and wetlands, critical biodiversity areas (WBSP 2023), estuaries, vegetation units, ecosystem threat status, catchment boundaries, geology, land uses, etc.) in a Geographical Information System (GIS). A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the National Biodiversity Assessment of 2018 (Van Deventer *et al.* 2018). The SAIIAE offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourses and the coastal dynamic. The conservation planning information aids in the determination of the level of importance and sensitivity, management objectives, and the significance of potential impacts.

Following this, desktop delineation and illustration of all watercourses within the study area was undertaken utilising available site-specific data such as aerial photography, contour data and water resource data. Digitization and mapping were undertaken using QGIS 3.42 GIS software. These results, as well as professional experience, allowed for the identification of sensitive habitat that could potentially be impacted by the project and therefore required ground truthing and detailed assessment.

4.2 BASELINE ASSESSMENT METHODS

A site assessment was conducted on the 25th of June and 6th of August 2025 to confirm desktop findings, gather additional information, and define the boundaries of the aquatic habitat. General observations were made with regards to the vegetation, fauna and current impacts. The identified aquatic ecosystems were classified in accordance with the ‘*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa*’ (Ollis *et al.* 2013) and *WET-Ecoservices* (Kotze *et al.* 2009, 2020).

Infield delineation was undertaken with a hand-held GPS for mapping of any potentially affected aquatic ecosystems, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWA 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*. The delineation is based upon observations of

the landscape setting, topography, vegetation and soil characteristics (using a hand held soil auger for wetland soils).

Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated river/riparian habitats was undertaken utilising:

- Qualitative Index of Habitat Integrity (IHI) tool adapted from (Kleynhans, 1996) – PES
- DWAF (DWS) River EIS tool (Kleynhans, 1999) - EIS

Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitat was undertaken utilising:

- The health/condition or Present Ecological State (PES) of the wetland was assessed using the Level 2 WET-Health assessment tool Version 2 (Macfarlane *et al.* 2020), which is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and the structure and composition of wetland vegetation.
- The WET-Ecoservices tool (Kotze *et al.*, 2020) is utilised to assess the goods and services that the individual wetlands under assessment provide, thereby aiding informed planning and decision-making. Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing).

4.3 IMPACT ASSESSMENT METHODS

The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined. Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood / probability of the impact occurring. Unknown parameters are given the highest score as significance scoring follows the Precautionary Principle.

The methodology to determine the significance ratings of the potential environmental impacts and risks associated with the alternatives was provided by Sharples Environmental Services cc as well as the impact table template for completion by the specialist.

Cumulative impacts affect the significance ranking of an impact because the impact is taken in consideration of both onsite and offsite sources.

4.4 MITIGATION AND MONITORING

Actions are thereafter recommended to prevent and mitigate the identified impacts on aquatic habitat, in alignment with the mitigation hierarchy, as well as any measures necessary to restore disturbed areas or ecological processes. No-Go Areas will be determined, and any necessary monitoring protocol will be developed.

5 ASSUMPTIONS AND LIMITATIONS

Within the realm of EIA specialist assessments, there are often assumptions and limitations, which can influence the determination of specialist outcomes. Sometimes these can result in the project being fatally flawed, however frequently these are simply gaps of knowledge that will not have a significant impact on the findings of the specialist report. Therefore, specialists proceed and list the known assumptions and limitations associated with the project, such as these outlined below:

- Aquatic ecosystems vary both temporally and spatially. Once-off surveys such as this can miss certain ecological information due to seasonality, thus limiting accuracy and confidence. However, after detailed site assessment, we are highly confident of the presence of wetland habitat.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of aquatic ecosystems, it is important to note that the current extent and classification is reported on here.
- All soil/vegetation/terrain sampling points were recorded using a Garmin Montana Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed activities, while the remaining watercourses were delineated at a desktop level with limited accuracy.
- No detailed assessment of aquatic fauna/biota (e.g. fish, invertebrates, microphytes, etc.) was undertaken, and not deemed necessary.
- The vegetation information provided is based on observation not formal vegetation plots. As such species documented in this report should be considered as a list of dominant and/or indicator wetland/riparian species.
- The scope of work did not include water quality sampling and the water quality characteristics were inferred from the biophysical characteristics of the area and catchment land uses. This was deemed sufficient.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar projects. The degree of confidence is considered high.

6 DESCRIPTION OF THE STUDY AREA

The desktop/ screening study was informed by the available datasets relevant to water resources, as well as historic and the latest aerial imagery, to develop an understanding of the fluvial and geomorphic processes of the study area. The study area for the assessment was defined as the disturbance footprint i.e. the area on which the activity will take place, which includes the area that will be disturbed or impacted, plus any watercourses situated within 500 m of that activity, i.e. the ‘regulated zone’ of a watercourse as defined by the National Water Act. The desktop study was followed by the detailed site assessment. The general biophysical characteristics of the study area, as well as desktop data, are described below.

6.1 BIOPHYSICAL CHARACTERISTICS

George receives an average annual rainfall of about 700 to 900 mm, making it one of the wetter areas in the Western Cape. Rainfall is relatively evenly distributed throughout the year, with a slight peak during the autumn and spring months. However, in recent years the city has experienced intermittent heavy rainfall events (such as in 2021 when as much as 110mm of rain fell within an hour) which caused significant stormwater run-off in the urban area and flooding of watercourses throughout the town resulting in damage to urban infrastructure.

The site is located on the Outeniqua Mountain range foothills with gently undulating topography. The geology of the study area comprises low- to medium grade metasediments referred to as the Kaaimans Group intruded by granitic plutons. The metasediments belong to seven formations dominated by quartzites, shales, phyllites, schists and calc-silicates with a total thickness of about 6000 m (Ferre & Ameglio, 2000). The geological formation at the site consists largely of Saasveld schists.

The National Vegetation Map (SANBI 2018) indicates the vegetation unit of the study area is classified by Mucina and Rutherford (2006) as Garden Route Shale Fynbos. However, most of the area has been developed and any natural vegetation is restricted to urban open spaces and river corridors. The watercourses contain Cape Lowland Alluvial Vegetation (a Critically Endangered unit) but there is a high level of disturbance from anthropogenic activities and alien invasive tree infestation.

6.2 THE DRAINAGE NETWORK

The site is located in a drainage area of the Camfersdrift River within the DWS Quaternary Catchment K30B and falls within the Gouritz Coastal Water Management Area (Figure 4). The largest rivers in this catchment are the Gwaiing River, Malgas River, and the Camfersdrift River. The site falls within the Southern Coastal Belt Ecoregion which is described by Kleynhans *et al.* (2005) as an area of hills and mountains with moderate to high relief and surrounding plains.

The study area also falls within the Outeniqua Strategic Water Source Area for surface water and the George and Outeniqua SWSA for groundwater (Le Maitre *et al.* 2018). Refer to Figure 4. A Strategic Water Source Areas (SWSA) is where the water that is supplied is considered to be of national importance for water security. Surface water SWSAs are found in areas with high rainfall and produce most of the runoff. Groundwater SWSAs have high groundwater recharge and are located where the groundwater forms a nationally important resource. There are 22 national-level SWSAs for surface water (SWSA-sw) and 37 for groundwater (SWSA-gw). The SWSA-sw in South Africa, Lesotho and Swaziland occupy 10% of the land area and generate 50% of the mean annual runoff. They support at least 60% of the population, 70% of the national economic activity, and provide about 70% of the water used for irrigation.

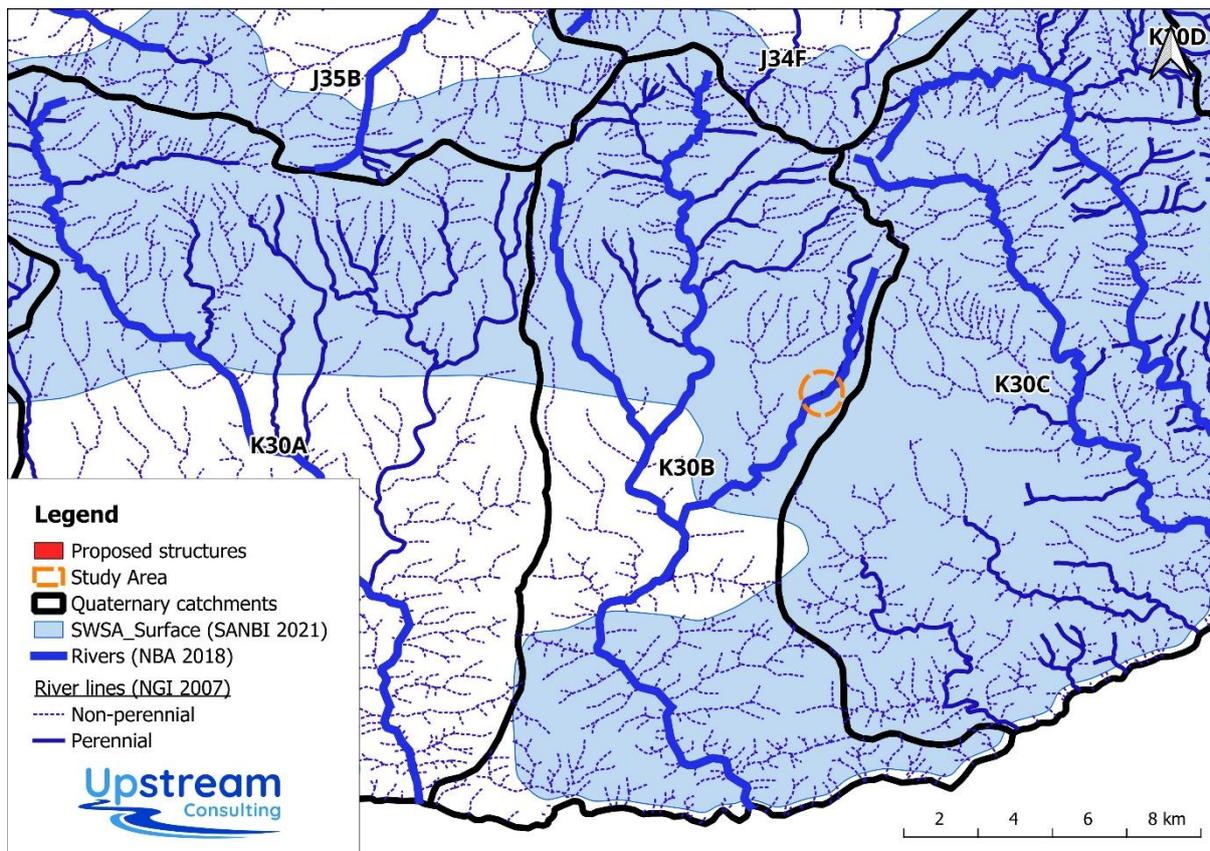


Figure 4: The study area in relation to the quaternary catchment and SWSAs

6.3 NATIONAL WETLAND AND RIVER INVENTORIES

A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the 2018 National Biodiversity Assessment (Van Deventer *et al.* 2018). The SAIIAE offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands, such as the National Wetland Map 5 (NWM5) and NBA 2018 Rivers Map.

6.3.1 Wetlands

The National Wetland Map 5 (NWM5) includes inland wetlands and estuaries, associated with river line data and many other data sets. The data indicate no wetlands at the substation site itself, but that the nearby reach of the Camfersdrift River contains inland valley floor

wetland habitat. The data has characterised the wetland as a natural, unchannelled valley bottom system (Figure 5), in poor condition, located within the Eastern Fynbos-Renosterveld Bioregion. The wetland type is listed as poorly protected and has a critically endangered ecosystem threat status. Site investigation later identified significantly more wetland habitat in the study area than shown in the NWM.

6.3.2 Rivers

The NBA 2018 Rivers Map is a GIS layer which summarises the river condition, river ecosystem types, flagship and free-flowing river information (Van Deventer *et al.* 2019). The GIS layer of origin is the 1:500 000 rivers data layer that DWAF coded for geomorphological zonation, with added data from the Chief Directorate Surveys and Mapping’s (CDSM) 1:50 000 rivers GIS layer, and information generated during the NFEPA project in 2011.

The NBA 2018 Rivers data does not show any rivers within the substation site but does indicate the Camfersdrift River directly east. It classifies the river as having non-perennial flow. However, the 1:50 000 river line data (2007) show it as the perennial Camfersdrift River. The nation river inventory shows that the river was classed within the ‘C’ PES category (Moderately Modified) in the 1999 determinations, however, it has deteriorated in health and the 2018 NBA classes the Camfersdrift River in the ‘D’ PES category as it is Largely Modified from the natural reference state. The NBA 2018 data also indicates that this river type is Least Threatened and Moderately Protected.

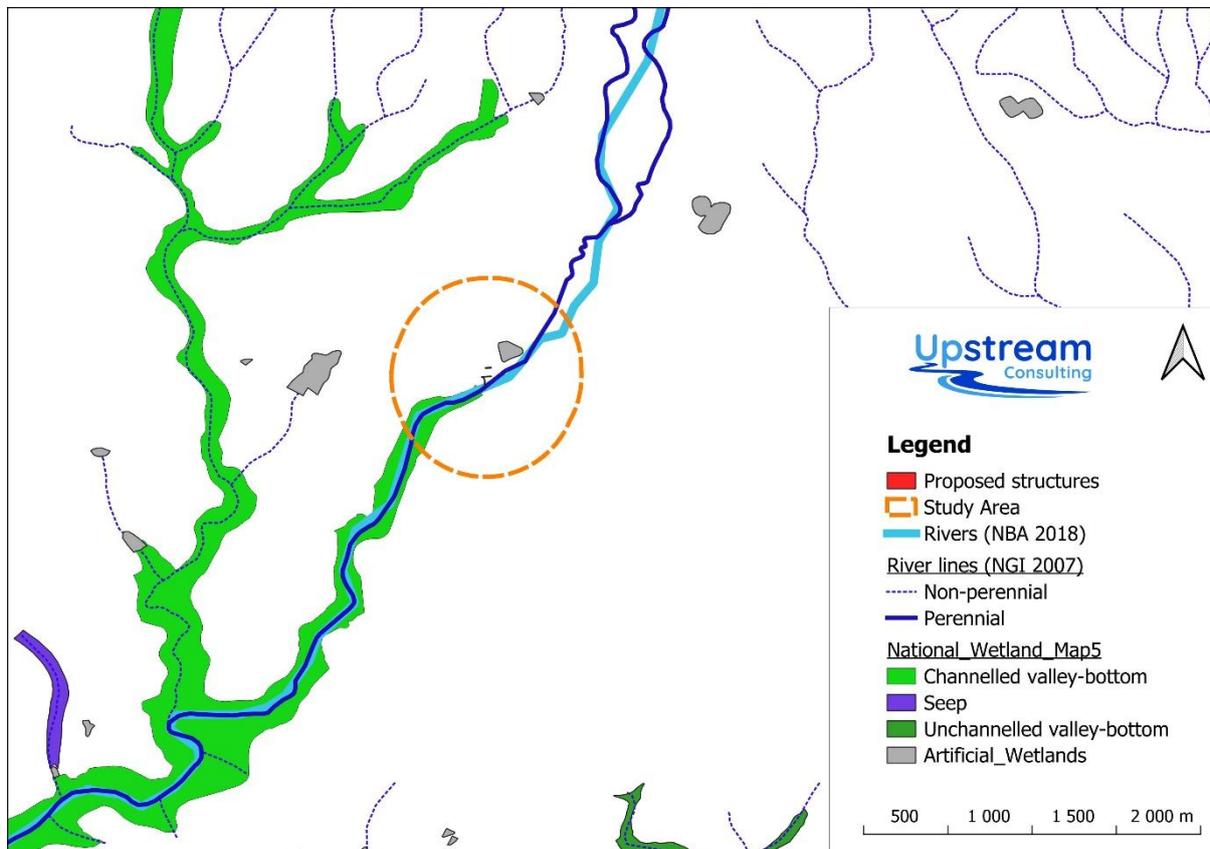


Figure 5: The site in relation to the national wetlands map 5 (Van Deventer *et al.* 2018)

6.4 CRITICAL BIODIVERSITY AREAS

The Western Cape Biodiversity Spatial Plan 2023 (WCBSP) identifies biodiversity priority areas, CBAs and Ecological Support Areas (ESAs), which, together with Protected Areas, are important for the persistence of a viable representative sample of all ecosystem types and species, as well as the long-term ecological functioning of the landscape as a whole. The primary purpose of a map of Critical Biodiversity Areas and Ecological Support Areas is to guide decision-making about where best to locate development. Critical Biodiversity Areas (CBA's) are required to meet biodiversity targets. According to the WCBSP, these areas have high biodiversity and ecological value and therefore must be kept in a natural state without further loss of habitat or species.

Figure 6 shows that the proposed activities will fall within CBA and ESA aquatic habitat as a biodiversity priority area for conservation. The activities on the southern side of the substation – to direct stormwater runoff in a channel into the Camfersdrift River – are within the CBA 1 River habitat named ‘South Eastern Coastal Belt Ephemeral Upper foothill’.

Despite being modified, the Camfersdrift River has potential to contain endemic or unique species. These species include the endangered Knysna leaf-folding frog (*Afrixalus knysnae*), Cape galaxias (*Galaxias zebratus*), and Cape kurper (*Sandelia capensis*).

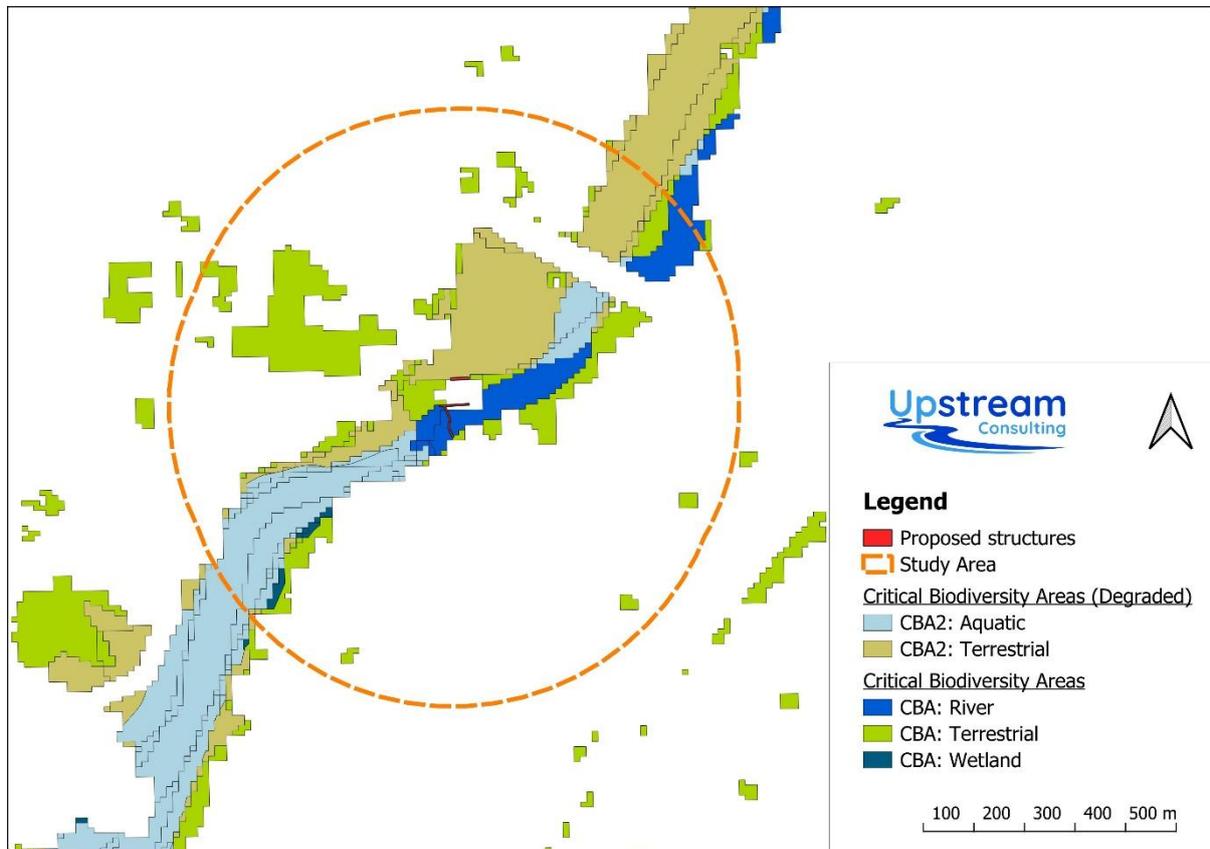


Figure 6: Map of the site in relation to aquatic biodiversity priority areas in the WCBSP (2023)

6.5 HISTORIC CONTEXT

Almost half (49.5%) of the George Local Municipality has been transformed. The site and surrounding area have been subjected to land use cover changes for many decades. Rivers in this reach of the catchment have largely been disturbed by urban development and alien invasive tree species. There is evidence to suggest that at least 40 % of riparian habitat has been lost.

Historic imagery shows that the substation was constructed within the extent of a wetland, although an already disturbed area. Refer to Figure 7 for an image from 1957 showing the estimated wetland boundary relative to the substation site prior to construction.

The construction resulted in loss of wetland habitat from infilling at the toe. As a result, an impoundment was created upslope of the substation. There is no overflow channel, and it seems that water collecting here either evaporates, infiltrates and moves as subsurface flow towards the mainstem river, or overtops the berm during floods. This impoundment may have saved the wetland from incision in the Camfersdrift mainstem. Therefore, it is very important that the berm remains as a local base level.

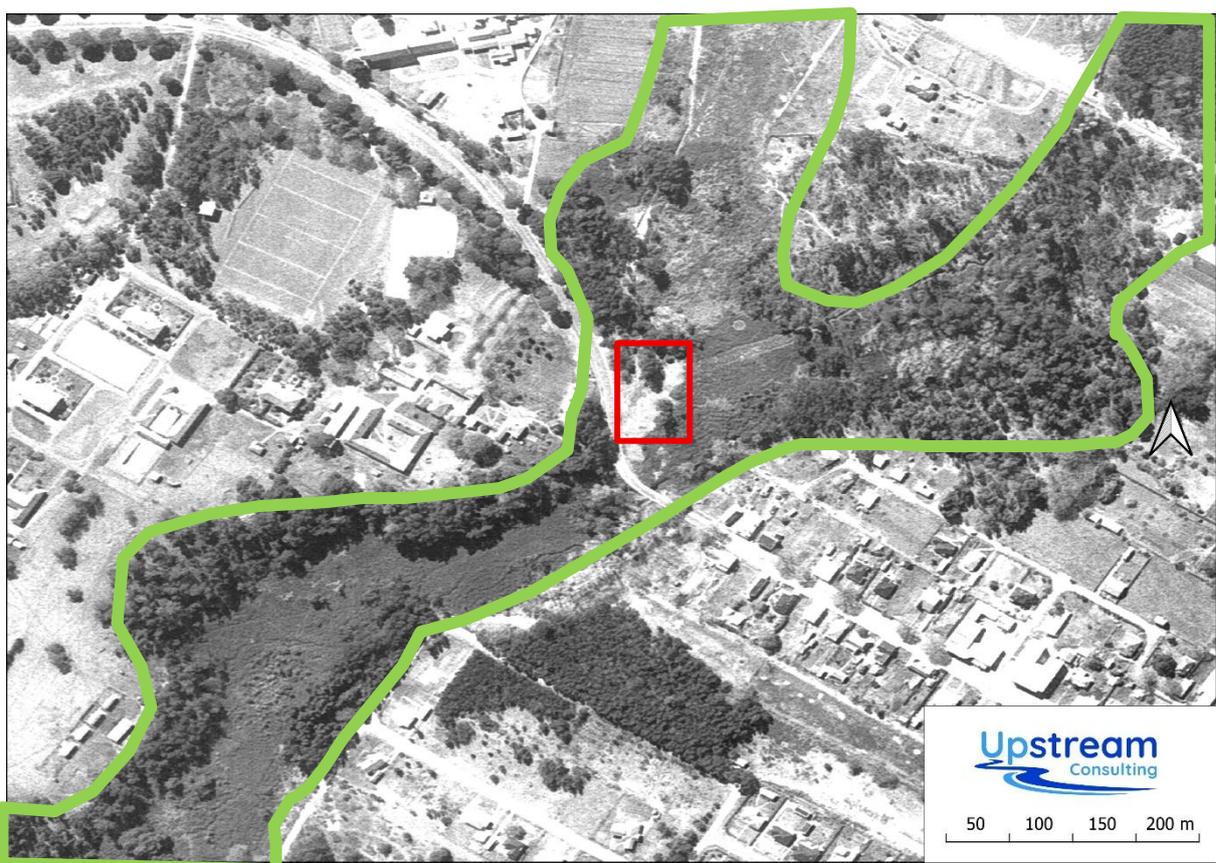


Figure 7: George Municipal 1957 image showing approximate location of site (red polygon) relative to and two extensive wetland systems (green polygon)

7 DESCRIPTION OF AFFECTED AQUATIC HABITAT

Following the contextualisation of the study area with the available desktop data, a site visit was conducted to ground truth the findings and delineate the aquatic habitat and map it within the 500m radius of the development area. The additional information collected in the field allowed for the development of an improved baseline aquatic habitat delineation map (Figure 8).

The proposed activities are in close proximity to two watercourses – the Camfersdrift River and a tributary wetland system. No other watercourses will be affected.

It was determined that the activities have potential to impact *(i)* the Camfersdrift River located < 20m to the south of the substation, and *(ii)* the unchannelled valley bottom wetland habitat remaining upslope. These watercourses are referred to as LSS-HGM1 and LSS-HGM2, respectively.

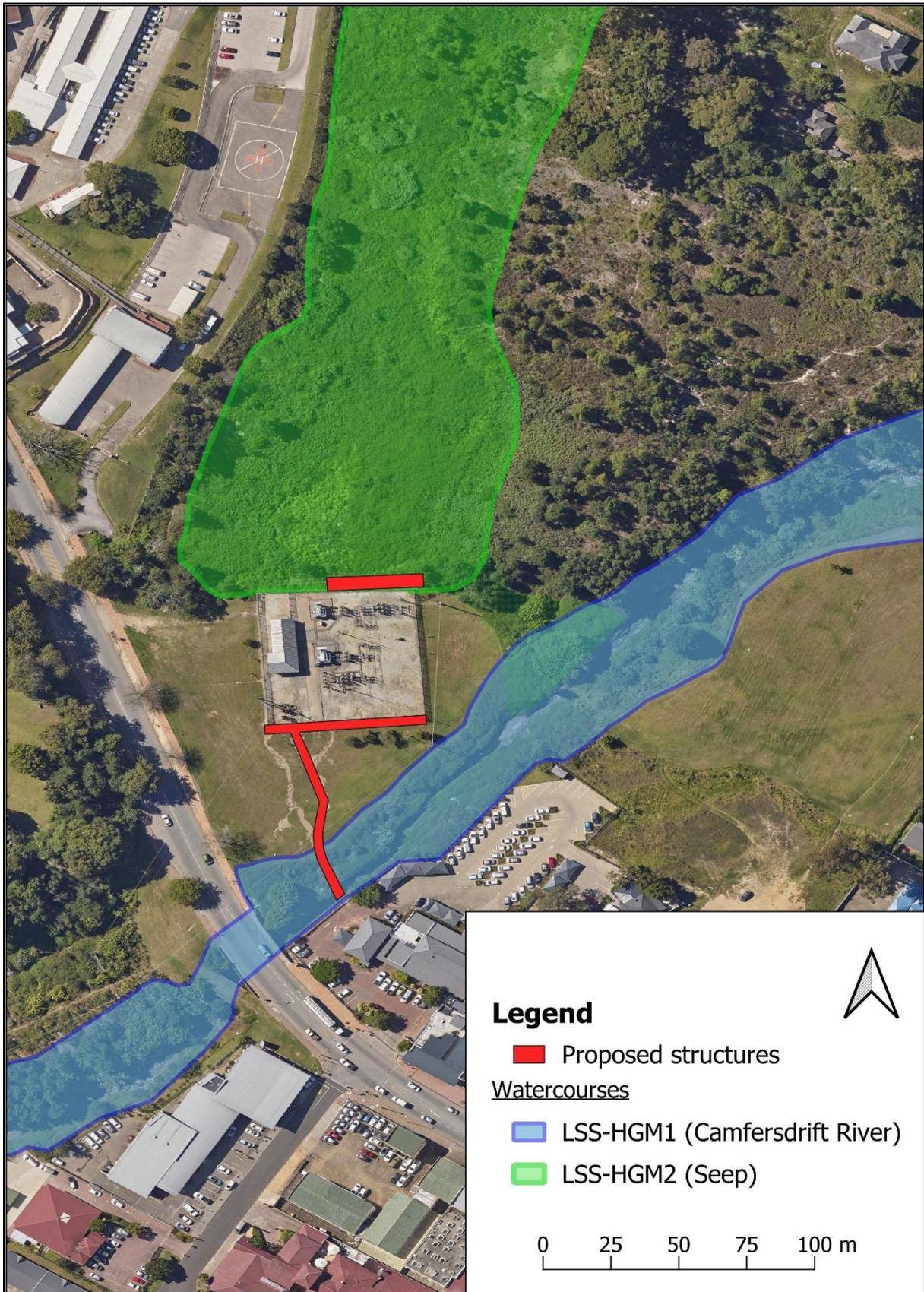


Figure 8: Delineated extent of aquatic habitat relative to the activities

7.1 LSS-HGM1 – CAMFERSDRIFT RIVER

The Camfersdrift River originates in the Outeniqua mountains and flows through the town of George before entering the Gwaiing River. The river system becomes increasingly modified as it flows through the town due to past and present impacts of human activities. The valley becomes less confined downslope of the mountains and historically it is likely that the river was more sinuous in nature. Valley bottom wetland associated with the river system has experienced significant loss, but pockets do remain, largely downstream where the slope lessens.

It is most typical of an Upper Foothills geomorphic zone river with a perennial (but highly variable) flow regime. In the reach assessed, it has a narrow, incised, single thread channel that is situated in a broader valley floor (Plate 1). The riparian zone has been narrowed by vegetation clearance and development with the open space between the right bank and substation consisting of infill material covered by cut grass (Plate 2).

Identified plant species in this reach include:

Isolepis digitata, *Cliffortia odorata*, *Zantedeschia aethiopica*, *Pteridium aquilinum*, *Isopelis prolifera*, *Helicrysum sp.*, and *Cynodon dactylon*. The vegetation is highly restricted to the riverbanks and interspersed with alien invasive plant species, such as *Callistemon viminalis* (Bottlebush), *Rubus cuneifolius* (Bramble) *Lantana camara*, *Arundo donax* (Spanish Reed), *Acacia mearnsii* (Black Wattle), *Cenchrus clandestinus* (Kikuyu grass), and *Solanum mauritianum* (Bugweed).

The river has a mixed bed alluvial channel which has undergone incision and is in a highly modified state. The right channel bank (nearest to the substation) is approximately 1.2m in height and relatively steep. However, it is densely vegetated by *Cliffortia odorata* (an indigenous, obligate wetland plant species) which provides protection against bank erosion.

The left bank in this reach has been straightened and stabilised with a gabion wall for development. Directly downstream of the reach assessed the river flows through the Langenhoven Street culvert. A newly upgraded stormwater pipe outlet and headwall has been constructed in the right bank. These stabilised banks prevent the natural migration of the active channel, and thereby reduce physical habitat diversity and dynamics, as well as altering the sediment trapping functions of rivers and their floodplains. Steep (near vertical) engineered banks also limit lateral connectivity, preventing some riverine fauna from moving up the bank and onto the floodplain. There are a number of locations along the river reach where the banks have been permanently straightened and stabilised via hard infrastructure such as steep gabion walls and concrete blocks (Plate 3).



Plate 1: Photograph of the Camfersdrift River looking upstream from the C.J. Langenhoven Street Bridge



Plate 2: Photograph of an eroded flow path on the infilled lawn between the substation and the Camfersdrift River created by concentrated stormwater runoff



Plate 3: Photograph showing the construction of a gabion wall on the left bank of the Camfersdrift River (Pre-2017) in the reach assessed, upstream of CJ Langenhoven Road, resulting in channel narrowing, deepening and straightening with reduced roughness, and increasing flood conveyance downstream

7.1.1 PES

In order to quantify the level of change described above, a Present Ecological State (PES) assessment was undertaken for both watercourses. The PES of a river, watercourse or wetland represents the extent to which it has changed from the reference or near pristine condition (Category A) towards a highly impacted system where there has been an extensive loss of natural habit and biota, as well as ecosystem functioning (Category E).

The rapid Index of Habitat Integrity (IHI) tool (Kleynhans, 1996) was used to determine Camfersdrift River PES score by comparing the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state without anthropogenic impacts. It was determined that the reach of the Camfersdrift River assessed is in a **largely modified** present ecological state, having scored within the 'C/D' Ecological Category. This is predominantly because of urban development and alien invasive plant encroachment in this reach. The reach has experienced a large loss of natural habitat, biota and basic ecosystem functions. Refer to Table 2 for a summary of PES assessment scoring.

Table 2: Present Ecological State of the Camfersdrift River reach

Rapid Habitat Integrity Assessment (Ecoquat Model)			
Characteristic	Score (0-5)	% intact	Rationale
Bed modification	4	30	Infilling, channel straightening, excavations, and the concentration of flows due to development within the river have had direct impacts upon the bed. The bed has incised due to indirect impacts such as altered water and sediment inputs as a result of land cover changes. The cross-sectional morphology has therefore been largely modified.
Flow modification	3	50	There have been large changes in the temporal and spatial characteristics of flow. There is no water abstraction within this reach of the river but there is little natural catchment land cover remaining resulting in decreased water inputs and altered surface runoff. Flows are redirected and channelised and now confined to the slightly incised channel. There is no natural overtopping and lateral connectivity has largely been severed.
Inundation	2	70	The reach assessed does not have any significant impoundments along its length, but the longitudinal profile has been altered by infrastructure (such as roads or buried pipelines) causing small obstructions.
Bank condition modification	2	70	The morphology of the bed and banks has been modified by excavation and infilling along the majority of the reach investigated. There is significant bank erosion. In areas, the banks have been completely replaced with gabions or bridge infrastructure. The reach assessed has been subjected to significant channel straightening.
Riparian condition modification	4	30	The riparian condition has been largely modified and little of the riparian habitat remains. There is a limited buffer area before a very narrow riparian zone caused by vegetation. The vast physical disturbances and alien species encroachment have resulted in the loss of habitat diversity within the riparian zone.
Water quality modification	3	50	As this reach is located within the urban area it is highly likely to be impacted by point and diffuse point pollution sources. Stormwater runoff from urban surfaces may include nutrients, pollutants, and other domestic waste. Due to the small size of the stream, this would be aggravated by a decrease in the volume of water during low flow conditions.
Ecological Category	C/D		Largely Modified. The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability.

7.1.2 EIS

The Ecological Importance and Sensitivity (EIS) of riparian areas is a representation of the importance of the aquatic resource for the maintenance of ecological functioning, and ability to recover from disturbance (Kleynhans & Louw, 2007). The ecological importance and sensitivity category of the Camfersdrift River was determined as being ‘High’ (B category). It is an important longitudinal linkage between the mountains and the Gwaiing River and does contain some unique species that are sensitive to change. The river provides significant flood attenuation services and natural habitat in the urban area. Table 3 below provides a summary of the EIS assessment determinants and results for the river.

Table 3: The Ecological Importance and Sensitivity of the Camfersdrift River reach assessed

Ecological Importance and Sensitivity assessment (Rivers)			
Determinants	Score (0-4)	Rationale	
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	3.0	High: Although no rare or endangered species were encountered on site, the Knysna Leaf-Folding Frog may be present, and there may be some species that are vulnerable on a local scale due to the location within the fynbos biome.
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	3.0	High: Although the river has been subjected to many modifications it is known to contain endemic or unique species such as Longfin eel (<i>Anguilla mossambica</i>), Cape galaxias (<i>Galaxias zebratus</i>) and Cape kurper (<i>Sandelia capensis</i>). The African clawed frog <i>Xenopus laevis</i> also occurs within the river systems in the area as well as several more sensitive macroinvertebrate families. The extend of the Knysna Leaf-Folding Frog habitat is known to be extremely limited.
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	3.0	High: The river is perennial but small in size therefore a high proportion of the biota (especially the as there are fish and amphibians within the system) is expected to be dependent on flowing water during their life cycle.
	Species/taxon richness (range: 4=very high - 1=low/marginal)	2.0	Moderate: The vast disturbances within the lower reach assessed have resulted in the dominance of disturbance tolerate species and thus the species/taxon richness is not expected to be significant at any scale. Alien invasive plants have infested the river between Davidson Road and downstream towards CJ Langenhoven Road. However, there is more diversity and richness of species in the less disturbed reaches.

RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	2.0	Moderate: The topography and substrate of the channel within this reach is relatively uniform. However, there are marginal habitats remaining, increasing habitat diversity. Erosion has reduced pool/riffle habitats.
	Refuge value (4=Very high - 1=marginal/low)	2.0	Moderate: The remaining habitat is likely to provide refuge to biota during times of environmental stress, at a local scale.
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	2.0	Moderate: It is expected that some habitat will be susceptible to flow decreases or increases during certain seasons.
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	3.0	High: Although perennial, the river is small in size and a decrease in flow volume will impact habitat at all times. However, it is important to consider that it is likely these waters are already subjected to significant water quality changes from the natural condition.
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	3.0	High: The river is an important corridor between the Outeniqua Mountains and the Gwaiing River. It does provide a link between upstream and downstream biological functioning. Although much of the lateral connectivity has been severed the longitudinal connectivity remains. The river is sensitive to modification such as impoundments (but has already been subjected to various changes).
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	3.0	High: The river is a CBA habitat and a FEPA Fish Support Area. It is located within ESA 2 as it is important for water resource protection. The reach in the Gardens is moderately protected.
MEDIAN OF DETERMINANTS		3.00	
Ecological Importance And Sensitivity Category (EIS)		High, EC=B	

7.2 LSS-HGM2 – UNCHANNELLED VALLEY BOTTOM WETLAND

The unchannelled valley bottom wetland is located directly upslope of the substation – with the substation having been constructed historically within the toe of the watercourse (Plate 4). The head of the wetland (NNE of the substation) has been lost to urban development but there is still significant habitat remaining from Davidson Street and downslope. Despite the modifications from urban development, it is geomorphically stable, well-vegetated, and the hydroperiod remains largely seasonal (Plate 5).

Indigenous wetland plant species (such as *Cliffortia odorata*, *Wachendorphia thyrsiflora*, *Carpha glomerata*, *Zantedeschia aethiopica*, *Pteridium aquilinum*, and *Typha capensis*) still dominate the permanently saturated and seasonally inundated zone but alien invasive species have established on the periphery (mostly *Eucalyptus* sp. (Gum trees), *Pinus* sp. (Pine trees), *Acacia mearnsii* (Black Wattle), and *Solanum mauritianum* (Bugweed)).

The infilling of the toe, and the creation of a berm above the substation, has resulted in an impoundment directly upslope in the wetland (Plate 6). This has resulted in an area of increased inundation and disconnected the wetland to the Camfersdrift River. It is suspected that water collecting here (which does not evaporate) infiltrates the soil and flows as sub-surface flow towards the Camfersdrift River channel. During flow events it will overtop the berm and flow as surface flow across the infilled area and into the river. In the more recent, extreme flood events, this has caused damage to the substation and created preferential flow paths from the substation into the river.

However, this berm is now supporting the wetland and should be retained. It has prevented the channel incision of the mainstem Camfersdrift River from having lowered the local base level and initiated erosion in the tributary wetland.

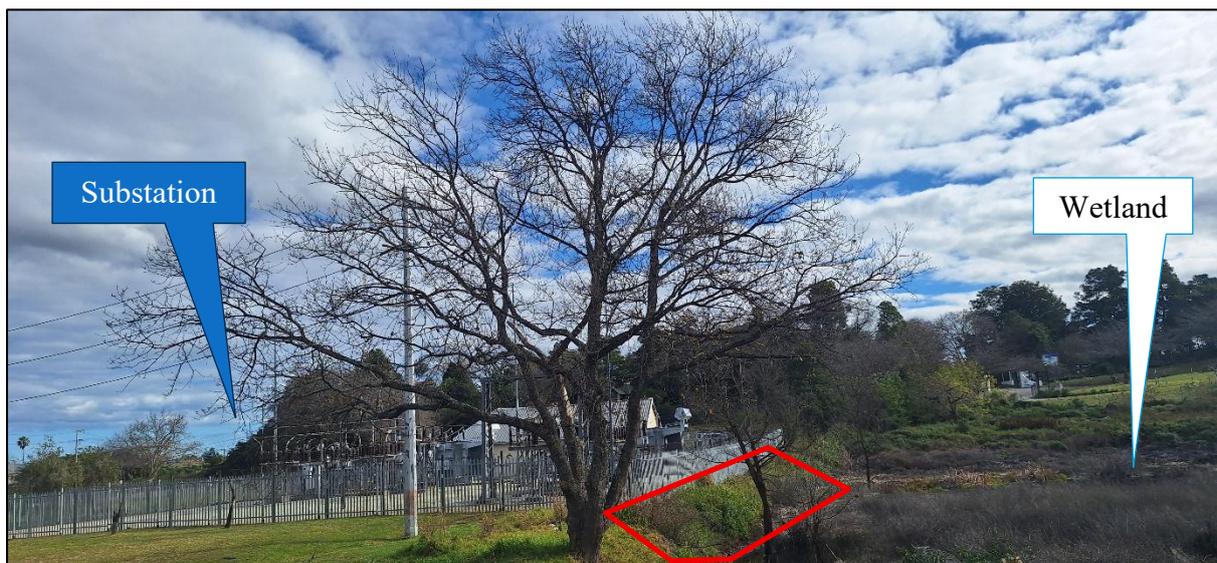


Plate 4: Photograph showing the wetland upslope of the infilled area upon which the substation was built and the red polygon indicating the location of the proposed gabion wall for flood protection



Plate 5: Photograph of the unchannelled valley bottom wetland viewed from downstream looking upstream towards the George Hospital. A portion of vegetation has been burnt in a recent fire but without alien invasive plant in encroachment it will reestablish quickly.



Plate 6: Photograph showing the infilling upon which the substation has been constructed has resulted in an impoundment upslope and disconnected the wetland from the Camfersdrift River beyond. During extreme flood events this berm is overtopped and flows around and through the substation resulting in damage to infrastructure and specifically erosion at the northeastern corner.

Historically, this area in Camfersdrift likely supported a larger and more continuous wetland, extending both upslope and farther downstream. However, construction of the substation in the wetland and urban development in its catchment have resulted in significant habitat loss. The map in Figure 9 below shows the remaining extent of aquatic habitat in the area relative to the estimated wetland extent.



Figure 9: Map of the delineated aquatic habitat

7.2.1 PES

While the hydrogeomorphic type remains characteristic of an ‘unchannelled valley bottom wetland’ the longitudinal connectivity has been fragmented and there is artificial inundation at the toe from flow impoundment. Urban wetlands are subjected to severe pressures, and it is also probable that this wetland receives contaminated stormwater runoff. But to quantify the level of wetland modification, the WET-Health (Version 2) tool was utilized to assess the present ecological state (PES) of the LSS-HGM2 wetland.

Refer to Table 2 showing a summary of the results. The Present Ecological State (PES) of a river, watercourse or wetland represents the extent to which it has changed from the reference or near pristine condition (Category A) towards a highly impacted system where there has been an extensive loss of natural habit and biota, as well as ecosystem functioning (Category E).

The overall ecological category for LSS-HGM2 was determined to be ‘C’ indicating a **moderately modified PES**. The recommended management objective for this wetland would be to prevent any further deterioration of ecological state and, as a minimum, to maintain the ‘C’ PES category.

Table 4: WET-Health summary for LSS-HGM2 wetland

	Wetland PES Summary			
Wetland name	Unnamed			
Assessment Unit	LSS-HGM2			
Wetland area (Ha)	1,6 Ha			
PES Assessment	HYDROLOGY	GEOMORPHOLOGY	WATER QUALITY	VEGETATION
Impact Score	3,0	2,8	3,9	1,5
PES Score (%)	70%	72%	61%	85%
Ecological Category	C	C	C	B
Combined Impact Score	2,8			
Combined PES Score (%)	72%			
Combined Ecological Category	C			

7.2.2 Ecological Importance and Sensitivity (EIS)

Despite the pressures it faces, the wetland is currently in moderately modified ecological condition, corresponding to a Category C Present Ecological State. Its hydrology remains intact enough to support a strong obligate vegetation community and maintain ecosystem functions. These include attenuation of peak flows, erosion control, sediment retention, and the improvement of water quality through filtering of urban runoff and partial absorption of nutrient inputs from upstream sewage leaks.

Although no rare or endangered species were found during site assessment, there is suitable habitat for them to occur here. The system provides valuable ecological refuge in a predominantly urban landscape. It functions as a critical node in the broader drainage network, both in terms of biodiversity support and landscape stability. The wetland EIS is considered **moderate**.

Future threats to the system are cumulative in nature. Continued pressure from urban expansion, ageing and leaking municipal infrastructure, and incremental increases in stormwater runoff are all factors that could tip the system toward collapse. If the constructed berm or infilling acting as a control at the toe of the system is completely removed or the wetland drained, the wetland’s current stability may be compromised. In such a scenario, the wetland would likely become incised, and with the loss of its ability to retain water and slow flows, the upper catchment would be left vulnerable to accelerated erosion, water quality degradation, and loss of ecological function.

7.2.3 Functional Assessment

Wetlands and riparian areas are globally threatened ecosystems and are well-recognized for the ecosystem services which they supply. Furthermore, these ecosystems make potentially important ecosystem services contributions to several broad-scale imperatives of government, including: water resource management; biodiversity conservation; human safety and disaster resilience; socio-economic development and poverty elimination; and climate change mitigation and adaptation. Individual wetland/riparian areas differ according to their characteristics, contexts and the particular suite of ecosystem services which they supply to society (Kotze *et al.* 2020). Thus, there is a need to assess and compare wetland/riparian areas in terms of ecosystem services delivery.

A WET-Ecoservices (Version 2) field-based assessment was undertaken to assess the ecosystem services supplied by the HGM unit (Kotze *et al.* 2020). The assessment technique has recently been revised and now distinguishes clearly both ecosystem services’ supply and the demand for all ecosystem services. This helps determine the potential of the wetland for delivering ecosystem services, by understanding its capacity to produce a service while also considering the societal demand for that service.

Table 3 shows the summary of results from the WET-EcoServices assessment, with Figure 9 giving a visual representation in the form of a spider-diagram. As discussed in the section above, the assessment determined that the LSS-HGM2 wetland has a **moderate** importance and sensitivity. Due to the regulatory services this type of wetland supports, and very high demand due to its location within the urban area, it scored especially well for sediment trapping, pollution assimilation, and biodiversity maintenance importance. It scored very low for cultural services, but largely due to the lack of demand. Refer to Table 3 and Figure 11.

Table 5: WET -EcoServices assessment summary for GBD-HGM2 wetland

ECOSYSTEM SERVICE		Present State			
		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1,7	3,7	2,0	Moderate
	Stream flow regulation	2,7	1,0	1,7	Moderately Low

	Sediment trapping	2,4	4,0	2,9	High
	Erosion control	1,7	4,0	2,2	Moderate
	Phosphate assimilation	2,1	4,0	2,6	Moderately High
	Nitrate assimilation	2,3	4,0	2,8	High
	Toxicant assimilation	2,9	3,0	2,9	High
	Carbon storage	2,7	2,7	2,6	Moderately High
	Biodiversity maintenance	3,1	2,5	2,9	High
PROVISIONING SERVICES	Water for human use	1,0	0,3	0,0	Very Low
	Harvestable resources	2,5	2,0	2,0	Moderate
	Food for livestock	1,5	0,0	0,0	Very Low
	Cultivated foods	2,1	0,0	0,6	Very Low
CULTURAL SERVICES	Tourism and Recreation	1,5	0,0	0,0	Very Low
	Education and Research	1,5	0,0	0,0	Very Low
	Cultural and Spiritual	2,0	0,3	0,7	Very Low

8 IDENTIFIED IMPACTS

Aquatic ecosystems are particularly vulnerable to human activities and these activities can often result in irreversible damage or longer term, cumulative changes. The significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed. The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined.

The direct and indirect impacts associated with the project are grouped into four encapsulating impact categories where associated or interlinked impacts are grouped. Therefore, the potential impacts assessed, including cumulative impacts, were:

- Impact 1: Disturbance to aquatic habitat and biota
- Impact 2: Hydrological modification
- Impact 3: Changes to geomorphology
- Impact 4: Potential impact on localised surface water quality

8.1 DISTURBANCE TO AQUATIC HABITAT AND BIOTA

The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance of aquatic habitat caused by earthworks, vegetation clearing, and encroachment and colonisation of habitat by invasive alien plants.

8.1.1 Pre-construction:

Site clearing and the presence of heavy machinery and human activity will result in some disturbance to aquatic habitat. While habitat loss is minimal, the presence of people and machines can temporarily displace wildlife, such as birds and small mammals, and disrupt breeding cycles or foraging.

8.1.2 Construction:

During construction there will be excavation and earthworks within the HGM2 wetland for installation of the gabion structure, as well as within the right bank riparian area of the Camfersdrift River for construction of the swale. This will require the clearance of vegetation and transformation of peripheral riparian habitat for infrastructure. The movement of soil can result in turbidity and sedimentation directly harming or burying aquatic organisms. Additionally, noise and vibration from machinery can disturb wildlife, forcing them to abandon the area.

8.1.3 Operational Phase:

The earthen bank in the HGM2 wetland will be permanently replaced with the gabion wall, and should construction encroach into the wetland itself, there will be some loss of habitat. This is the same for the encroachment of the swale into the Camfersdrift River (but requires less hard infrastructure). Post construction, invasive alien plants will colonise any disturbed areas which are not rehabilitated and will out-compete indigenous vegetation. Without mitigation, the impact can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.

8.2 HYDROLOGICAL MODIFICATION

Hydrological alterations associated with the project include changes in the distribution of water inputs and flows within the watercourses. These are likely to be minor and highly localised (if not entirely avoided). However, it is assumed that the project will not result in the removal of the 'berm' or 'wall' created by the historic infilling in the HGM2 system. The existing earthen berm/ wall has created a static local hydrological base level for the wetland. This has maintained a higher water table within the valley bottom than would otherwise exist, preventing the wetland from draining into the lower-lying mainstream. Therefore, any drain connecting this wetland with the Camfersdrift River channel has the potential to initiate severe headward erosion and wetland collapse. It is assumed that no such drain or channel will be created, and the wall will simply be stabilised.

8.2.1 Pre-Construction Phase:

Site clearing and access routes can result in a minor, localised compaction of soils which can reduce water infiltration, potentially leading to increased surface runoff from the disturbed area, but the overall hydrological impact is low.

8.2.2 Construction Phase:

Excavation of the existing infill and installation of the new wall and its foundation will require temporary drainage alteration and minor flow concentration. The excavation will temporarily disrupt the flow of surface water and shallow groundwater in the immediate vicinity. Contractors may need to de-water the site, which can temporarily lower the water level. The new formal wall may slightly alter the way floodwaters move past the structure, but since the existing infill already had a "damming" effect, this is likely a modification of an existing condition rather than a new impact.

8.2.3 Operational Phase:

The presence of the formal gabion wall in the HGM2 wetland during both low flow and high flow (flood) conditions will reduce overtopping and increase flood attenuation behind the wall. This could increase the extent of inundation upstream of the wall during major flood events. Additionally, the compacted foundation and the wall itself can act as a permanent subsurface barrier, altering shallow groundwater flow patterns. However, the infilling is not a new impact and the change in material may only have minor effect.

8.3 CHANGES TO GEOMORPHOLOGY

Geomorphology refers to the physical form and structure of the wetland, including its channels, banks, and overall shape. This shape is also driven by sedimentation and erosion as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for aquatic dependent flora & fauna.

Noteworthy here is the fact that the existing earthen infill wall in HGM2, despite its instability and non-engineered nature, is currently serving a critical and unintended function: it acts as a local base level for the unchannelled valley bottom wetland upstream. It is important that this local base level remains. The mainstream into which this wetland drains has experienced downcutting and bed incision. Under natural conditions, this lowering of the mainstream's elevation would cause a corresponding drop in the local base level of the tributary wetland. This would typically trigger headward erosion—a process where a new channel begins to form and erode its way upstream into the wetland, potentially leading to the drainage and de-watering of the entire system. However, the existing earthen infill wall has effectively dammed the valley bottom and maintained a higher local base level, thereby preventing this process.

The wetland's current unchannelled state is a direct result of this physical barrier and the wetland must not be drained as a result of the project.

8.3.1 Pre-Construction Phase:

Site access and establishment will involve clearing vegetation and compacting the soil at the wetland's edge. However, the existing infill bank is already an altered geomorphic feature. The pre-construction activities may cause localised soil compaction and minor erosion from the access path. This is generally a low-level impact unless the access path is extensive or poorly planned.

8.3.2 Construction Phase:

Vegetation clearing, earthworks, and exposure of bare soils within and upslope of the aquatic habitat during construction will decrease the soil binding capacity and cohesion of the upslope soils and thus increase the risk of erosion and sedimentation downslope and in the wetland. This may cause the burying of aquatic habitat and also cause aquatic faunal fatalities. Ineffective site stormwater management, particularly in periods of high runoff, can lead to soil erosion from confined flows. This increase in volume and velocity of runoff increases the particle carrying capacity of the water flowing over the surface.

Where soil erosion problems and bank stability concerns initiated during the construction phase are not timeously and adequately addressed, these can persist into the operational phase of the project and continue to have a negative impact.

8.3.3 Operational Phase:

The gabion wall will replace the existing earthen bank and therefore no significant changes in the wetland are expected. However, should the wall be constructed into the wetland it will change the geomorphology. Also, if the wall's foundation is placed at a lower elevation than the existing berm, or if it is undermined by scour during flood events, it could fail and trigger erosion.

The swale from the substation to the Camfersdrift River will concentrate sheetwash to a single discharge point resulting in changes to water input patterns and potential bank instability/erosion. This increase in volume and velocity of runoff increases the particle carrying capacity of the water flowing over the surface.

8.4 CHANGES TO SURFACE WATER QUALITY

Water and/or soil pollution cause negative changes in the physical, chemical and biological characteristics of water resources (i.e. water quality). This can result in possible deterioration in aquatic ecosystem integrity and a reduction in, or loss of, species of conservation concern (i.e. rare, threatened/endangered species). The result is only disturbance tolerant species remaining.

8.4.1 Construction Phase:

During construction there are a number of potential pollution inputs into the aquatic system (such as hydrocarbons and raw cement). These pollutants alter the water quality parameters such as turbidity, nutrient levels, chemical oxygen demand and pH. These alternations impact the species composition of the systems, especially species sensitive to minor changes in these parameters. Sudden drastic changes in water quality can also have chronic effects on aquatic biota in general and result in localised extinctions. Hydrocarbons including petrol/diesel and oils/grease/lubricants associated with construction activities (machinery, maintenance, storage, handling) may potentially enter the system by means of surface runoff or through dumping by construction workers.

As the existing earthen material is excavated, it will inevitably mix with the wetland's water, causing high turbidity. This is also the case for the excavation of the swale upslope of the river. The fine sediment particles will remain suspended for a period, reducing light penetration for aquatic plants and potentially smothering macroinvertebrates.

8.4.2 Operational Phase:

Operationally there should be minimal impact on water quality. Provided the swale to the Camfersdrift River does not result in any erosion or introduce and contaminants, it may have a positive impact by reducing the current volume of sediment being washed into the river from unmanaged stormwater runoff.

8.5 CUMULATIVE IMPACTS

Cumulatively, there should be no residual impact provided the footprint of the infill and gabion is not extended farther into HGM2 (thereby reducing habitat extent) nor resulting in transformation of habitat in the riparian area of the Camfersdrift River. The project's construction provides a new opportunity for invasive species to establish. These plants can outcompete native wetland vegetation, further reducing biodiversity and ecosystem function. This must be managed accordingly to prevent cumulative impacts.

9 IMPACT ASSESSMENT

9.1 ALTERNATIVES ASSESSED

Two project alternatives were provided for assessment, with the only structural difference being the design of the swale outlet. Alternative A has *“an outlet as close to the river as possible with energy dissipators to protect against erosion”* while Alternative B is described as *“a flared swale to spread the water out on the edge of the bush near the river.”*

From an aquatic biodiversity perspective, Alternative B is preferred as it is set back from the Camfersdrift River channel (meaning less riparian vegetation and bank disturbance) and

diffuses the discharge over a broader area, effectively reducing flow velocity and promoting natural attenuation through filtration. Alternative A, by directing water to a single, discrete outlet, concentrates its energy, which can lead to localized erosion and habitat degradation at the discharge point.

The No-Go Alternative has a slight negative impact due to the continuation of sediment being deposited in the river from rill erosion / artificial stormwater flow paths in rainfall events. Additionally, should the infilling supporting the substation fail, the HGM2 wetland will be negatively impacted.

9.2 SIGNIFICANCE

The impact significance upon aquatic biodiversity for the project was determined as Low after mitigation. Alternative B is likely to have a lower impact significance, and is therefore the preferred alternative, however, with mitigation, both designs can achieve low impact upon aquatic biodiversity.

Refer to Tables 6 to 10 for the results of impact assessment.

Table 6: Impact 1 – Disturbance of aquatic habitat and biota

PHASE:	Pre-construction and Construction	
Potential impact and risk:	Disturbance of aquatic habitat biota from clearance of vegetation, earthworks, and further invasive alien plant infestation, which can result in deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.	
Nature of impact:	Negative	
Alternative:	Alternative A	Alternative B
Extent and duration of impact:	Local and Short-term	Site Specific and Short-term
Magnitude of impact or risk:	Moderate	Small
Probability of occurrence:	Highly Probable	Highly Probable
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	No Loss
Degree to which the impact can be reversed:	Partly Reversible	Partly Reversible
Indirect impacts:	Probable	Probable
Cumulative impact prior to mitigation:	Low	Low
Significance rating of impact prior to mitigation	Medium	Medium
Degree to which the impact can be avoided:	Low	Medium
Degree to which the impact can be managed:	High	High

Degree to which the impact can be mitigated:	Can be partly mitigated	Can be mitigated
Proposed mitigation:	<ul style="list-style-type: none"> • A construction method statement must be compiled and available on site. Use the smallest possible working corridor. Outside the working corridor, all watercourses are to be considered no go areas. • Do not infill any wetland habitat and keep the gabion wall within current disturbance footprint. • Work as far as possible from the bank with limited work within the wetland. • The construction boundary must be clearly demarcated. • Vegetation removal must be avoided as far as possible. Any indigenous vegetation removed during construction must be stored in a wet area nearby for replacement following construction. • Remove any alien plant species within the working corridor. • Stockpiles must not be located within 15 metres of the riparian zone. The furthest threshold must be adhered to. Erosion control measures including silt fences, low soil berms and/or shutter boards must be put in place around the stockpiles to limit sediment runoff from stockpiles. • Where possible, construction activities should be conducted during the drier months of the year to minimise the possibility of erosion, sedimentation and transport of suspended solids associated with disturbed areas and rainfall events. Planning for such a situation must be undertaken. • Diversions/ dewatering areas must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse. Sandbags used in any diversion or for any other activity within a watercourse must be in a good condition, so that they do not burst and empty sediment into the watercourse. Upon completion of the construction at the site, the diversions shall be removed to restore natural flow patterns. Under no circumstance shall a new channel or drainage canals be excavated to divert water away from construction activities. • Monitoring should be conducted by an independent ECO before commencement to confirm demarcations are in place and indigenous vegetation is relocated where possible nearby, and frequently during construction within the wetland to ensure no unnecessary disturbance occurs. 	
Residual impacts:	Very Low	None
Cumulative impact post mitigation:	Negligible	None

Significance rating of impact after mitigation	Low	Low
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Table 7: Impact 2 – Changes to the hydrological regime

PHASE:	Construction and operation	
Potential impact and risk:	Changes to surface water input patterns and retention	
Nature of impact:	Negative	
Alternative:	Alternative A	Alternative B
Extent and duration of impact:	Site Specific and Short-term	Site Specific and temporary
Magnitude of impact or risk:	Minor	Negligible
Probability of occurrence:	Improbable	Improbable
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	No Loss
Degree to which the impact can be reversed:	Partly	Reversible
Indirect impacts:	Probable	Improbable
Cumulative impact prior to mitigation:	Low	Negligible
Significance rating of impact prior to mitigation	Low	Low
Degree to which the impact can be avoided:	Medium	High
Degree to which the impact can be managed:	High	High
Degree to which the impact can be mitigated:	Partly	Can be mitigated
Proposed mitigation:	<ul style="list-style-type: none"> • Diversions must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse. • The stormwater management infrastructure, such must be designed to ensure the runoff is not highly concentrated before entering the riparian area. • Effective stormwater management must include effective stabilisation (gabions and Reno mattresses) of exposed soil and drain outlets. Contingency plans must be in place for high rainfall events which may occur during construction. <ul style="list-style-type: none"> • Allow for grass to grow taller in swale – don't mow it. • Direct it to stormwater outlet, (if possible). 	
Residual impacts:	Low	None
Cumulative impact post mitigation:	None	None
Significance rating of impact after mitigation	No impact	No impact

Table 8: Impact 2 – Geomorphological changes

PHASE:	Construction and operation	
Potential impact and risk:	Excavation in the wetland and in Camfersdrift River riparian area, and erosion at swale outlet in operation	
Nature of impact:	Negative	
Alternative:	Alternative A	Alternative B
Extent and duration of impact:	Local and long term	Site Specific and medium term
Magnitude of impact or risk:	Moderate	Small
Probability of occurrence:	Highly Probable	Improbable
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	No Loss
Degree to which the impact can be reversed:	Partly Reversible	Partly Reversible
Indirect impacts:	Probable	Improbable
Cumulative impact prior to mitigation:	Low	Very Low
Significance rating of impact prior to mitigation	Medium	Low
Degree to which the impact can be avoided:	Medium	Low
Degree to which the impact can be managed:	High	High
Degree to which the impact can be mitigated:	Can be partly mitigated	Can be mitigated
Proposed mitigation:	<ul style="list-style-type: none"> • Prevent unnecessary encroachment into the wetland • Rehabilitate disturbed areas to pre-disturbance state • Prevent and monitor erosion at swale outlet • Do not drain the wetland • Sedimentation must be minimised with appropriate measures. • All stockpiles must be protected and located in flat areas where run-off will be minimised and sediment recoverable. • Construction must have contingency plans for high rainfall events during construction. 	
Residual impacts:	Low	None
Cumulative impact post mitigation:	Low	No impact
Significance rating of impact after mitigation	Low	Very Low

Table 9: Impact 4 –Changes to surface water quality

PHASE:	Construction
Potential impact and risk:	During construction, earthworks will expose and mobilise earth materials, and a number of materials

	as well as hydrocarbons/ cement/ chemicals may end up in the surface water. This can result in possible deterioration in aquatic ecosystem integrity and species diversity.	
Nature of impact:	Negative	
Alternative:	Alternative A	Alternative B
Extent and duration of impact:	Local and short term	Local and short term
Magnitude of impact or risk:	Medium	Medium
Probability of occurrence:	Probable	Improbable
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	Marginal loss
Degree to which the impact can be reversed:	Reversible	Reversible
Indirect impacts:	Probable	Probable
Cumulative impact prior to mitigation:	Medium	Medium
Significance rating of impact prior to mitigation	Medium	Medium
Degree to which the impact can be avoided:	High	High
Degree to which the impact can be managed:	High	High
Degree to which the impact can be mitigated:	Can be mitigated	Can be mitigated
Proposed mitigation:	<ul style="list-style-type: none"> • Spills or leaks from vehicles or machinery must be entirely avoided. Cement/concrete batching is to be located in an area of low environmental sensitivity away from the river channel and pre-approved by the ECO. No batching activities shall occur on unprotected ground. Adequate surface protection will be required. Concrete batching should be restricted to a level and bunded/sealed surface above the riverbanks. • Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered site. • Sedimentation must be minimised with appropriate measures. • Where possible, construction activities should be conducted during the drier months of the year. • All post-construction building material and waste must be cleared in accordance with the EMP. The solid domestic waste must be removed and disposed of offsite. • Any use of herbicides in removing alien plant species is required to be investigated by the ECO before use, for the necessity, type proposed to be 	

	used, effectiveness and impacts of the product on aquatic biota. <ul style="list-style-type: none"> • Construction must be immediately followed by rehabilitation. 	
Residual impacts:	None	None
Cumulative impact post mitigation:	None	None
Significance rating of impact after mitigation	No impact	No impact

10 CONCLUSION

The aquatic biodiversity assessment for the proposed repair works at the Langenhoven Substation has identified the presence of riparian and wetland habitat of moderate ecological importance and sensitivity. Potential impacts relating to habitat disturbance, hydrological modification, geomorphological change and water quality degradation were assessed. With appropriate mitigation, these impacts are of low significance.

Alternative B, which makes use of a flared swale to diffuse stormwater before it enters the Camfersdrift River, is considered the preferred option from an aquatic biodiversity perspective. Implementation of the mitigation measures, strict control of construction activities, and rehabilitation of disturbed areas will ensure that the ecological condition of the affected watercourses is maintained and that no unacceptable impacts occur.

On this basis, the proposed works can be authorised from an aquatic biodiversity perspective, subject to adherence to the recommended mitigation measures and monitoring requirements.

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APPENDIX 1 –DETAILED METHODOLOGY

For reference the following definitions are as follows:

- **Drainage line:** A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may not be present.
- **Perennial and non-perennial:** Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and thus contains flows for short periods, such as a few hours or days in the case of drainage lines.
- **Riparian:** the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).
- **Wetland:** land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al.*, 1979).
- **Water course:** as per the National Water Act means -
 - (a) a river or spring;
 - (b) a natural channel in which water flows regularly or intermittently;
 - (c) a wetland, lake or dam into which, or from which, water flows; and
 - (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks

11.1 WETLAND DELINEATION AND HGM TYPE IDENTIFICATION

Wetland delineation includes the confirmation of the occurrence of wetland and a determination of the outermost edge of the wetland. The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual ‘A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas’ (DWAF, 2005a). Wetland indicators were used in the field delineation of the wetlands: position in landscape, vegetation and soil wetness (determined through soil sampling with a soil auger and the examining the degree of mottling).

Four specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.

- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

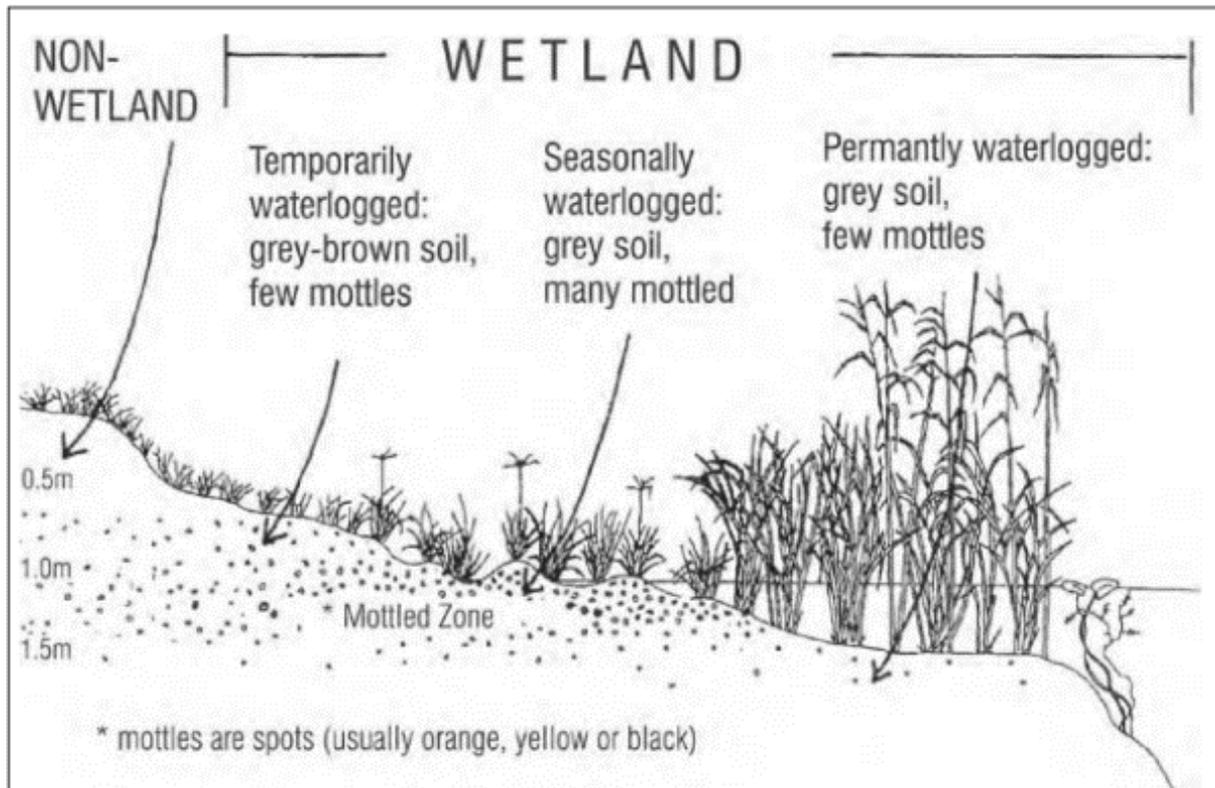


Figure A12.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

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 for several centuries).

The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display (Table A12.1a)

A12.1a: Soil Wetness Indicators in the various wetland zones

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (<10%)	Grey matrix (<10%)	Prominent grey matrix

Few high chroma mottles	Many low chroma mottles present	Few to no high chroma mottles
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year round (possible sulphuric odour)

Table A12.1b: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands

Vegetation	Temporary Wetness Zone	Seasonal Wetness Zone	Permanent Wetness Zone
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (<i>Phragmites australis</i>), a mixture of sedges and bulrushes (<i>Typha capensis</i>), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).
Symbol	Hydric Status	Description/Occurrence	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)	
D	Dryland species	Almost always grow in drylands	

In order to identify the wetland types, using Kotze *et al.* (2009) and Ollie *et al.* (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. These have been defined based on the geomorphic setting of the wetland in the landscape (e.g. hillslope or valley bottom, whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated), how water flows through the wetland (diffusely or channelled) and how water exits the wetland (Figure A12.1b).

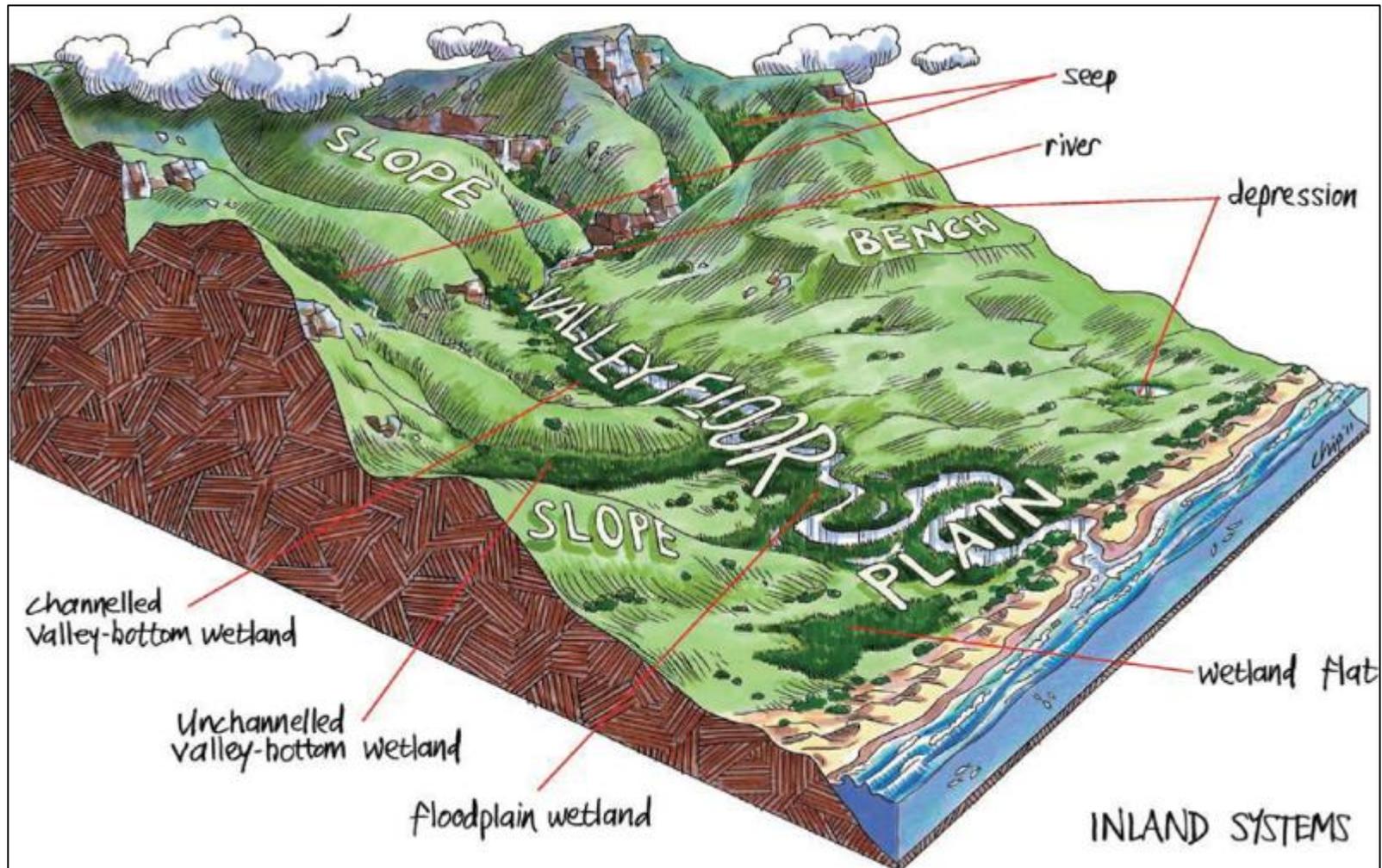


Figure A12.1b: Illustration of wetland types and their typical landscape setting (From Ollie *et al.* 2013)

11.2 DELINEATION OF RIPARIAN AREAS

Riparian zones are described as “the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas” i , Riparian zones can be thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas (Figure 12.2a). Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel.

Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are: - **Landscape position**; - Alluvial soils and recently deposited material; - **Topography** associated with riparian areas; and - **Vegetation** associated with riparian areas. Landscape Position As discussed above, a typical landscape can be divided into 5 main units), namely the: - Crest (hilltop); - Scarp (cliff); - Midslope (often a convex slope); - Footslope (often a concave slope); and - Valley bottom. Amongst these landscape units, riparian areas are only likely to develop on the valley bottom landscape units (i.e. adjacent to the river or stream channels; along the banks comprised of the sediment deposited by the channel). Alluvial soils are soils derived from material deposited by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators. Quaternary alluvial soil deposits are often indicated on geological maps, and whilst the extent of these quaternary alluvial deposits usually far exceeds the extent of the contemporary riparian zone; such indicators are useful in identifying areas of the landscape where wider riparian zones may be expected to occur.

Topography and recently deposited material associated with riparian areas The National Water Act definition of riparian zones refers to the structure of the banks and likely presence of alluvium. A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised “macro-channels” which are typical of many of southern Africa’s eastern seaboard rivers. Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus the likely presence of wetlands. Vegetation associated with riparian areas unlike the delineation of wetland areas, where redoxymorphic features in the soil are the primary indicator, the identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs: - in species composition relative to the adjacent terrestrial area; and - in the physical structure, such as vigour or robustness of

growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

As with the delineation approach for wetlands, the field delineation method for riparian areas focuses on two main indicators of riparian zones: - **Vegetation Indicators**, and - **Topography** of the banks of the river or stream.

Additional verification can be obtained by examining for any recently alluvial deposited material to indicate the extent of flooding and thus obtain at least a minimum riparian zone width. The following procedure should be used for delineation of riparian zones: A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. The macro-channel is an incised feature, created by uplift of the subcontinent which caused many rivers to cut down to the underlying geology and creating a sort of “restrictive floodplain” within which one or more active channels flow. Floods seldom have any known influence outside of this incised feature. Within the macro-channel, flood benches may exist between the active channel and the top of the macro channel bank. These depositional features are often covered by alluvial deposits and may have riparian vegetation on them. Going (vertically) up the macro channel bank often represents a dramatic decrease in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

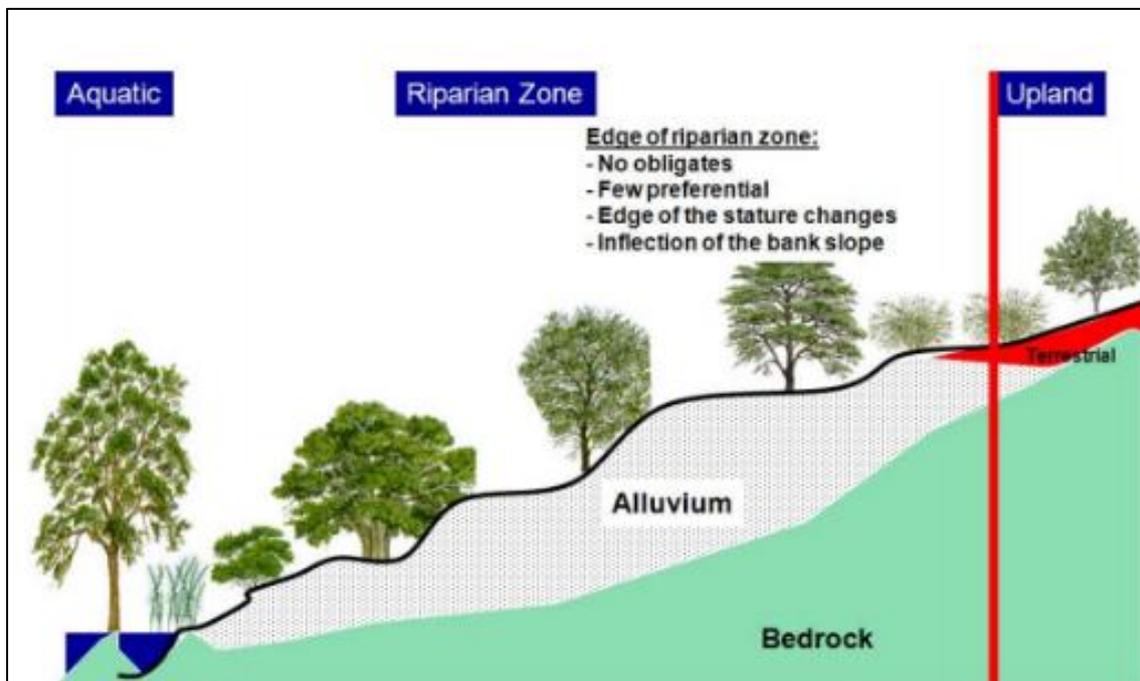


Figure A12.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAf 2008).

11.3 PRESENT ECOLOGICAL STATE (PES) – WETLANDS

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland.

WET-Health is a tool designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. This technique attempts to assess hydrological, geomorphological and vegetation health in three separate modules.

Hydrology is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing, as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland.

Geomorphology is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (mineralogenic) and organic sediment (peat).

Vegetation is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite transformation and/or disturbance.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. The tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (Table A12.2a).

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from “unmodified/natural” (Category A) to “severe/complete deviation from natural” (Category F) as depicted in Table A12.2b, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

$$\text{Overall health rating} = [(\text{Hydrology} \times 3) + (\text{Geomorphology} \times 2) + (\text{Vegetation} \times 2)] / 7$$

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

Table A12.2a: Guideline for interpreting the magnitude of impact on integrity

Impact Category	Description	Score
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Table A12.2b. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2008).

Impact Category	Description	Range	PeS Category
None	Unmodified, natural.	0 – 0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features	6 – 7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 – 10	F

11.4 WETLAND FUNCTIONAL IMPORTANCE (GOODS AND SERVICES)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 20 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in Table A12.4a) - that is, the benefits provided to people by the ecosystem.

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits		Flood attenuation	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream	
				Streamflow regulation	Sustaining streamflow during low flow periods	
		Water quality enhancement benefits			Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
					Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
					Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
					Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
					Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
				Carbon storage	The trapping of carbon by the wetland, principally as soil organic matter	
	Direct benefits	Biodiversity maintenance ²			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity	
		Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes	
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.	
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods	
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants	
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife	
Education and research			Sites of value in the wetland for education or research			

Table A12.4a: Ecosystem services assessed by WET-Ecoservices

11.5 PRESENT ECOLOGICAL STATE (PES) – RIPARIAN

Habitat is one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996). The ‘habitat integrity’ of a river refers to the “maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region” (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

DWAF have developed a modified IHI, designed to accommodate the time constraints associated with desktop assessments or for instances where a rapid assessment of river conditions is required. The protocol does not distinguish between instream and riparian habitat and addresses six simple metrics to obtain an indication of Present Ecological State (PES). Each of the criteria are rated on a scale of 0 (close to natural) to 5 (critically modified) (Table A1.1) according to the following metrics:

- Bed modification
- Flow modification
- Inundation
- Bank condition
- Riparian zone condition
- Water quality modification

This assessment was informed by (i) a site visit where potential impacts to each metric were assessed and evaluated and (ii) an understanding of the catchment feeding the river and landuses / activities that could have a detrimental impact on river ecosystems.

Table A1.1: The rating scale for each of the various metrics in the assessment

Rating Score	Impact Class	Description
0	None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
0.5 - 1.0	Low	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.
1.5 - 2.0	Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.
2.5 - 3.0	Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.

3.5 - 4.0	Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.
4.5 - 5.0	Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.

The six metric ratings of the HGM under assessment are then averaged, resulting in one value. This value determines the Habitat Integrity PES category for the HGM (Table A1.2).

Table A1.2: The habitat integrity PES categories

Habitat Integrity PES Category	Description
A: Natural	Unmodified, natural.
B: Good	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: Fair	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D: Poor	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E: Seriously modified	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F: Critically modified	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.

11.6 ECOLOGICAL IMPORTANCE & SENSITIVITY – RIPARIAN

The ecological importance of a wetland/river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system’s ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh et al., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (Table A1.3).

The scores assigned to the criteria in Table A1.3 were used to rate the overall EIS of each mapped unit according to Table A1.4, below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane et al., 2008).

Table A1.3: Components considered for the assessment of the ecological importance and sensitivity of a riparian system. An example of the scoring has also been provided.

Ecological Importance and Sensitivity assessment (Rivers)		
Determinants		Score (0-4)
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	0,0
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	0,5
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	1,0
	Refugia (4=Very high - 1=marginal/low)	1,5
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	1,0
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	1,0
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	2
MEDIAN OF DETERMINANTS		1,00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		LOW, EC=D

Table A1.4: The ratings associated with the assessment of the EIA for riparian areas

Rating	Explanation
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

11.7 IMPACT ASSESSMENT METHODOLOGY PROVIDED BY SES

Methodology to determine the significance ratings of the potential environmental impacts and risks associated with the alternatives.

The assessment criteria utilised in the Basic Assessment Report is based on, and adapted from, the Guideline on Impact Significance, Integrated Environmental Management Information Series 5 (Department of Environmental Affairs and Tourism (DEAT), 2002) and the Guideline 5: Assessment of Alternatives and Impacts in Support of the Environmental Impact Assessment Regulations (DEAT, 2006).

Determination of Extent (Scale):

Site specific	On site or within 100 m of the site boundary, but not beyond the property boundaries.
Local	The impacted area includes the whole or a measurable portion of the site and property, but could affect the area surrounding the development, including the neighbouring properties and wider municipal area.
Regional	The impact would affect the broader region (e.g., neighbouring towns) beyond the boundaries of the adjacent properties.
National	The impact would affect the whole country (if applicable).

Determination of Duration:

Temporary	The impact will be limited to the construction phase.
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than 8 months after the completion of the construction phase.
Medium term	The impact will last up to the end of the construction phase, where after it will be entirely negated in a period shorter than 3 years after the completion of construction activities.
Long term	The impact will continue for the entire operational lifetime of the development but will be mitigated by direct human action or by natural processes thereafter.
Permanent	This is the only class of impact that will be non-transitory. Such impacts are regarded to be irreversible, irrespective of what mitigation is applied.

Determination of Probability:

Improbable	The possibility of the impact occurring is very low, due either to the circumstances, design or experience.
Probable	There is a possibility that the impact will occur to the extent that provisions must therefore be made.
Highly probable	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up to mitigate the activity before the activity commences.
Definite	The impact will take place regardless of any prevention plans.

Determination of Significance (without mitigation):

No significance	The impact is not substantial and does not require any mitigation action.
Low	The impact is of little importance but may require limited mitigation.
Medium	The impact is of sufficient importance and is therefore considered to have a negative impact. Mitigation is required to reduce the negative impacts to acceptable levels.
Medium-High	The impact is of high importance and is therefore considered to have a negative impact. Mitigation is required to manage the negative impacts to acceptable levels.
High	The impact is of great importance. Failure to mitigate, with the objective of reducing the impact to acceptable levels, could render the entire development option or entire project proposal unacceptable. Mitigation is therefore essential.
Very High	The impact is critical. Mitigation measures cannot reduce the impact to acceptable levels. As such the impact renders the proposal unacceptable.

Determination of Significance (with mitigation):

No significance	The impact will be mitigated to the point where it is regarded to be insubstantial.
Low	The impact will be mitigated to the point where it is of limited importance.
Medium	Notwithstanding the successful implementation of the mitigation measures, the impact will remain of significance. However, taken within the overall context of the project, such a persistent impact does not constitute a fatal flaw.
High	Mitigation of the impact is not possible on a cost-effective basis. The impact continues to be of great importance, and taken within the overall context of the project, is considered to be a fatal flaw in the project proposal.

Determination of Reversibility:

Completely Reversible	The impact is reversible with implementation of minor mitigation measures
Partly Reversible	The impact is partly reversible but more intense mitigation measures
Barely Reversible	The impact is unlikely to be reversed even with intense mitigation measures
Irreversible	The impact is irreversible, and no mitigation measures exist

Determination of Degree to which an Impact can be Mitigated:

Can be mitigated	The impact is reversible with implementation of minor mitigation measures
Can be partly mitigated	The impact is partly reversible but more intense mitigation measures
Can be barely mitigated	The impact is unlikely to be reversed even with intense mitigation measures
Not able to mitigate	The impact is irreversible, and no mitigation measures exist

Determination of Loss of Resources:

No loss of resource	The impact will not result in the loss of any resources
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Marginal loss of resource	The impact will result in marginal loss of resources
Significant loss of resources	The impact will result in significant loss of resources
Complete loss of resources	The impact will result in a complete loss of all resources

Determination of Cumulative Impact:

Negligible	The impact would result in negligible to no cumulative effects
Low	The impact would result in insignificant cumulative effects
Medium	The impact would result in minor cumulative effects
High	The impact would result in significant cumulative effects

Determination of Consequence significance:

Negligible	The impact would result in negligible to no consequences
Low	The impact would result in insignificant consequences
Medium	The impact would result in minor consequences
High	The impact would result in significant consequences

Assessment of each impact and risk identified for each alternative.

Note: The following table was taken from a Basic Assessment Report document and must be filled out by the specialist when undertaking an Impact Assessment.

Alternative:	Alternative A (Option 1)	Alternative B (Option 2)	No-Go Alternative
PHASE:			
Potential impact and risk:			
Nature of impact:			
Extent and duration of impact:			
Consequence of impact or risk:			
Probability of occurrence:			
Degree to which the impact may cause irreplaceable loss of resources:			
Degree to which the impact can be reversed:			
Indirect impacts:			
Cumulative impact prior to mitigation:			
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)			
Degree to which the impact can be avoided:			
Degree to which the impact can be managed:			
Degree to which the impact can be mitigated:			
Proposed mitigation:			
Residual impacts:			
Cumulative impact post mitigation:			
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)			

APPENDIX 2- SPECIALIST CV

CURRICULUM VITAE

Debra Jane Fordham

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Email: debrajanefordham@gmail.com

Date of birth: 26th August 1987

Country of origin: South Africa

ID Number: 8708260094081

Professional profile

Debbie is a registered ecologist (119102), with over 8 years of working experience, largely specialising in aquatic ecology. She has authored over 80 reports and applications and she constantly contributes to the scientific and local community. Most of her projects involve (as a minimum) in-depth wetland and river field delineation (including soil investigations via augering, vegetation identification, and classifying the hydrological characteristics), laboratory analysis (such as water quality and sediment analysis), classification, characterisation, ecological health and ecosystem functioning assessments (using the latest available tools), as well as impact rating, buffer determinations, mitigation recommendations and detailed rehabilitation plans. She is highly proficient using GIS software to incorporate accurate spatial analysis and visual aids (No Go Area maps etc.) into her reports.

Debbie holds a M.Sc. degree in Environmental Science from Rhodes University, by thesis, entitled: The geomorphic origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She is a member of scientific organisations such as the Society of Wetland Scientists (SWS), the South African Wetland Society (SAWS), the Southern African Association of Geomorphologists (SAAG), and the International Association for Impact Assessment (IAIASa). Debbie is registered with SACNASP in the field of Ecological Science (Reg Number: 119102).

Tertiary Education

- M.Sc. Environmental Science (Rhodes University):
Master of Science thesis entitled: The geomorphic origin, evolution and collapse of a peatland dominated by *Prionium serratum*: a case study of the Tierkloof Wetland, Western Cape.
- BA Hons. Environmental Science (Rhodes University):
Honours dissertation: The status and use of *Aloe ferox*. Mill in the Grahamstown commonage, South Africa.

Courses: Wetland Ecology, Environmental Water Quality /Toxicology, Biodiversity, Non-Timber Forest Products (NTFPs) and Rural Livelihoods, Environmental Impact Assessment (EIA), Statistics

- BA - Environmental Science and Geography (Rhodes University)

Work Experience:

- Ecological specialist (2022/03/01 – present)
- Sharples Environmental Services cc (2016/08/10 – 2022/03/01)

Position: Aquatic Ecologist and WULA Manager

- KSEMS Environmental Consulting (2015/08/10 - 2016/07/31)

Position: Wetland specialist

- AGES EC (Pty) Ltd (2014/10/01 – 2015/08/10)

Position: Aquatic Ecologist and WULA Manager

- Environmental Impact Management Services (2014/02/04-2014/02/07)

Position: Environmental consultant

- Rhodes University Alumni Relations (2010/04/01 – 2010/12/17)

APPENDIX 3 -SPECIALIST DECLARATION

Specialist Name:	Company	Upstream Consulting		
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	NA
Specialist name:	Debra Fordham			
Specialist Qualifications:	M.Sc. – Environmental Science (Wetland Ecology) B. Sc. (Hons) - Environmental Science B.A. – Environmental Science and Geography SACNASP registered Professional Wetland Scientist			
Professional affiliation/registration:	Debra Fordham is a Professional Wetland Scientist and SACNASP registered ecologist with 10 years of experience in the environmental and conservation sectors, specialising in aquatic biodiversity assessment.			
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Postal code:	6530	Cell:	0724448243	
Telephone:		Fax:		
E-mail:	debbie@upstreamconsulting.co.za			

DECLARATION BY THE SPECIALIST

I, Debra Fordham, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



Signature of the Specialist

Name of Company: Upstream Consulting

DATE: 05/09/2025

REVIEWER DECLARATION

Specialist Name:	Company	Upstream Consulting		
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	4	Percentage Procurement recognition	NA
Specialist name:	Colin Fordham			
Specialist Qualifications:	M.Sc. – Entomology (Biological Control) B. Sc. (Hons) - Botany (Environmental Management) B.Sc. – Botany and Biochemistry SACNASP registered Professional Wetland Scientist			
Professional affiliation/registration:	Colin Fordham is a SACNASP registered Professional Natural Scientist (Pr. Sci. Nat.) Ecologist with 14 years of experience in the environmental and conservation sectors.			
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E-mail:	Colin@upstreamconsulting.co.za			

DECLARATION BY THE SPECIALIST

I, Colin Fordham, declare that –

- I act as the independent review specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



Signature of the Reviewer

Name of Company: Upstream Consulting

DATE: 05/09/2025