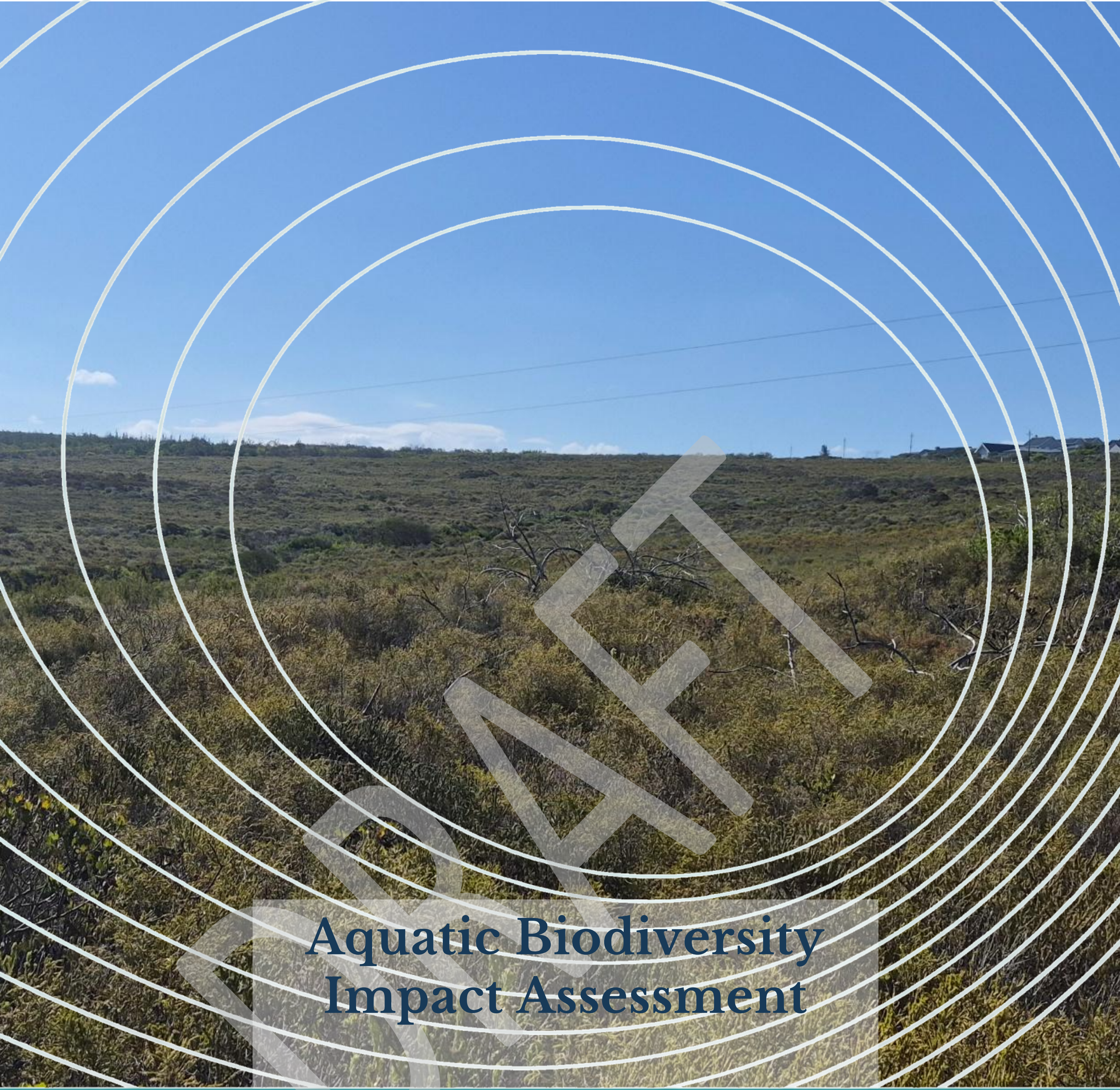

Aquatic Biodiversity Impact Assessment

Development on Portions 59 and 62 of Farm Brakkloof No. 443, Plettenberg Bay, Bitou Local Municipality

Date:
1 March 2026

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Executive Summary

Upstream Consulting was appointed by Stargate Innovations Pty Ltd to undertake an aquatic biodiversity site sensitivity verification, baseline assessment and aquatic impact assessment for development proposed on Portions 59, 63 and 62 of Brakkekloof Farm 443, near Plettenberg Bay.

The project consists of two main components. The first is an upmarket life rights retirement estate on Portion 59. This estate will include approximately 121 single storey units with internal roads, services, and shared facilities. The second component comprises a cultural and tourism precinct on Portions 62 and 63. These properties are proposed to be rezoned to Open Space III and incorporated into the Robberg Coastal Corridor for Stewardship. Within this protected landscape, a cultural node will be established, including the Museum of Mankind, a boutique accommodation component with nineteen units, a grassed amphitheatre, and related visitor facilities. According to the information provided, the development cannot be supplied with water or sewerage connections from Bitou Municipality and will therefore be dependent on its own off grid water supply and sewerage treatment infrastructure.

The need for the assessment as part of the environmental authorisation application was triggered by a *Very High* aquatic sensitivity rating assigned by the DFFE Screening Tool, due to the site's partial overlap with the Outeniqua Strategic Water Source Area (SWSA) and an Aquatic Ecological Support Area (ESA 1). The SSV and baseline report confirmed that the site contains areas of high sensitivity for the aquatic biodiversity theme, not for the mapped ESA habitat, but due to the presence of watercourses. It was recommended that a full aquatic biodiversity impact assessment be undertaken to evaluate potential impacts on hydrology, geomorphology, water quality and associated ecological processes of the aquatic features identified on-site.

Field verification confirmed that only two of the aquatic features, both situated downslope of the proposed development footprint (HGM 1 and HGM 2), have any potential to be affected. Both watercourses are classified as riparian systems following the hydrogeomorphic framework. These systems are non-perennial, narrow, valley-bottom drainage features characterised by intact indigenous riparian vegetation, stable channel morphology, and limited contemporary anthropogenic disturbance. PES assessments indicate that both non-perennial streams are in a Good Present Ecological State (Category B), reflecting their structurally intact riparian vegetation and moderate resilience to disturbance.

Ecosystem Services analysis identified high importance for biodiversity maintenance, reflecting the role of these features as ecological corridors, but achieved only low to moderate importance for regulatory and societal ecoservices. EIS scores for both units are High (Category B), driven largely by biodiversity-supporting functions, their intactness, and their contribution to ecological connectivity. The recommended management objective is therefore to maintain the watercourses in their present condition.

Based on the findings of the baseline assessment report, the proposed layout has been designed to avoid the recommended aquatic buffer zones but required detailed assessment for potential impacts associated with changes in catchment land cover and the discharge of treated effluent from the wastewater treatment plant. The direct and indirect impacts associated with the project were grouped into four encapsulating impact categories where associated or interlinked impacts are grouped. Therefore, the potential impacts assessed, including cumulative impacts, were:

- Impact 1: Loss or disturbance of aquatic habitat and biota
- Impact 2: Alterations to the hydrological regime
- Impact 3: Sedimentation and erosion
- Impact 4: Changes to surface water quality
- Impact 5: Cumulative impacts on the aquatic resources of the area

During the construction phase, potential impacts relate primarily to upslope earthworks, including risks of increased stormwater concentration, sediment mobilisation, and indirect disturbance of riparian edges. During the operational phase, the most important consideration is the use of a package wastewater treatment plant, which will discharge treated effluent into HGM 1. This will convert the currently dry, non-perennial channel into a system with sustained baseflow, thereby altering its hydrological regime and downstream moisture conditions. The quality and volume of this discharge will determine the extent of ecological change. With correct operation, monitoring, and compliance with general authorisation limits, these effects are manageable. The incorporation of SUDs techniques into the proposed stormwater management of the civil design report significantly mitigate impacts related to surface runoff.

A summary of the impact assessment results is illustrated in the table below and indicate that the No-Go Alternative will have a low, negative impact, as no additional disturbance occurs; however, existing pressures on the catchment (including historic land transformation and minor water quality alteration from neighbouring properties) will persist. The Preferred Alternative was determined to have a medium level of negative impact significance, but after mitigation this decreased to low significance. Mitigation assumes adequate implementation of stormwater management, erosion control, buffer compliance, and operational monitoring of the package plant. Therefore, all assessed impacts are of low residual significance under the mitigated preferred scenario.

Table: A summary of impact significant assessment process

Impact	**Significance**		**After Mitigation**	
	Preferred Alternative	No-Go	Preferred Alternative	No-Go
Loss or disturbance of aquatic habitat and biota	Medium -Low Impact (30)	Low Impact (14)	Low Impact (4)	Low Impact (14)
Alterations to the hydrological regime	Medium Impact (48)	Low Impact (9)	Low Impact (22)	Low Impact (9)
Sedimentation and erosion	Medium Impact (39)	Low Impact (8)	Low Impact (18)	Low Impact (8)
Changes to surface water quality	Medium Impact (36)	Low Impact (7)	Low Impact (12)	Low Impact (7)
Cumulative impacts on the aquatic resources of the area	Medium Impact (36)	Low Impact (9)	Low Impact (13)	Low Impact (9)

From an aquatic perspective, the proposed development is deemed acceptable, provided that mitigation measures and monitoring commitments are strictly implemented.

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.	Colin Fordham (400166/14 Ecology) Debbie Fordham (119102 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 4 – Desktop Information Section 5 - Results
(a) aquatic ecosystem types; and (b) presence of aquatic species, and composition of aquatic species communities, their habitat, distribution and movement patterns;	Section 4 – Desktop Information Section 5.1 – Identified habitat
2.3.2. the threat status of the ecosystem and species as identified by the screening tool;	Very High 1.2 -Screening tool results Section 4 – Conservation context Section 4 - SAIIAE
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 4 – Desktop Information
2.3.4. a description of the ecological importance and sensitivity of the aquatic ecosystem including:	Section 5.2 Section 5.3
(a) the description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); and (b) the historic ecological condition (reference) as well as present ecological state of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).	Section 5.4 Section 5.1 – Identified aquatic habitat Section 4.7 –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 5.1
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 7 –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 6 – 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 6.2 –Flow pattern changes 6.3 - Erosion and Sedimentation Section 6.1 – Loss of aquatic habitat Section 6.4 Water Quality impacts
2.5.4. how will the proposed development impact on the functioning of the aquatic feature? This must include:	Section 7 – 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 7–Impact assessment and tables Section 6 – Identified Impacts Section 7 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 7 – 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 6 – 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 6 and Impact Table of Section 7
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).	Section 4 – Drainage network
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;	Appendix 3 - Declaration of Independence and below– Page viii
2.7.3. a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	2.2 – Site assessment Section 2 – Approach and methodology Section 3 - Assumptions
2.7.4. the methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;	Section 2 – Approach and methodology

Declaration of Independence

SPECIALIST REPORT DETAILS

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 License Application and Appeals Regulations, 2017 Government Notice R267 in Government Gazette 40713 dated 24 March 2017, which includes the minimum requirements for an Aquatic Compliance Statement.

Report prepared by: Colin Fordham (SACNASP No. 400166/14 Ecology)
Co- author: Debbie Fordham (SACNASP No. 119102)

Expertise / Field of Study: Debbie Fordham is an aquatic ecologist and Professional Wetland Scientist, registered with the SWSPCP (No. 3683) and SACNASP (No. 119102). Debbie was awarded her Master of Science degree, by thesis, in Wetland Science, entitled: The origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She has been consulting since 2010, producing numerous aquatic habitat impact assessment reports. She is a certified Professional Wetland Scientist (PWS certification number 3683) by the Society for Wetland Scientists (SWS) Professional Certification Program, which is internationally accredited by the Council of Engineering and Scientific Specialty Boards (CESB). She also holds a committee portfolio position with the SWS. She is a member of the Society for Wetland Scientists, the South African Wetland Society, the Southern African Association of Geomorphologists, the South African Hydrological Society (SAHS) and SACNASP.

Colin Fordham is a SACNASP registered Professional Natural Scientist (Pr. Sci. Nat.) Ecologist with 14 years of experience in the environmental and conservation sectors. He began his career in environmental consulting, spending six years compiling botanical and aquatic specialist reports for diverse development applications across Southern Africa. He then joined CapeNature as a Land Use Scientist, where he reviewed specialist reports to ensure compliance with best practices and legislation. In 2025 Colin joined Upstream Consulting as a professional aquatic ecologist. Amongst other qualifications, Colin holds a M.Sc. degree in Entomology (Biological Control of Aquatic Plants) from Rhodes University.

I, **Colin 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:…1 March 2026 ………..

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1 INTRODUCTION

Upstream Consulting was appointed by Stargate Innovations Pty Ltd to undertake an aquatic site sensitivity verification, baseline assessment and aquatic impact assessment for Portions 59 and 62 of Brakkekloof Farm 443 near Plettenberg Bay. The purpose of these assessments is to determine the condition of the aquatic habitat on the property and to evaluate how the proposed development may affect these freshwater features.

As per the information supplied, the proposed development is situated on the Remainders of Portions 59, 62 and 63 of Farm Brakkloof No. 443, adjacent to Plettenberg Bay within the Bitou Municipality. The project consists of two main components. The first is an upmarket life rights retirement estate on Portion 59. This estate will include approximately 121 single storey units with internal roads, services, and shared facilities.

The second component comprises a cultural and tourism precinct on Portions 62 and 63. These properties are proposed to be rezoned to Open Space III and incorporated into the Robberg Coastal Corridor for Stewardship. Within this protected landscape, a low impact cultural node will be established, including the Museum of Mankind, a boutique accommodation component with nineteen units, a grassed amphitheatre, and related visitor facilities.

The design of the overall development responds to the topography, drainage features, hydrological sensitivities, and heritage constraints of the area. All development footprints avoid delineated non perennial drainage lines and their recommended buffers, and the museum precinct has been located outside zones of highest archaeological sensitivity. Civil engineering services such as water supply, wastewater treatment, stormwater attenuation, and energy provision have been planned for on-site implementation due to limited municipal service capacity.

The Aquatic Impact Assessment Report evaluates how the development design will affect the rivers, wetlands, and other aquatic features identified in the Baseline Assessment, which was used to inform the project design (Figure 1). The baseline study mapped and described these systems to inform the layout and avoid sensitive areas; the impact assessment now determines the actual impacts of the chosen design, identifies any required water-use authorisations, and provides mitigation and management measures to ensure the development remains environmentally responsible and legally compliant.

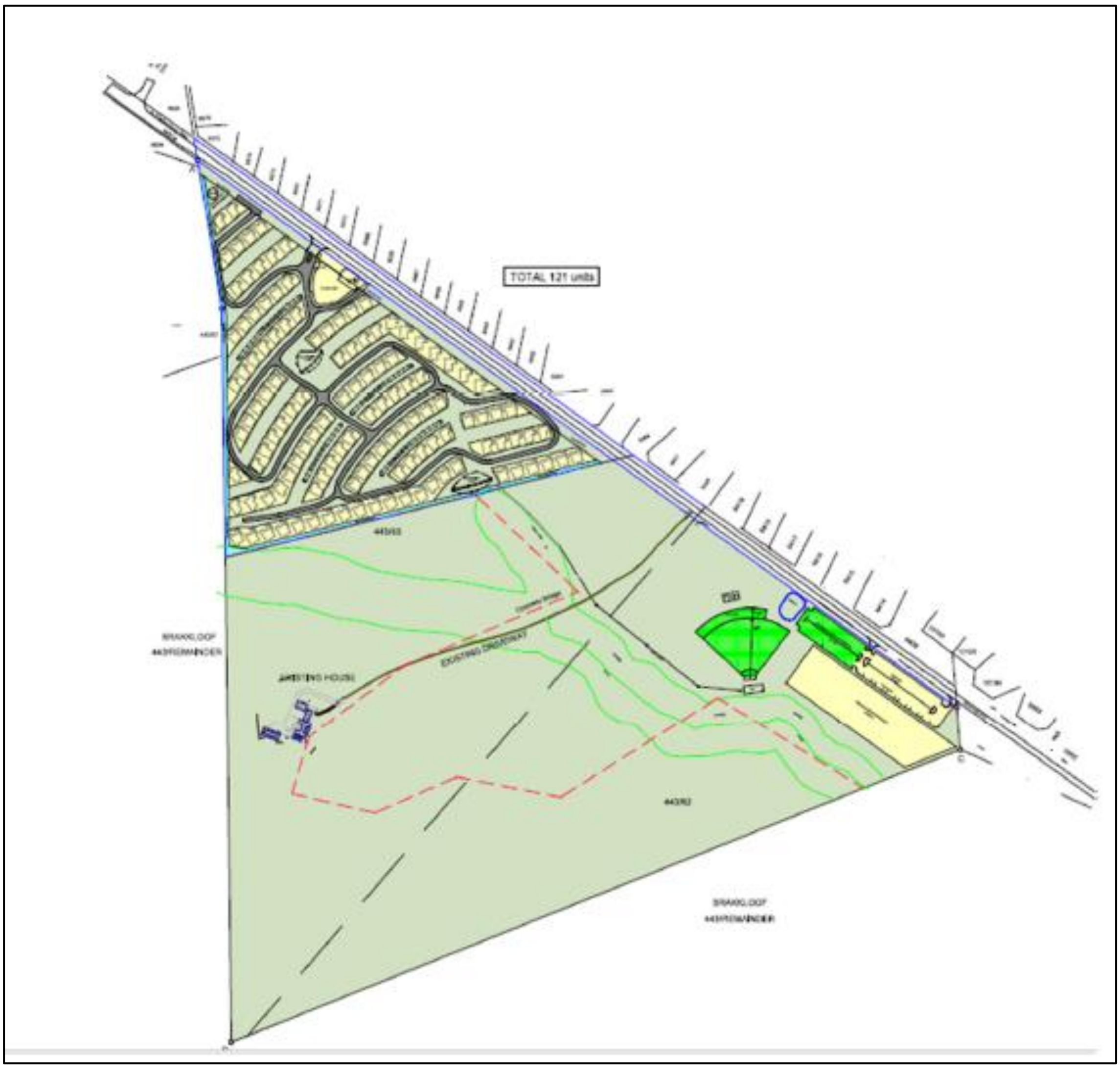

Figure 1: The Stargate development layout.

1.1 Purpose of the report

The study area is located on the coastal platform less than 5km from the centre of Plettenberg Bay in Bitou Local Municipality. The site extends over three triangular farm portions in an undeveloped area between Robberg Road and the coastline (Figure 2). It is bordered (and accessed) by Whale Rock Drive (opposite the Whale Rock Ridge housing estate) which leads to the Robberg Nature Reserve on the peninsula.

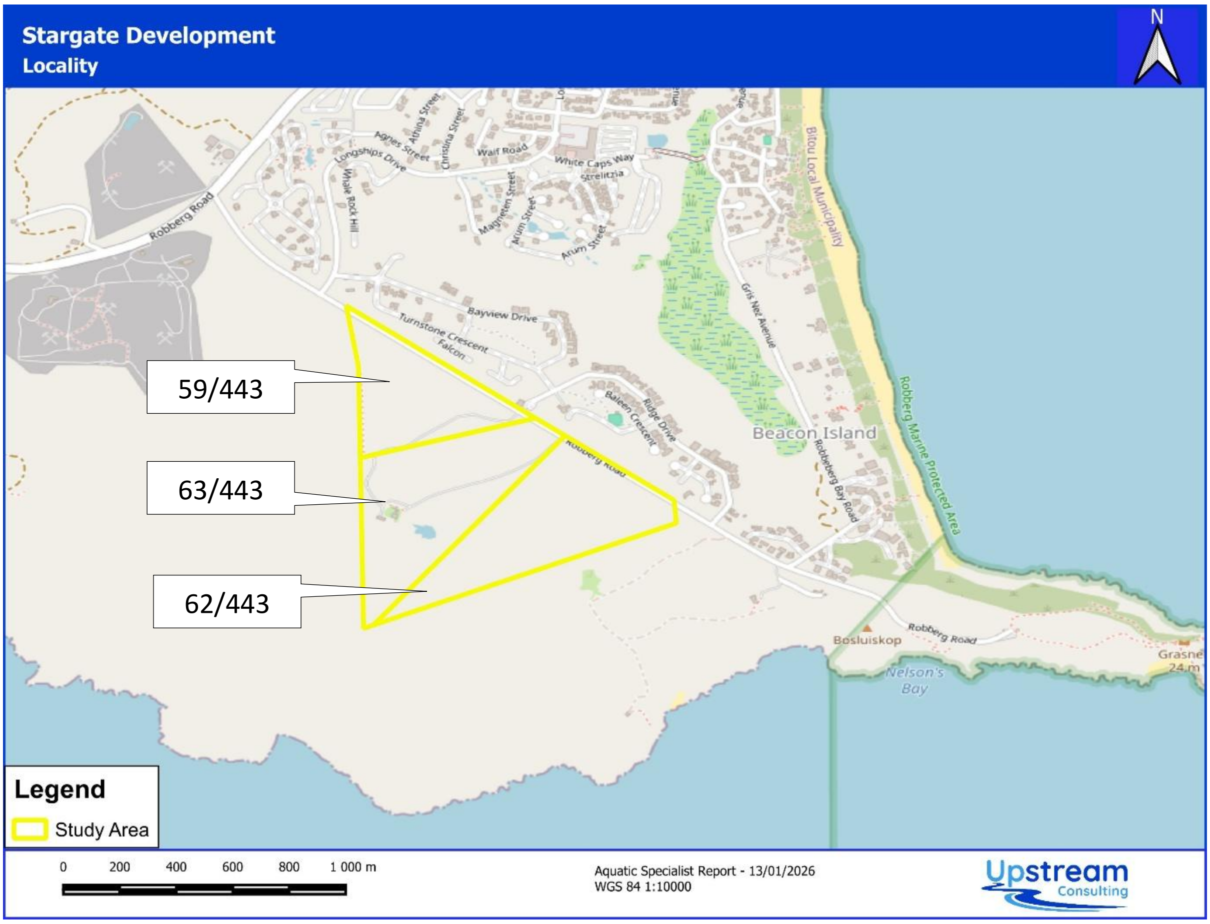

Figure 2: Locality map of the three farm portions in relation to the developed urban area and the Robberg Peninsula

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 must go with 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 study area is classified as 'Very High' and 'Low" aquatic sensitivity habitat, which was confirmed in the Baseline Aquatic and Site Sensitivity and Verification Report (Figure 3). The very high sensitivity rating from the SSV is due to the presence of watercourses as opposed to any potential impacts to the mapped SWSA and ESA.

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity
Very High	ESA 1: Aquatic
Very High	SWSA (sw)_Outeniqua

Figure 3: DFFE Screening Tool map of aquatic biodiversity theme sensitivity indicating very high sensitivity for the survey area.

1.3 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 2 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.
National Environmental Management Protected Areas Act 57 of 2003	Provides for the protection and management of protected areas, buffer zones, and conservation areas. Relevant for offsets and where developments are near or adjacent to nature reserves, marine protected areas, or conservation corridors.
Environmental Impact Assessment (EIA) 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	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. Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a license which should be obtained from the Department of Water and Sanitation (DWS).
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 arising from bioprospecting involving indigenous biological resources; and the establishment of a South African National Biodiversity Institute.
Conservation of Agricultural Resources Act 43 of 1967	To provide for control over the utilization of the natural agricultural resources to promote the conservation of the soil, water sources and vegetation and the combating of weeds and invader plants.
Western Cape Biodiversity Act 6 of 2021 (WCBA)	The Western Cape Biodiversity Act 6 of 2021 guides land use planning by requiring that developments avoid or minimise impacts on sensitive ecosystems, ecological corridors, wetlands, and species of concern. It ensures that provincial biodiversity layers and municipal spatial plans are considered in all land use decisions. The Act also requires the control of invasive species and places added responsibility on developments near conservation or ecological support areas. Overall, it ensures that biodiversity sensitivities are integrated into responsible planning and development.

1.4 Scope of Work

To ensure compliance with the specialist protocols this report will ensure to meet the Terms of Reference supplied in this section. This report therefore fulfils the DFFE Protocol requirements for an aquatic biodiversity impacts assessment report.

- 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 using 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 (DWAF 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).
- Conduct a Present Ecological State (PES), Functional Importance Assessment, and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland and riparian habitats, using appropriate and recognised methods in accordance with relevant Department of Water and Sanitation (DWS) guidelines and protocols.
- 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.

2 Approach and Methods

This study followed the approaches of the provided method of assessment as well as several national guidelines with regards to wetland/ riparian identification and delineation.

2.1 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 in a Geographical Information System (GIS). It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourses. The conservation planning information aids in the determination of importance and sensitivity, management objectives, and the significance of potential impacts.
- Following this, desktop delineation and illustration of all potential watercourses within the study area was undertaken using available site-specific data such as aerial photography, contour data and water resource data. Digitization and mapping were undertaken using QGIS 3.43 GIS software.
- These results, as well as professional experience, allowed for the identification of specific areas that could potentially be impacted by the activities and therefore required groundtruthing and detailed assessment. The following data sources listed within Table 2 assisted with the assessment.

Table 2: References for spatial data used for map compilation

Data	Source
Google Earth Pro™ Imagery	Google Earth Pro™
DWS Eco-regions (GIS data)	DWS (2005)
South African Vegetation Map (GIS Coverage)	Mucina & Rutherford (2006-2018)
National Biodiversity Assessment Threatened Ecosystems (GIS Coverage)	SANBI (2018)
Geology	Council for Geoscience (2019)
Contours (elevation) - 5m intervals	Surveyor General
NBA river and wetland inventories (GIS Coverage)	CSIR (2011)
NBA river, wetland and estuarine FEPAs (GIS Coverage)	CSIR (2011) and Skowno *et al.* (2019)
Western Cape Biodiversity Conservation Plan	CapeNature (2023)
National Wetland Map 5	Van Deventer, *et al.* (2018)

2.2 Site Assessment Methods

Infield site assessment was conducted on the 6th of January 2026 to identify if there are any discrepancies with the current use of land and environmental status quo versus the environmental sensitivity as identified on the national web based environmental verification tool, such as new developments, infrastructure, indigenous/pristine vegetation, etc. This in field assessment was undertaken with a hand-held GPS, for mapping, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas,* and a Dutch soil auger.

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

- Qualitative Index of Habitat Integrity (IHI) tool adapted from Kleynhans, 1996 – PES
- DWAF (DWS) River EIS tool (Kleynhans, 1999) – EIS
- Where site conditions are suitable, the South African Scoring System (SASS5) may also be used to support the assessment of riverine ecological condition, particularly in relation to macroinvertebrate communities.

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

- The health/condition or Present Ecological State (PES) of the wetland was assessed using the 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 used 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).

2.3 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.

Cumulative impacts affect the significance ranking of an impact because the impact is taken in consideration of both onsite and offsite sources. For example, pollution making its way into a river from a development may be within acceptable national standards. Activities in the surrounding area may also create pollution which does not exceed these standards. However, if both onsite and offsite pollution activities take place simultaneously, the total pollution level may exceed the standards. For this reason, it is important to consider impacts in terms of their cumulative nature. Detailed method of impact assessment is provided in Appendix 1.

2.4 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.

3 Assumptions and Limitations

Within the realm of 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. It is recommended that another site assessment be undertaken should there be any future development proposed on the properties which requires environmental authorisation or water use authorisation.
- The scope of work is restricted to contextualisation of the study area in relation to water resource management, watercourse identification, and delineation of aquatic habitat within 500m of the survey area only.
- 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 is reported on here.
- All soil/vegetation/terrain sampling points were recorded using a Garmin Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- Conditions on the day were clear and no significant rainfall had been recently recorded in the area. The full extent of the site was walked, and a detailed inspection of the surrounding watercourses were undertaken.
- 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 there was no surface water to sample.
- 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.
- It was assumed that the WTP discharge volume and quality, in the 'after mitigation' scenario, will be compliant with the General Limits of the NWA and of relatively low volume, in alignment with the Design Report. Additionally, it is assumed that the outlet will be appropriately designed to prevent erosion of the bed or banks while not transforming more riparian vegetation than absolutely necessary.

4 Description of the Affected Environment

4.1 Topography and Drainage

The study area is characterized by a gentle seaward-sloping gradient, descending from approximately 90 m amsl at the western boundary along Robberg Road to roughly 70 m amsl at the eastern perimeter. This topographic profile defines a localised catchment that feeds a central non-perennial drainage line and two minor tributaries. The hydrological regime of these features is strictly episodic, with surface flow occurring only as a result of high-intensity precipitation events. Under typical climatic conditions, these channels remain dry and function as intermittent pathways for storm-driven discharge. Refer to Figure 5 indicating the desktop-mapped location of these features by the national 1: 50 000 river line data (NGI, 2007).

While the site falls within the K60G DWS quaternary catchment, it is hydrologically disconnected from any major inland river systems. Instead, surface drainage terminates after a short distance within the coastal littoral zone. Despite this lack of connectivity to larger fluvial networks, the drainage lines perform a critical role in regional catchment-to-coast regulation and landscape connectivity. They serve as essential longitudinal corridors, providing natural pathways for the movement of biota between the inland fynbos plateaus and the coastal zone. Consequently, the conservation value of the site is not derived from perennial “high flow” river dynamics, but from its functional role as a biological and hydrological link within the coastal landscape.

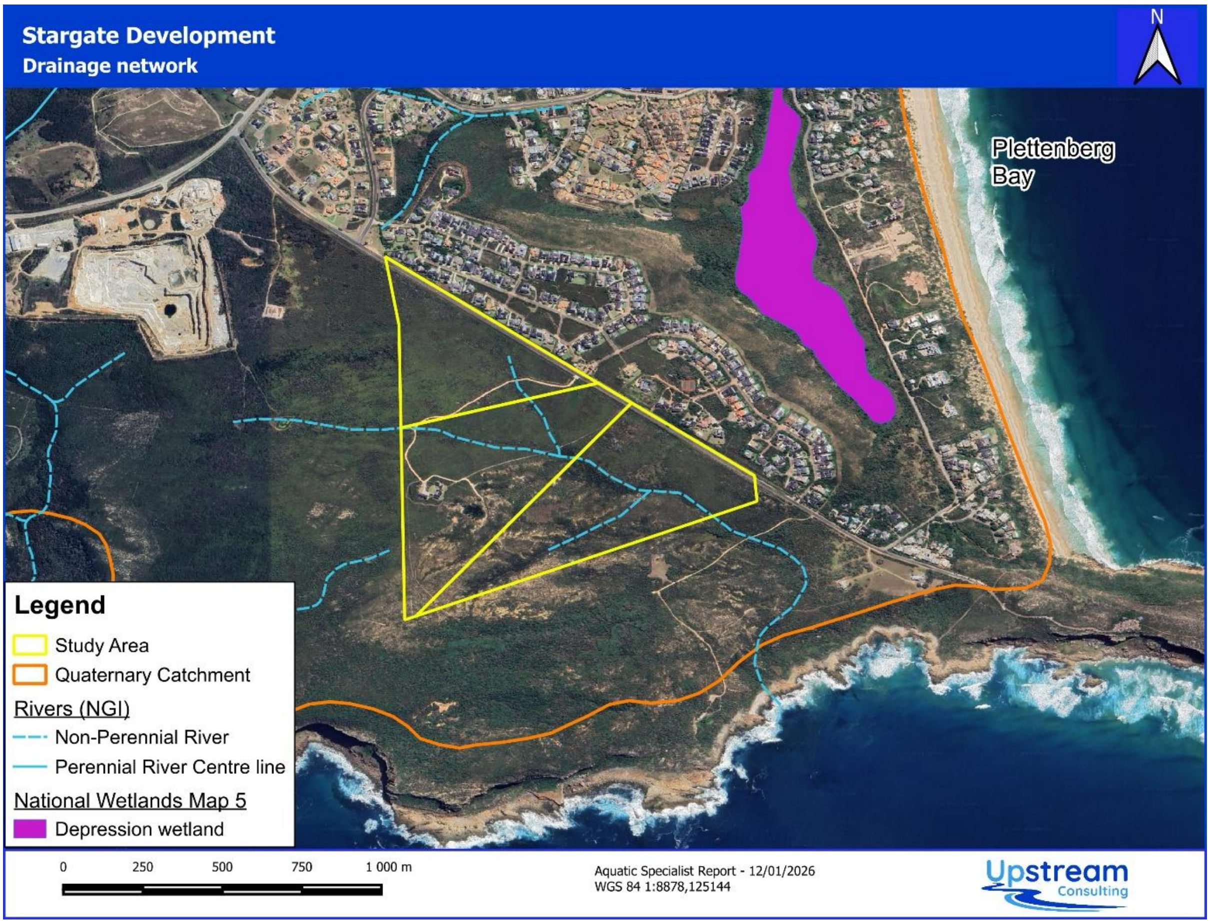

Figure 4: Map of the study area in relation to the national wetland and river desktop data inventories

4.2 Geology and Soils

The site is underlain by Quaternary alluvial and aeolian deposits that overlie Cretaceous sedimentary rocks of the Robberg Formation, with deeper basement units comprising quartzites of the Peninsula Formation. Soils consist of a thin, organic-rich silty sand topsoil horizon underlain by a thicker residual layer of low-permeability sandy silty clay and clayey silt, corresponding to CL, MH and ML material classes (refer to geotechnical investigation report). These residual horizons contain ferricrete nodules formed through repeated wetting and drying cycles, indicating historical soil moisture fluctuation. The low permeability of the clay-rich subsoil restricts infiltration and promotes rapid surface runoff generation during rainfall events, directing flow toward the central drainage line.

4.3 Climate

The regional climate is temperate and maritime, with a Mean Annual Precipitation of approximately 650–850 mm and Mean Annual Evaporation exceeding 1200 mm. This moisture deficit limits sustained soil saturation and groundwater recharge, resulting in short-lived surface flow responses following rainfall. Consequently, the non-perennial drainage line and its tributaries function primarily as intermittent conduits, transporting episodic runoff through the site toward the adjacent coastal environment only when precipitation thresholds are exceeded.

4.4 Vegetation

Based on the botanical specialist findings in the Scoping Report, the vegetation is characterised as a transitional ecotone between fynbos and thicket (Vlok, 2010). The distribution of these communities is strictly governed by the site's topography and moisture availability. The upper, more exposed slopes are dominated by a diverse fynbos community, specifically Garden Route Shale Fynbos, which includes a high variety of *Erica* and *Proteaceae* species. However, as the topography descends into the sheltered valley and along the drainage lines, the vegetation transitions into a denser thicket component. In these lower-lying drainage areas, the increased protection from wind and the higher soil moisture levels facilitate the growth of taller, woodier species typical of coastal thicket. The botanical specialist report notes that while fynbos is the matrix vegetation, the valley bottoms and drainages act as refugia for these thicket elements, creating a structural mosaic.

4.5 Strategic Water Source Areas

The northwestern portion of the study area is formally identified as part of the Outeniqua Strategic Water Source Area (SWSA) for surface water (Lötter, M.C., and Le Maitre, 2021). Refer to Figure 6. This map resulted in the DFFE Screening Tool having a "Very High" sensitivity for the Aquatic Biodiversity Theme. It is important to note that the SWSA mapping is conducted at a national desktop scale and often identifies broad catchment areas based on modeled hydrological contribution rather than the presence of discrete on-site aquatic features.

Site-specific ground-truthing confirmed that no surface watercourses are located within this specific northwestern corner. The hydrological importance of this area is therefore likely related to subsurface processes and groundwater recharge rather than the maintenance of active surface water systems. While SWSAs are critical for regional water security, the potential impacts of development on groundwater infiltration and aquifer recharge fall under the ambit of a specialist geohydrological assessment, which is being conducted as a separate component of this application.

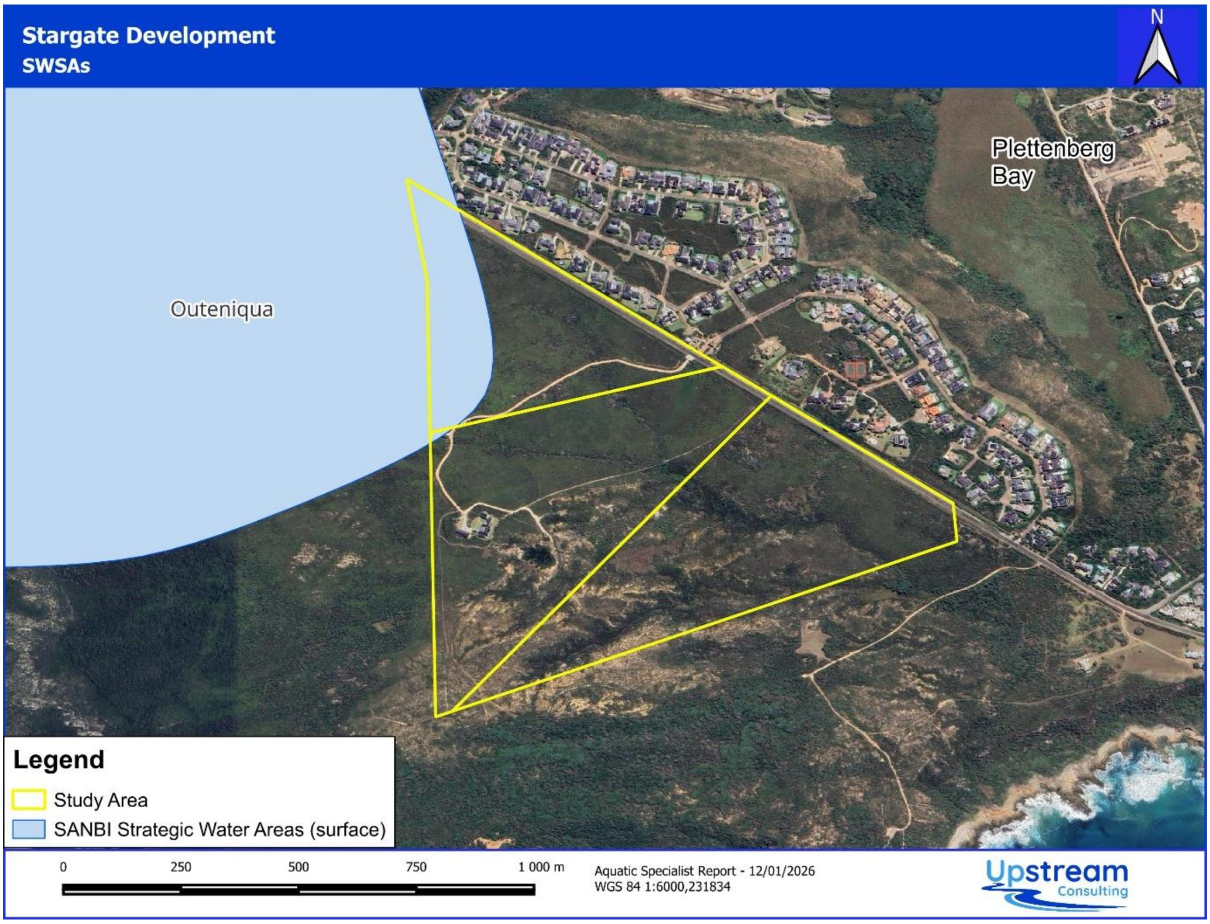

Figure 5: Map of the study area in relation to the South African Strategic Water Source Areas map

4.6 Critical Biodiversity Areas

According to the 2023 Western Cape Biodiversity Spatial Plan (WCBSP) (CapeNature, 2023), the study area is predominantly mapped as a Terrestrial Critical Biodiversity Area (CBA 1). No Aquatic CBAs are indicated within the site, and the non-perennial drainage features present on the property are not explicitly captured in the provincial spatial dataset. Refer to Figure 7.

A section of the northern portion of the site is mapped as an Aquatic Ecological Support Area (ESA 1), intended to function as a corridor supporting aquatic processes. However, site-specific ground-truthing and topographical analysis indicate that this mapped corridor does not correspond with the actual drainage lines observed on site, nor does it align with the local catchment's natural low points, flow paths, or the Strategic Water Source Area footprint.

This misalignment suggests that the ESA 1 designation in this locality is a product of broad-scale desktop modelling and the WCBSP encourages field work by the relevant specialists to refine the mapping. As a result, the functional relevance of the mapped ESA corridor to on-site aquatic biodiversity is considered low. The aquatic ecological value of the site is more accurately defined by the presence of episodic drainage features that convey surface runoff during rainfall events, rather than by the provincially mapped ESA designation. Additionally, the southern portions are planned to be included in the Robberg Coastal Corridor Protected Environment. Given the property's proximity to the Robberg World Heritage Site the client has stated that the proponent has already engaged with CapeNature Landscape East Stewardship officials about joining the RCCPE.

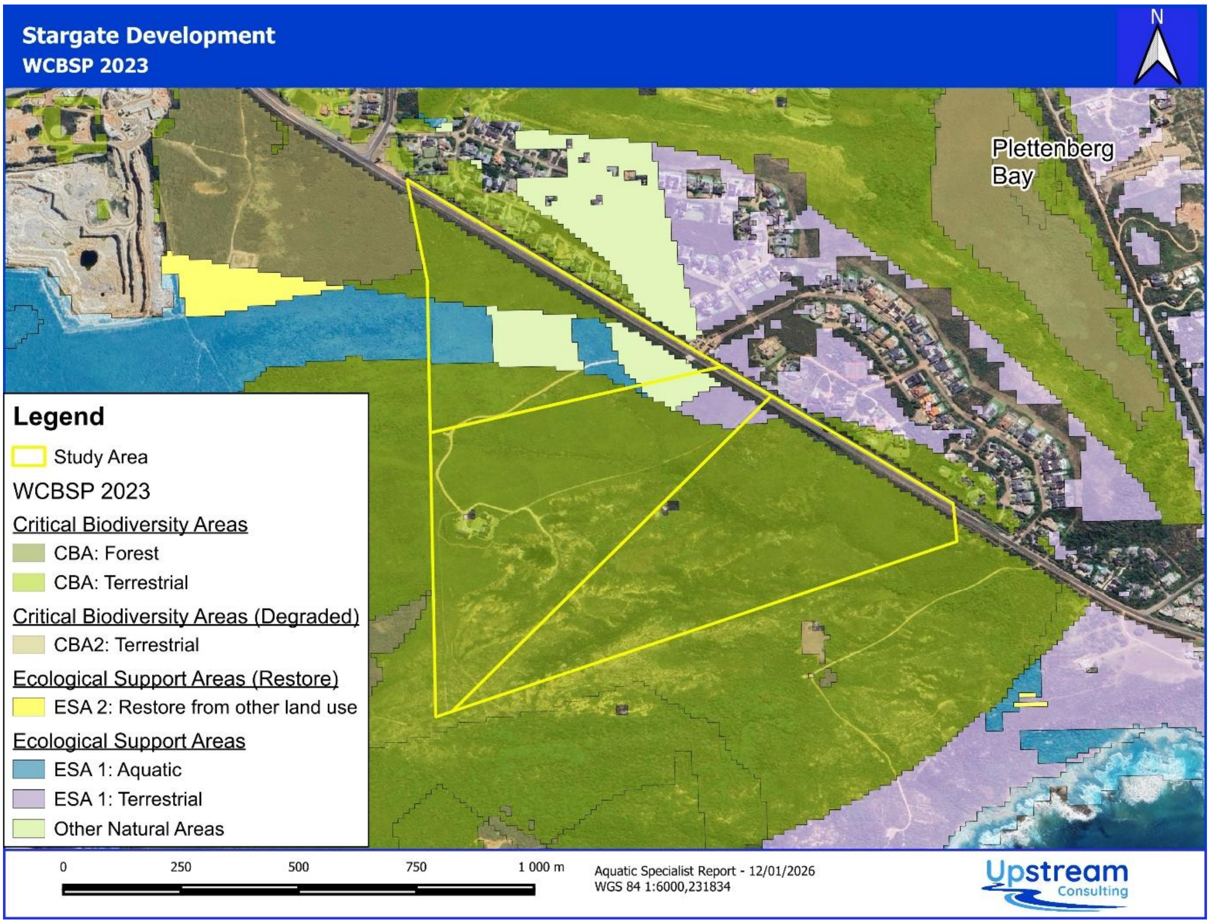

Figure 6: Map of the study area in relation to the conservation priority area mapped by the Western Cape Biodiversity Spatial Plan (CapeNature 2023)

4.7 Historic Land Use

The current ecological and hydrological condition of the study area reflects a history of agricultural use, mineral extraction and fluctuating levels of invasive alien plant infestation. Review of historical aerial imagery (Figures 8 & 9), together with site observations, indicates a landscape characterised by variable disturbance intensity, with some portions of the site having been extensively transformed while others remain comparatively intact.

4.7.1 **Agricultural and Mining Impacts**

The northern (upper) portion of the site shows clear evidence of historical cultivation, with visible plough lines and altered soil structure indicating past crop production. These activities would have significantly disturbed the original soil horizons and indigenous fynbos seedbank. In contrast, the central and lower portions of the site were historically subjected to sand and gravel extraction. These mining activities represent the most substantial anthropogenic modification to the site's hydrology. Excavation along one of the non-perennial tributaries resulted in the formation of a localised basin that now functions as a seasonal, artificial wetland feature. This has altered natural flow attenuation, sediment deposition and the geomorphic behaviour of that drainage line.

4.7.2 **Hydrological Modification and Stormwater Regimes**

Local infrastructure and surrounding development have further modified surface flow patterns across the site. The gravel access road that traverses the property intercepts upslope runoff via a longitudinal drainage ditch, which concentrates previously diffuse overland flow and directs it through small culverts into the drainage lines. This has created confined discharge points and altered the spatial distribution of stormwater entering the channels.

At a broader scale, the surrounding landscape has transitioned from a largely rural coastal plain to an increasingly developed node. Residential estates and an active commercial quarry have increased the extent of impervious surfaces in the upstream catchment. This is likely to have resulted in higher peak flows and higher velocity stormwater pulses entering the site during rainfall events compared to historical conditions.

4.7.3 **Alien Invasive Plants**

Past soil disturbance associated with cultivation and mining facilitated extensive invasion by alien woody species, which displaced the indigenous fynbos–thicket mosaic. Unlike many neighbouring properties, recent management interventions have successfully cleared large stands of invasive alien trees from the site.

Despite these historical pressures, parts of the site have experienced minimal direct disturbance. These areas retain elements of the original geomorphic form and indigenous vegetation, providing important reference conditions for understanding the site's natural ecological template.

Figure 7: Historic aerial imagery from 1974 (purple polygon depicts ploughed lands and red polygon depicts approx. mined area but there is also other disturbances visible)

Figure 8: Historic aerial imagery from 1990 (purple polygon depicts ploughed lands and red polygon depicts approx. mined area but there are also other types of disturbance visible)

5 INITIAL SITE SENSITIVITY VERIFICATION

5.1 Identification And Delineation

A site visit was undertaken on the 6th of January 2026 to identify, groundtruth, and delineate aquatic features within the study area. Following which, an accurate baseline map of aquatic features was developed.

The site assessment confirmed the presence of the three non-perennial watercourses depicted by the 1:50 000 national river line data. Additionally, artificial wetland habitat was identified in the old quarry pit, a stormwater outlet pond alongside Whale Rock Drive, and within the dam. Refer to Figure 10.

The watercourses were then separated and classified into six (6) hydrogeomorphic units and referred to as follows (Figure 11):

- HGM1 (Non-perennial stream)
- HGM2 (1st order tributary stream)
- HGM3 (Artificial wetland – road stormwater outlet)
- HGM4 (1st order tributary stream – with wetland depression)
- HGM5 (Artificial wetland - dam)
- HGM6 (1st order tributary stream)

Further screening determined that only the HGM1 (non-perennial stream), HGM2 (minor tributary channel), and HGM3 (artificial wetland) watercourses are at risk of being impacted by the project. The other watercourses were therefore not assessed in further detail.

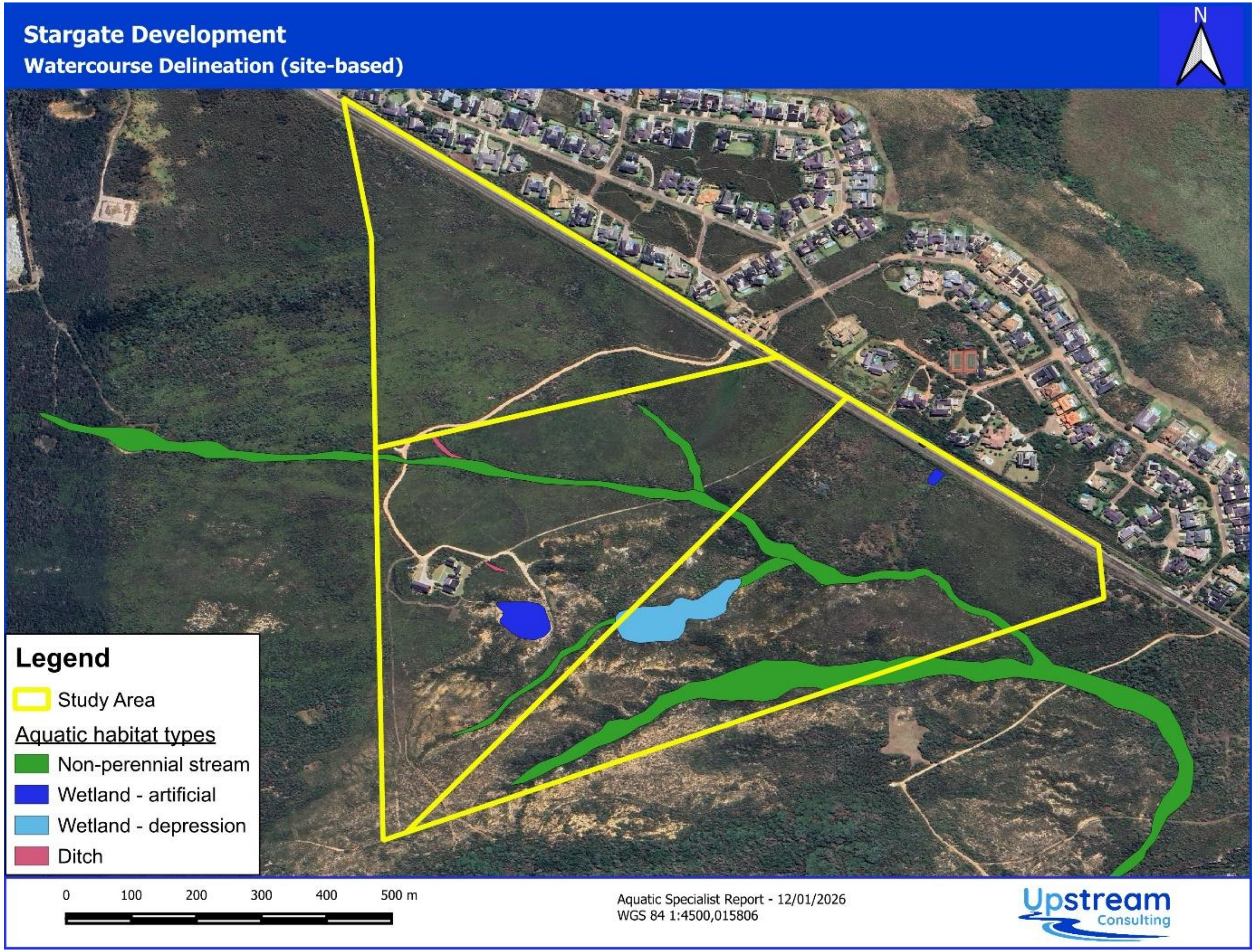

Figure 9: Mapped aquatic habitat within the study area

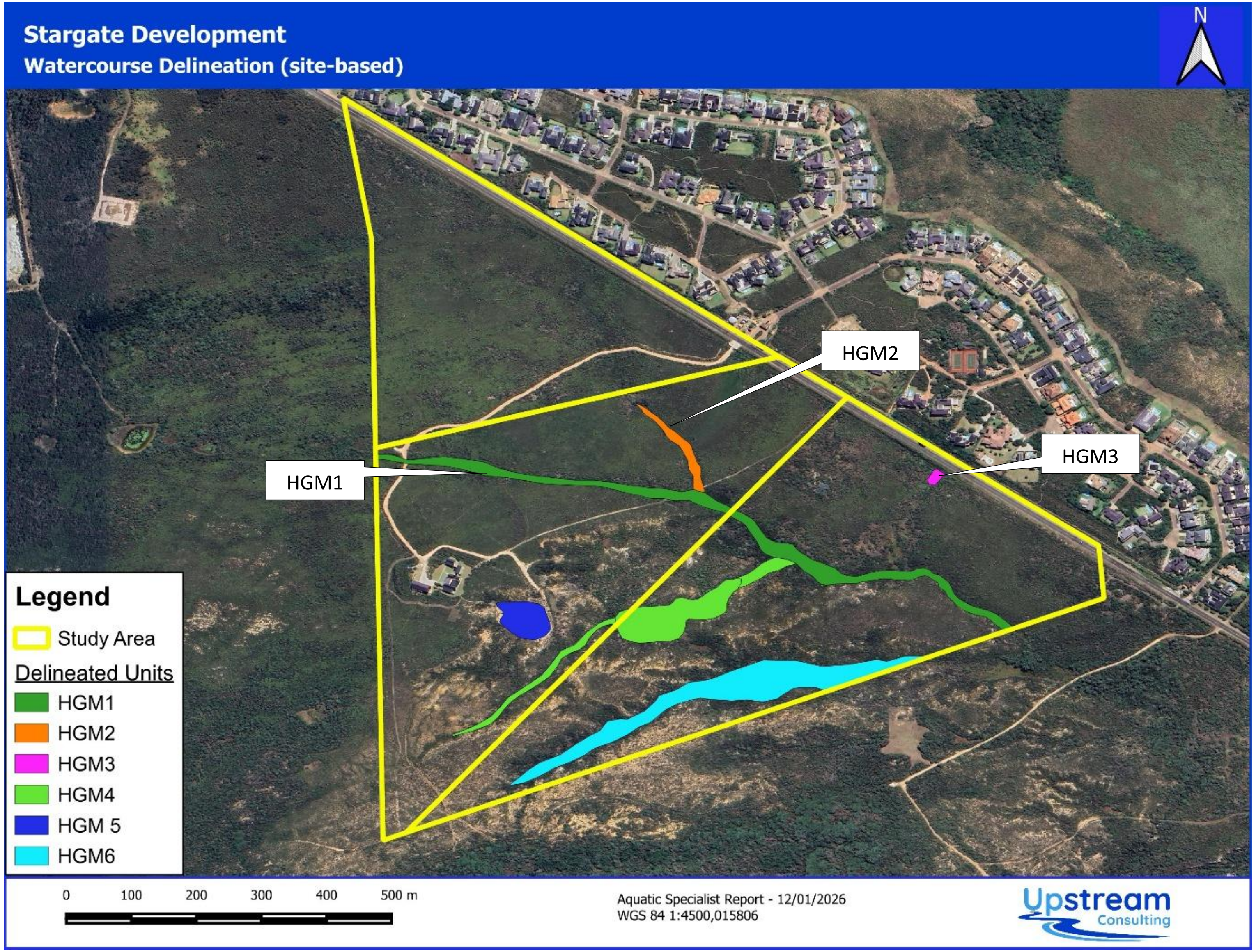

Figure 10: Map of delineated HGM units

5.2 Description Of Aquatic Habitat

The aquatic habitats of the study area are characterised by their non-perennial, episodic nature and are heavily influenced by the site's historical land use. No perennial rivers or large permanent water bodies exist on the property.

5.2.1 HGM1: Non-perennial Stream

The HGM1 watercourse is the main drainage line within the study area. It originates upslope, near the operational quarry off Robberg Road, and flows through the properties to the sea. It is classified as an episodic stream. Its primary functional role is the attenuation and conveyance of stormwater runoff from the upper catchments (including areas transformed by historical agriculture and upslope development) toward the coastal littoral zone. The riparian zone of HGM 1 is narrow and does not support obligate wetland vegetation due to the absence of prolonged saturation. Instead, it is characterised by a structural ecotone where fynbos species mix with taller thicket elements that thrive in the slightly higher moisture levels of the valley bottom. Previously densely invaded by alien invasive trees, the recent clearing operations have been successful.

The dry channel is approximately 2 meters in width with vertical 1m high banks. Its substrate consists primarily of fine alluvial silty sands over a low-permeability clayey-silt residual horizon, which facilitates the rapid seaward transport of surface runoff.

Despite the lack of permanent water, HGM 1 is still a significant aquatic feature on site from a functional perspective as it provides a longitudinal ecological corridor to and from the coast.

Plate 1: Photograph of the dry stream channel of HGM1 on portion 62

5.2.2 **HGM2: Non-perennial Tributary**

HGM 2 is a minor, first-order non-perennial tributary located on the left bank of the primary drainage line (HGM 1). It originates approximately 100 meters downslope (south) of the existing access road and its associated pipe culvert. This unit is characterized by a short, narrow, and relatively shallow channel set within a small, V-shaped first-order valley. Unlike HGM 1, HGM 2 has a more confined catchment and a very short flow path before it terminates at the confluence with the main system. While there are pipe culverts beneath the gravel road, the drainage lines do not extend north of the road. The culverts are there to direct stormwater runoff from upslope that collects in a drain under specific points below the road. Beyond the road, the drainage lines become more defined and form channels and riparian habitat.

The hydrological regime is strictly ephemeral and episodic. The channel remains dry throughout the year, only facilitating water movement during significant precipitation events that exceed the infiltration capacity of the surrounding slopes. The system lacks any wetland characteristics, such as hydromorphic soils or stagnant water indicators, and functions purely as a terrestrial-aquatic conduit.

HGM 2 has relatively intact riparian vegetation cover compared to the more disturbed upper slopes. Because the topography of the first-order valley provides a degree of shelter from wind and slightly higher localized moisture retention in the soil, the vegetation is characterized by a denser thicket-fynbos ecotone. Similar to the rest of the site, this corridor was historically affected by invasive alien plants but has benefited from recent clearing efforts.

The conservation importance of HGM 2 is primarily derived from its role as a supplementary ecological corridor. It is not of high EIS and is a minor feature with infrequent hydrological activity, but it contributes to the overall landscape connectivity of the site. It serves as a natural input to HGM 1, ensuring the continuity of the drainage network.

Plate 2: Photograph taken upslope of the road, showing no channel or riparian vegetation, looking towards HGM2 which forms beyond Portion 59

Plate 3: Photograph of the road culvert which is not in fact within riparian habitat but directs surface runoff, collected by the roadside ditch upslope, towards the downslope watercourse

Plate 4: Photograph of the HGM2 drainage line on portion 63 (indicated by the taller thicket plant species) which flows to the HGM1

5.2.3 **HGM3: Artificial temporary wetland**

HGM 3 is a small, highly localised, artificial depressional feature situated on the eastern perimeter of the site, immediately adjacent to Whale Rock Drive. This unit is entirely anthropogenic in origin, consisting of a shallow impoundment likely created during the construction of the road infrastructure. The feature is defined by low-relief earth berms (two situated perpendicular to the road and one running parallel to it) which act to impede surface runoff from the road drain (probably installed to prevent downslope erosion). These modifications have created a small, shallow basin that intermittently slows surface flow, though it lacks the geomorphology of a natural wetland system.

The hydrological regime is characterised by temporary soil wetness rather than sustained surface ponding. The contributing catchment (water input) is minor, and the feature receives very little actual stormwater runoff. Its "wetland" status is marginal, as the saturation is transient and occurs only after significant rainfall events. There is no evidence of a perched water table or groundwater emergence; instead, the feature simply delays the infiltration and evaporation of a negligible volume of surface water.

From a biodiversity perspective, HGM 3 is of negligible value. The short hydroperiod and the artificial nature mean it does not support aquatic dependent species. The vegetation is primarily opportunistic and does not consist of true obligate hydrophytes, and they are characteristic more of a disturbed area species. Additionally, while this feature technically displays signs of temporary saturation, its conservation importance is Very Low. It is a man-made feature of road construction that performs no significant ecological service. But it is recommended to retain it because it serves as a minor, localized point of surface water impedance to reduce the risk of erosion from the drain.

Plate 5: Phragmites australis below road stormwater outlet indicating HGM3 artificial wetland

5.3 PES, Ecosystem services and EIS

The Present Ecological State (PES) refers to the health or integrity of river systems and includes both instream habitat as well as riparian habitat adjacent to the main channel. The rapid Index of Habitat Integrity (IHI) tool (Kleynhans, 1996) be used to determine river PES by comparing the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state without anthropogenic impacts.

5.3.1 HGM1: Non-perennial Stream

The episodic stream (HGM 1) has deviated slightly from the estimated reference state but still maintains a good level of ecological functioning. HGM 1 was determined to have a PES score within the 'B' ecological category indicating that it is in a Good condition (Table 3). Table 3 below summarizes the PES assessment.

The HGM 1 unit has been subjected to little habitat loss and disturbance, erosion, and alien species infestation. The biggest impact on this system has come from the mine being located within the system. In terms of this project, when the mine closes and is rehabilitated, the water quality should revert back to or close to a reference state which will result in PES improvements in condition.

Table 3: HGM 1 Present Ecological State.

Determinand	Score (0-5)	% intact		Rationale
Bed modification	0,5	90	10	The system's bed is intact, except where the road culvert is located, there are minor signs of erosion.
Flow modification	0,5	90	10	The flow pattern remains natural. The active channel is stable, and well vegetated overtopping is possible, especially during flooding events. Lateral inputs remain in a good condition, only minor flow modifications due to the road constructed across the system.
Inundation	0,5	90	10	The system is episodic and is mostly confined to the active channel and inundation of the macro channel is possible in high flow and flooding events.
Bank condition	0,5	90	10	The banks are well vegetated and stable.
Riparian condition	0,5	90	10	The riparian area is mostly in a good natural condition with limited alien species noted. The presence of a well vegetated riparian area provides a level of ecosystem functionality and protection in terms of riparian stability.
Water quality modification	1,5	80	20	The upslope mine has resulted in water quality modification to a moderate degree
Average Score	**0,7**	88,3		To summarise the episodic stream is in a good condition, despite the historical land use change of its catchment. There is minor score impacts, but the primary determinand that impacted the score was the water quality aspect.
Ecological Category	**B**			

5.3.2 **HGM2: Non-perennial Tributary**

As previously descripted the HGM 2 is a minor, first-order non-perennial tributary located on the left bank of the primary drainage line (HGM 1). This system is small and its PES condition is close to a reference state episodic stream. HGM 2 was determined to have a PES score within the 'A' ecological category indicating that it is in a Natural condition (Table 4). Table 4 below summarizes the PES assessment. The landowner has kept HGM 2 free from alien invasive species and the only minor impact on the system is the presence of the upslope road, but this has only had minor impacts on the various determinands.

Table 4: HGM 2 Present Ecological State.

Determinand	Score (0-5)	% intact		Rationale
Bed modification	0,5	90	10	The systems bed is intact, only minor signs of erosion.
Flow modification	0,5	90	10	Similar to HGM 1, the flow pattern remains natural. The active channel is stable and well vegetated overtopping is possible, especially during flooding events. Lateral inputs remain in a good condition, only minor flow modifications due to the road construced across the system.
Inundation	0,5	90	10	Similar to HGM 1, the system is episodic and is mostly confined to the active channel and inundation of the macro channel is possible in high flow and flooding events.
Bank condition	0	95	5	The banks are well vegetated and stable and in a natural condition
Riparian condition	0	95	5	The riparian area is in a natural condition with no alien species noted. The presence of a well vegetated riparian area provides a level of ecosystem functiionality and protection in terms of riparian stability.
Water quality modification	0	95	5	Only minor water quality modification has occurred due to the construction of the upslope road introducing a minor volume of sediment.
Average Score	**0,3**	92,5	To summarise the episodic stream is in natural condition, despite the upslope historical land use change of its catchment. Similar to HGM 1, there are minor score impacts, but the system remains close to a reference state.	
Ecological Category	**A**			

5.4 Ecosystem services and EIS

Wetlands and rivers 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 suite of ecosystem services which they supply to society (Kotze *et al*. 2020). Thus, there is a need to assess and compare wetland areas in terms of ecosystem services delivery.

A WET-Ecoservices (Version 2) (Kotze *et al.*, 2020) is a field-based assessment was undertaken to assess the ecosystem services supplied by the two different wetland systems. 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 or river for delivering ecosystem services, by understanding its capacity to produce a service while also considering the societal demand for that service.

5.4.1 HGM 1: Non-perennial Stream

The HGM 1 system provides a range of regulating and supporting ecosystem services, although these vary in their relative supply and demand (Table 4 and Figure 8). Owing to its largely intact vegetation structure and a Present Ecological State of B, the system maintains good ecological functioning.

The ecosystem service assessment of HGM 1 shows that most regulating and supporting services provided by this small non perennial riparian system are of very low importance. Flood attenuation, erosion control, sediment trapping and nutrient assimilation all score very low because the system is narrow, the catchment is limited in size, and local demand for these services is negligible. Although the riparian vegetation is moderately intact, its ability to regulate flows or improve water quality is naturally constrained by the scale of the stream. Carbon storage has a low importance score as moderate supply is balanced by moderate landscape level demand. Biodiversity maintenance is the most significant service, with a very high importance score, reflecting the contribution of the intact riparian corridor to ecological connectivity and habitat continuity within the Robberg Coastal Corridor.

Provisioning services are uniformly low in importance. Water for human use, food for livestock and other extractive uses score very low because the system is not used for these purposes. Harvestable resources show a moderately low importance score due to moderate supply but minimal demand, while cultivated foods score low due to limited use of adjacent land and the sensitive nature of the riparian zone.

Cultural services range from low to moderately high importance. Tourism and recreation score moderate importance owing to the scenic qualities of the landscape and its proximity to Robberg Nature Reserve. Education and research score moderately high because the site offers opportunities for ecological training and scientific investigation within an ecologically meaningful corridor, next to Plettenberg Bay. Cultural and spiritual services score very low in the present state because the assessment tool derives these values from current community use and known living cultural practices, neither of which are presently expressed on the site.

However, the Ecosystem services tool does not adequately account for archaeological and historical cultural significance. The Robberg and Plettenberg Bay region forms part of an archaeologically rich landscape associated with Later Stone Age hunter gatherers and later Khoe related pastoralist groups. Research in the broader area has documented stone tools, shell middens, occupation floors and material culture linked to these communities (Henshilwood, 1997; Parkington, 2003; Nienaber, 2019). Stone tools and early implements present on the property suggest that the cultural meaning of the area may be deeper than current use patterns reflect, and it is likely that traditional knowledge of the landscape has been lost over generations. As such, the present cultural and spiritual scores underestimate the potential heritage value of the system. The planned Museum of Mankind, together with future archaeological research and engagement with descendant communities, is expected to increase the cultural, educational and spiritual importance of the site significantly. Once further research uncovers clearer links to early inhabitants and as cultural interpretation becomes active, these cultural ecosystem services may rise well above the current scores produced by the tool.

Overall, the system presently provides very low regulating and provisioning services, moderate to moderately high cultural services, and very high biodiversity value. Importantly, the cultural and spiritual significance of the area is likely to increase in future as archaeological research advances and the museum initiative reconnects people with the historical and cultural landscape.

Table 5: Summary of Ecosystem Service Assessment for HGM 1

	ECOSYSTEM SERVICE	Present State: Supply	Present State: Demand	Present State: Importance Score	Present State: Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1,3	0,2	0,0	Very Low
	Stream flow regulation	-	-	-	-
	Sediment trapping	1,8	0,0	0,3	Very Low
	Erosion control	1,4	0,0	0,0	Very Low
	Phosphate assimilation	1,8	0,0	0,3	Very Low
	Nitrate assimilation	1,7	0,0	0,2	Very Low
	Toxicant assimilation	1,6	0,0	0,1	Very Low
	Carbon storage	1,3	2,7	1,2	Low
	Biodiversity maintenance	4,0	3,5	4,0	Very High
PROVISIONING SERVICES	Water for human use	0,0	0,0	0,0	Very Low
	Harvestable resources	3,0	0,3	1,7	Moderately Low
	Food for livestock	1,0	0,0	0,0	Very Low
	Cultivated foods	2,8	0,0	1,3	Low
CULTURAL SERVICES	Tourism and Recreation	3,5	0,0	2,0	Moderate
	Education and Research	4,0	0,0	2,5	Moderately High
	Cultural and Spiritual	2,0	0,0	0,5	Very Low

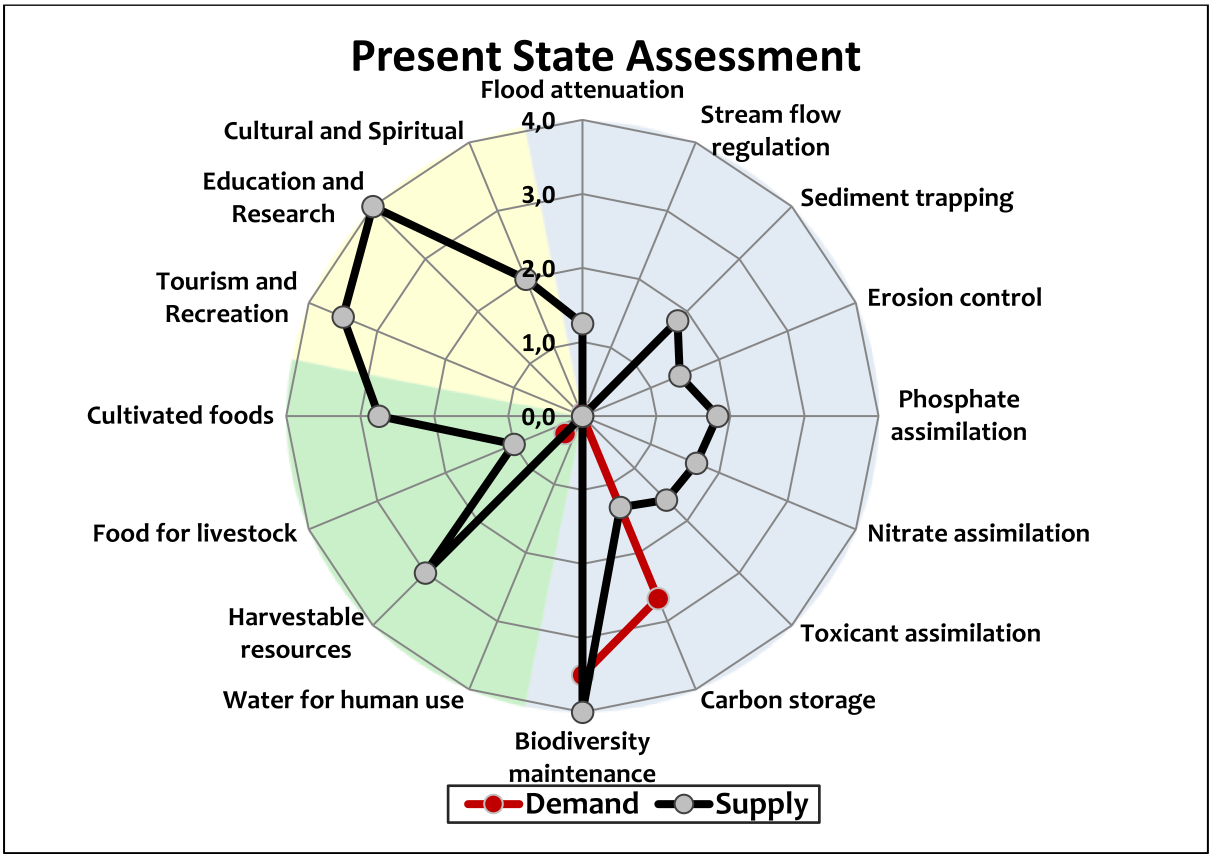

Figure 11: Spider diagram showing the demand and supply of various ecosystem services by the HGM 1 in its present ecological state

5.4.2 HGM 2: Non-perennial Tributary

The ecosystem services results for the small HGM 2 tributary follow the same general pattern as the main stream, but at a much smaller scale. Most regulating and provisioning services score very low because the tributary is narrow, carries limited flow and has a very small contributing catchment. Functions such as sediment trapping, nutrient assimilation and erosion control therefore contribute minimally to the broader system. Carbon storage and cultivated food supply reflect low importance. As with the main stream, biodiversity maintenance is the only strongly expressed service and scores very high due to the tributary's contribution to riparian continuity and ecological connectivity into the Robberg Coastal Corridor.

Cultural services also align with those of the main system, with moderate tourism and moderately high education and research value because of the setting and the broader conservation landscape. Cultural and spiritual services remain very low because the ecosystem services tool assigns importance based only on current cultural use, which is absent on this tributary. However, as with the HGM 1 system, this score does not account for the archaeological potential of the property. Stone tools and early implements found on the property, together with the regional Later Stone Age and Khoe heritage context, indicate that cultural meaning may have been lost over generations. The planned Museum of Mankind and future archaeological work are likely to increase the cultural and educational importance of this tributary beyond what the present tool can represent.

5.5 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) method, as outlined by Rountree and Kotze (2013), provides a structured and defensible framework for assessing the ability of a watercourse to support biodiversity, maintain ecological processes and sustain ecosystem resilience. The EIS score reflects both the ecological significance of the system and its sensitivity to anthropogenic disturbance, thereby guiding decision making during environmental assessments. A higher EIS category indicates a watercourse that plays an important role in landscape level ecological functioning and should be afforded a greater level of protection in planning processes in line with the National Water Act and NEMA. Most EIS determinants were informed by the WET Ecosystem Services assessment and field based observations.

As shown in Table 6, both riparian units (HGM 1 and HGM 2) attained a High EIS ratings (EC = B). This outcome reflects the way the EIS method is applied, with many determinants assessed at the scale of the shared riparian corridor rather than at the scale of very small systems. The two units occur within the same narrow valley, share the same catchment context, vegetation condition, habitat types and conservation planning status, and are both embedded in a mapped Critical Biodiversity Area within the Robberg Coastal Corridor. As a result, key biotic and habitat determinants such as species richness, rarity, uniqueness, refugia and importance for conservation areas were scored identically for both units. Although the systems are small and largely intermittent, making them tolerant of flow and water quality changes, they collectively support high biodiversity value and provide important refugia and connectivity functions. These combined factors justify the identical High EIS classification and indicate that both HGMs are watercourses of high ecological importance that require careful management and protection.

Table 6: Summary of EIS score for the HGM 1 and HGM 2 systems

<table>
<tr><th>RIPARIAN SYSTEM</th><th>ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)</th><th>RATIONALE</th></tr>
<tr><td>HGM 1</td><td>HIGH, EC=B</td><td rowspan="2">Both HGM 1 and HGM 2 attain a High EIS rating (EC = B), reflecting the broad scale nature of the assessment tool and the similar ecological context shared by the two units. Although these riparian features are small and largely intermittent, making them tolerant of flow and water quality changes, they support high species richness, regionally significant biotic elements and important refugia. The intact riparian structure also contributes to landscape connectivity within the Robberg Coastal Corridor, elevating their biodiversity importance beyond what their size would suggest. Their placement within an Ecological Support Area further strengthens their conservation significance. Taken together, these determinants justify the High EIS classification for both HGMs and indicate that the riparian system, while modest in hydrological function, plays an important ecological role that warrants careful management and protection.</td></tr>
<tr><td>HGM 2</td><td>HIGH, EC=B</td></tr>
</table>

5.6 Aquatic Buffer Zones

An aquatic impact buffer zone is defined as a zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels (Macfarlane and Bredin 2016). For any development, an appropriately sized buffer between activities and a watercourse is a key mitigation measure that assists in managing a variety of potential impacts. Because both riparian units (HGM 1 and HGM 2) were assigned High EIS ratings, the need for effective buffers is elevated. High EIS systems warrant strong protective measures due to their biodiversity value, refugia function and contribution to landscape connectivity within the Robberg Coastal Corridor. The buffer therefore plays a dual role: it protects water quality and physical habitat, and it safeguards the ecological features that underpin the high sensitivity and importance identified in the EIS analysis.

The recommended buffers also align with the Present Ecological State (PES) and ecosystem service outcomes. Both systems are in a moderately intact state, with riparian vegetation providing habitat structure, refugia and high biodiversity maintenance scores. Although most regulating services score very low due to the small size and intermittent nature of the channels, the biodiversity function is very high, and cultural and research values are expected to increase as archaeological work develops. Buffers are therefore necessary to maintain the moderate PES and to protect the ecosystem services that remain important, particularly biodiversity maintenance, education and research.

Because no provincial riverine buffer guidelines exist, the buffer model of Macfarlane and Bredin (2017) was applied. The tool recommends a 29 metre buffer for the main stream (HGM 1) and a 26 metre buffer for the small tributary (HGM 2). These widths reflect the ecological sensitivity, PES condition and key ecosystem services associated with both systems. The values represent the after mitigation scenario, which assumes implementation of stormwater control, erosion management and velocity reduction measures. Together, the EIS, PES and ecosystem service results clearly support the need for these buffer distances to ensure long term protection of the riparian corridor and its ecological functions.

	Buffer Segment 1	Buffer Segment 2	Buffer S
Final aquatic impact buffer requirements (including practical management considerations)			
Construction Phase	16	15	Not A
Operational Phase	29	26	Not A
Final aquatic impact buffer requirement	29	26	Not A

Figure 12 is a map of the buffer zones in relation to the delineated riparian habitat. The artificial wetland at the stormwater outlet has been afforded a 5m buffer to prevent direct disturbance.

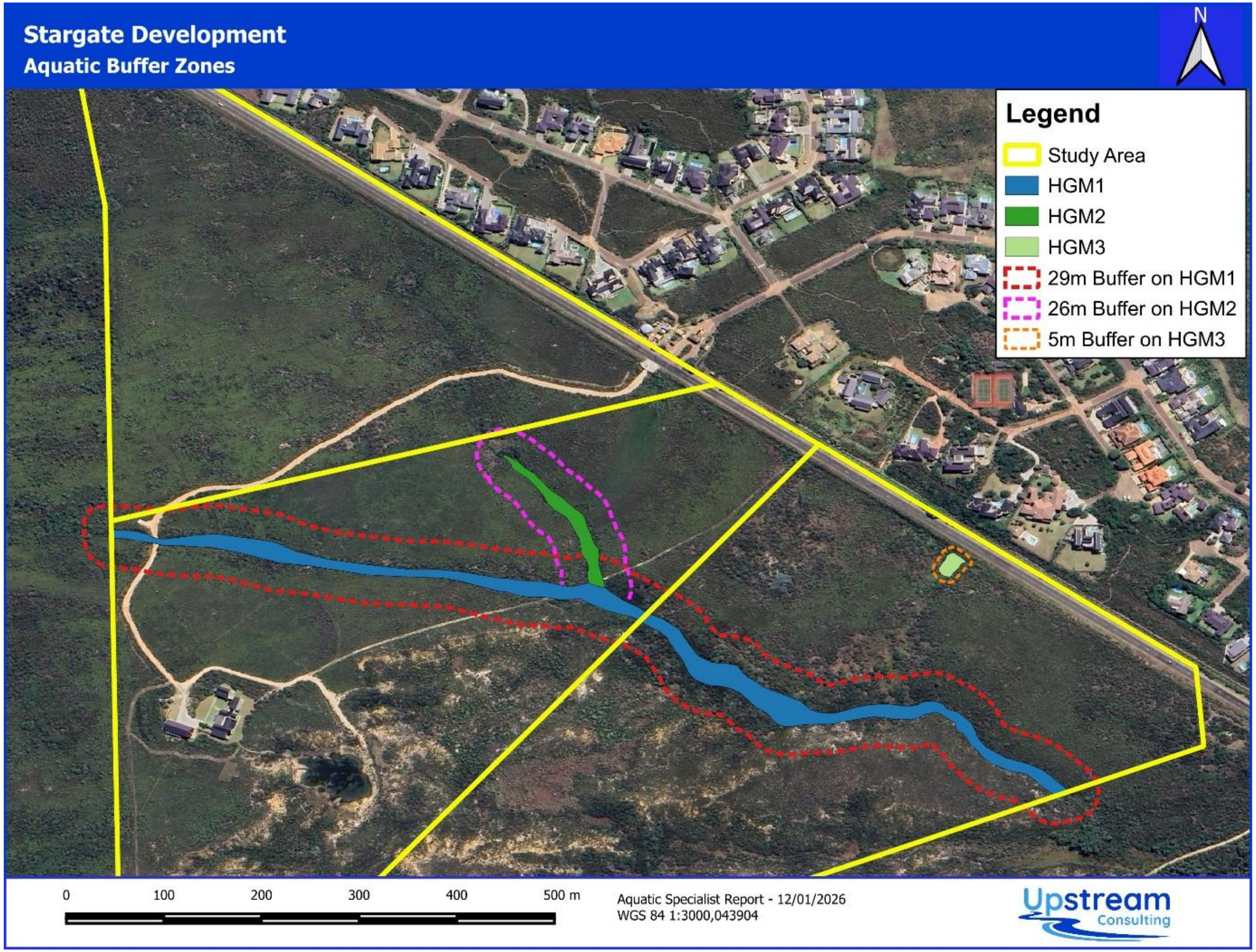

Figure 12: Recommended aquatic buffer areas

6 POTENTIAL IMPACTS

The impacts of any proposed development will directly correlate with the design and layout of the development and proposed operational phases of the development. A detailed impact investigation will need to be conducted after the design phase.

The potential direct and indirect impacts associated with the project were identified and can be grouped into four encapsulating impact categories where associated or interlinked impacts are grouped.

Therefore, the potential impacts include:

- Impact 1: Loss or disturbance of aquatic habitat and biota
- Impact 2: Alterations to the hydrological regime
- Impact 3: Sedimentation and erosion
- Impact 4: Changes to surface water quality
- Impact 5: Cumulative impacts on the aquatic resources of the area

6.1 Aquatic habitat disturbance

Direct disturbance of the riparian channels is not expected as the development layout avoids the delineated buffer zones for both HGM 1 and HGM 2. Habitat disturbance may still occur indirectly during construction where vegetation clearance, ground shaping and soil exposure take place upslope of the buffers. These activities can alter habitat structure along the buffer edges and may influence vegetation composition over time. Disturbed soils can become more susceptible to colonisation by invasive plants, which has relevance for the moderately high PES of both systems and the ecosystem service of biodiversity maintenance. In the operational phase, long-term edge effects may persist where altered soil or vegetation conditions adjacent to the buffers subtly modify ecological functioning without direct intrusion into the riparian corridor.

6.2 Hydrological changes

Hydrological alterations may occur during construction and operation as stormwater pathways are temporarily and then permanently modified. Changes in surface compaction and temporary earthworks during construction can alter the direction and concentration of runoff reaching the buffer margins. Once operational, the engineered stormwater system and the introduction of treated effluent into the non perennial channel associated with HGM 1 will influence the timing, persistence and distribution of flows entering the riparian zones. These changes can modify sediment transport dynamics, flow-dependent ecological processes and channel form, which has implications for the High EIS rating and moderately high PES. Ecosystem services linked to ecological connectivity, flow-driven processes and research or educational value may also shift as hydrology is altered.

6.3 Erosion and sedimentation

Soil disturbance during construction can increase the likelihood of erosion on slopes that drain toward the riparian corridor. Mobilised sediments may reach the outer buffer margins and influence water clarity or habitat structure in isolated sections of the system. Concentrated runoff generated by disturbed ground or temporary access areas may create rills or gullies that route sediments downslope. In the operational phase, hardened surfaces and altered stormwater pathways may contribute to long-term changes in sediment delivery patterns, particularly during high rainfall events. Such changes can influence the moderately high PES of both HGMs and affect ecosystem services linked to habitat stability and biodiversity support.

6.4 Water quality

Water quality may be affected during construction where sediments, hydrocarbons, cement residues and general waste are mobilised by stormwater and transported downslope toward the non perennial channels. These pollutants can alter turbidity, nutrient levels and chemical conditions, which may affect biota sensitive to short term changes in water quality. Such shifts have relevance for ecosystem services linked to biodiversity maintenance and educational or research value, given the High EIS rating and moderately high PES of both HGMs.

Operational phase impacts include changes associated with stormwater runoff from hardened surfaces within the development and, importantly, the introduction of treated effluent from the package wastewater treatment plant into the non perennial stream associated with HGM 1. Treated effluent that complies with General Standard limits will still differ chemically from natural runoff and may change nutrient loads, temperature and dissolved oxygen conditions in the receiving environment. These changes can persist during dry periods where low flow volumes result in limited dilution, and the natural intermittency of the system may amplify such effects. Alterations of this kind can influence microbial processes, nutrient cycling, algal dynamics and the species composition of aquatic and riparian biota. Water quality changes linked to effluent discharge may also affect ecosystem services, particularly those related to biodiversity support, carbon processes and long-term educational or research opportunities. The moderately high PES of the system indicates that water quality alterations have the potential to influence ecological functioning even where the upstream water quality is already degraded.

6.5 Cumulative impacts

Cumulative impacts may arise through the interaction of the proposed development with the limited existing pressures in the small catchment. The upper portion of the catchment has Robberg Road and a quarry on the neighbouring property, both of which contribute minor changes to water quality and localised sediment mobilisation. The influence of these activities remains modest, as the non perennial nature of HGM 1 and HGM 2 results in extended dry periods where flow is absent and natural dilution processes do not operate. Even small changes in water quality or sediment characteristics can therefore persist in isolated pools when rainfall occurs.

Additional long-term alterations introduced by the development, including redirected stormwater and the presence of treated effluent in the otherwise dry channel of HGM 1, may combine with these existing pressures. The cumulative effect may influence the pattern and timing of flows, impact sediment distribution and modify the chemical profile of water reaching the riparian corridor. Systems with High EIS and moderately high PES show sensitivity to cumulative shifts in ecological conditions, and the combined influences may affect habitat structure, species composition and ecological resilience. Changes of this nature can alter ecosystem services provided by the riparian systems, particularly biodiversity maintenance, carbon-related processes and educational or research value.

The connected nature of the valley means cumulative effects may extend beyond the immediate footprint and influence reaches further downstream during episodic flow events.

7 Impact Assessment

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: Loss or disturbance of aquatic habitat and biota
- Impact 2: Alterations to the hydrological regime
- Impact 3: Sedimentation and erosion
- Impact 4: Changes to surface water quality
- Impact 5: Cumulative impacts on the aquatic resources of the area

7.1 Significance

The impact significance of the proposed project was determined for each potential impact, direct and indirect for each phase. Refer to impact summary tables in the section below.

It was determined that, after mitigation, the project is generally of Low negative significance to aquatic biodiversity. There is potential for positive impacts and risk avoidance. Therefore, from an aquatic perspective, the proposed project is deemed as acceptable, following mitigation, rehabilitation, and on-going monitoring. The No-Go Alternative was determined to have no new impacts upon aquatic biodiversity.

The mitigation of negative impacts on biodiversity and ecosystem goods and services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the specific area being affected. Mitigation requires the adoption of the precautionary principle and proactive planning that is enabled through a mitigation hierarchy. Its application is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimize, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity (DEA 2013). Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality.

Mitigation measures related to the impacts associated with the activities are intended to augment standard/generic mitigation measures included in the project-specific Environmental Management Programme (EMP). The monitoring of the activities is essential to ensure the mitigation measures are implemented. Therefore, compliance with the mitigation recommendations must be audited by a suitably qualified independent Environmental Control Officer with an appropriately timed audit report. Monitoring should focus on rehabilitation of disturbed areas, preventing erosion and pollution.

7.2 Impact Tables

The potential impacts of the project are provided in Tables 7 - 12 which show that after mitigation, it will have Low impact significance. The methodology to determine the significance ratings of the potential environmental impacts and risks associated with the alternatives is provided in Appendix 3.

The impact of aquatic habitat and biota disturbance was assessed and is summarised in Table 7. The No-Go alternative results in a low impact because no new disturbance would occur and HGM 1 and HGM 2 would remain in their current condition with only existing background pressures. The Preferred Alternative, which places all development outside the delineated buffer zones, results in a low impact with mitigation, as, apart from the discharge of treated effluent, only minor indirect edge effects are possible. Application of the EMPr, observance of no-go areas and avoidance of riparian buffers further reduces the significance score of the Preferred Alternative, retaining it within the low impact category.

Table 7: Impact assessment summary for Impact 1 – Disturbance of aquatic habitat biota.

Impact Phase: Construction and Operational phases					
Nature of the impact: Disturbance or loss of aquatic vegetation and habitat may occur where upslope activities alter soil, runoff patterns or vegetation structure near the riparian corridor. These changes can influence habitat quality, species presence and ecological functioning in HGM 1 and HGM 2, even when the development footprint avoids the delineated buffers.					
Description of Impact: During construction, earthworks and increased human activity upslope of the riparian areas may cause minor edge disturbance to vegetation near the buffer boundary. Localised trampling, soil disturbance and changes in shade or moisture conditions may temporarily affect habitat quality. Because works remain outside the buffers, any disturbance is limited and does not extend into HGM 1 or HGM 2. During operation, altered stormwater patterns and sustained flow in HGM 1 may influence riparian vegetation moisture regimes and associated habitat structure. These changes remain localised to buffer edges and do not directly affect the riparian channel. HGM 2 remains unaffected due to no direct hydrological inputs. With correct management, long term habitat disturbance remains limited.					
No-Go Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Site	Long Term	Reversible	Very Low	Low Probability
Score	1	4	1	1	2
Significance Calculation	Without Mitigation				
S=(E+D+R+M)*P	Low (14)				
Preferred Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Local	Short Term	Recoverable	Moderate	Probable
Score	2	2	3	3	3
With Mitigation	Site	Immediate	Reversible	Low	Improbable
Score	1	1	1	2	1
Significance Calculation	Without Mitigation		With Mitigation		
S=(E+D+R+M)*P	Medium-Low Impact (30)		Low Impact (5)		

Hydrological impacts relate to changes in stormwater concentration during construction and the shift in HGM 1 from a non perennial system to one with sustained flow due to the package plant discharge. Without implementation of the EMPr and associated mitigation measures, the Preferred Alternative would result in a medium impact on the hydrological regime. With mitigation in place this impact is reduced to a low significance. The No-Go alternative results in a low impact because the natural hydrological patterns of both HGM units remain unchanged.

Table 8: Impact assessment summary for Impact 2 – Alterations to the hydrological regime.

Impact Phase: Construction and Operation					
Nature of the impact: Changes to the timing, concentration and distribution of water, stormwater and treated effluent that alter the hydrological behaviour of HGM 1 and HGM 2. These changes may modify flow pulses, runoff patterns and short term water availability within the riparian corridor, including a shift in HGM 1 from a non perennial to a sustained flow system during operation.					
Description of Impact: During construction, earthworks and compacted areas may change microtopography and increase concentrated surface runoff downslope. Short term flow peaks can reach the buffer edges around HGM 1 and HGM 2, but do not alter channel form. The footprint remains outside the delineated buffers, and the systems are tolerant of intermittent flow, so hydrological alteration is localised and limited in magnitude. During operation the package plant will discharge treated effluent into HGM 1, introducing a sustained flow into a naturally non perennial system. This may change HGM 1 to a reach with near permanent baseflow, altering flow timing, downstream moisture regimes and small scale channel behaviour. HGM 2 receives no direct discharge and remains unchanged. When discharge volumes are controlled and monitored, hydrological change remains confined to the riparian corridor of HGM 1.					
No-Go Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Site	Permanent	Reversible	Very Low	Improbable
Score	1	5	1	1	1
Significance Calculation	Without Mitigation				
S=(E+D+R+M)*P	Low Impact (9)				
Preferred Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Regional	Long-Term	Recoverable	Low	High probability
Score	3	4	3	2	4
With Mitigation	Local	Long-Term	Recoverable	Low	Low Probability
Score	2	4	3	2	2
Significance Calculation	Without Mitigation		With Mitigation		
S=(E+D+R+M)*P	Medium Impact (48)		Low Impact (22)		

Sedimentation and erosion can negatively affect freshwater ecosystems by altering channel stability, reducing habitat quality and increasing sediment loads delivered downstream. The No-Go alternative the impact is low because no new disturbance is introduced and existing patterns of erosion remain unchanged in the catchment. For the Preferred Alternative the construction and operational phases may cause localised erosion and sediment mobilisation where soils are exposed or where concentrated stormwater or effluent flows reach downslope areas. This results in a medium impact without mitigation. With the application of mitigation measures, including implementation of the EMPr, maintenance of delineated no-go areas, stabilisation of disturbed soils, dispersal of stormwater and protection of discharge points, the significance is reduced to a low impact. Continuous monitoring during operation allows early identification and correction of any erosion features that may form around infrastructure or at outlet points.

Table 9: Impact assessment summary for Impact 3 – Sedimentation and erosion.

Impact Phase: Construction and Operation					
Nature of the impact: Altered runoff patterns during construction and operation may increase sediment mobilisation and erosion risk upslope of HGM 1 and HGM 2. Concentrated flows can detach soil, transport sediment downslope and initiate gully formation at drainage outlets. These processes may reduce aquatic habitat quality and affect ecosystem functioning if not managed.					
Description of Impact: Construction earthworks and exposed soils increase the likelihood of sediment being mobilised during rainfall events. Concentrated stormwater from compacted areas can carry disturbed soils downslope, increasing the risk of rilling and localised erosion. As work is located outside the buffers of HGM 1 and HGM 2, effects remain limited to upland areas and do not directly alter the channels. Sediment delivery is fully reversible with stabilisation and rehabilitation. During operation, poorly dispersed stormwater or the discharge from the package plant may create concentrated flow paths that trigger erosion at outlet points. Increased flow volumes in HGM 1 can destabilise small sections of banks if unmanaged. HGM 2 is less affected due to no direct discharge. With appropriate flow dispersion and outlet protection, erosion risk remains localised and of low magnitude.					
No-Go Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Site	Long-Term	Reversible	Very Low	Improbable
Score	1	4	1	1	1
Significance Calculation	Without Mitigation				
S=(E+D+R+M)*P	Low (8)				
Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Local	Permanent	Recoverable	Moderate	Probable
Score	2	5	3	3	3
With Mitigation	Site	Short term	Recoverable	Moderate	Low Probability
Score	1	2	3	3	2
Significance Calculation	Without Mitigation		With Mitigation		
S=(E+D+R+M)*P	Medium Impact(39)		Low Impact (18)		

Changes to surface water quality can alter the physical and chemical conditions of freshwater ecosystems and may influence sensitive biota. For the No-Go alternative the impact is low because no new pollution sources are introduced and existing water quality conditions remain unchanged. Under the Preferred Alternative, construction and operational activities introduce a risk of contaminants entering the system, and without mitigation this results in a medium impact due to the potential for sediment, hydrocarbons or inadequately treated effluent to affect HGM 1. These effects are generally reversible if identified early. With the implementation of appropriate mitigation measures, including correct operation of the package plant, stormwater controls, spill management and adherence to the EMPr, the significance of the impact is reduced to a low level. With mitigation the risk of sustained water quality deterioration is minimal and the ecological functioning and PES of HGM 1 and HGM 2 can be maintained.

Table 10: Impact assessment summary for Impact 4 –Changes to surface water quality.

Impact Phase: Construction and Operation					
Nature of the impact: Localised deterioration of surface water quality may occur where contaminants from construction activities or operational infrastructure enter HGM 1 and HGM 2. Pollutants such as sediment, hydrocarbons, cement residues or inadequately treated effluent can alter physical and chemical water quality, influencing aquatic integrity and sensitive biota.					
Description of Impact: During construction disturbed soils, cement residues, hydrocarbons and accidental spills may wash into downslope areas during rainfall events. These inputs can temporarily increase turbidity and introduce contaminants to the riparian corridor. Because construction occurs outside the buffers, any water quality effects remain localised and short term, with limited reach into HGM 1 and HGM 2. During operation the main risk to water quality arises from the discharge of treated effluent into HGM 1, as well as possible contamination of stormwater from the developed footprint. If the package plant is poorly operated, treated effluent may elevate nutrient levels or introduce pollutants. When the plant functions correctly and stormwater is managed, water quality effects remain localised and of low magnitude.					
No-Go Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Site	Short-Term	Reversible	Very Low	Improbable
Score	1	2	1	1	1
Significance Calculation	Without Mitigation				
S=(E+D+R+M)*P	Low (7)				
Preferred Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Regional	Long Term	Recoverable	Moderate	Probable
Score	2	4	3	3	3
With Mitigation	Local	Short Term	Reversible	Low	Low Probability
Score	2	2	1	1	2
Significance Calculation	Without Mitigation		With Mitigation		
S=(E+D+R+M)*P	Medium Impact (36)		Low Impact (12)		

Although HGM 1 and HGM 2 both have a moderately high PES scores (B), existing pressures in the catchment are limited and the systems remain relatively resilient. Under the No-Go alternative the cumulative impact is low because no new disturbance is added and current background pressures remain unchanged. The Preferred Alternative results in a medium cumulative impact without mitigation due to the combined effect of construction disturbance, localised stormwater changes and sustained flow in HGM 1 during operation. With the application of effective mitigation, including buffer maintenance, stormwater management and correct operation of the package plant, the cumulative impact is reduced to a low significance, and the ecological functioning of both riparian units can be maintained.

Table 11: Cumulative impact assessment for aquatic biodiversity.

Cumulative Impact: Cumulative impacts relate to the combined effect of the proposed development and existing pressures within the small catchment. These include long standing agricultural disturbance, the nearby quarry and minor runoff from the access road. Although individually limited, repeated or overlapping disturbances can influence the ecological condition and functioning of HGM 1 and HGM 2 over time.					
Description of Cumulative Impact: During construction, soil disturbance and short term increases in runoff may add to existing background pressures on the catchment. These contributions remain small because work occurs outside the riparian buffers and sediment delivery is limited. The combined effect with current pressures is low and temporary, with impacts confined to the upper parts of the catchment. During operation the discharge from the package plant and changes to stormwater patterns may interact with existing activities in the catchment. These effects remain localised to HGM 1 and occur at a small scale. When discharge quality is maintained and stormwater is managed, the added contribution to cumulative change remains low and does not meaningfully alter the broader ecological condition of the system.					
No-Go Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Site	Permanent	Reversible	Very Low	Improbable
Score	1	5	1	1	1
Significance Calculation	Without Mitigation				
S=(E+D+R+M)*P	Low Impact (9)				
Preferred Alternative Impact Status: Negative					
	E	D	R	M	P
Without Mitigation	Local	Permanent	Recoverable	Moderate	Probable
Score	2	5	3	3	3
With Mitigation	Local	Permanent	Recoverable	Low	Improbable
Score	2	5	3	2	1
Significance Calculation	Without Enhancement		With Enhancement		
S=(E+D+R+M)*P	Medium Impact (36)		Low Impact (13)		

It was determined that, after mitigation, the overall impacts associated with the preferred alternative are of Low negative significance to aquatic biodiversity. The No-Go Alternative will result in no new impacts therefore, from an aquatic perspective the no-go alternative is preferred, but there is no significant aquatic impacts associated with the preferred alternative provided relevant mitigation is implemented.

8 MITIGATION

A mitigation measure is an action or strategy designed to reduce, prevent, or offset negative environmental impacts caused by a proposed development. These measures are commonly used in environmental management, conservation, and impact assessments to ensure that developments or land-use activities do not cause significant harm to aquatic ecosystems. The aim of mitigation measures is primarily to reduce the negative impact rating score and where possible increase any positive impact rating scores according. The implementation of mitigation hierarchy is key to reducing the level of negative impacts. In this case the primary mitigation measure should be avoidance. Avoid any physical disturbance, erosion, or pollution of the riparian ecosystems. It is important to note that these mitigation measures are subject to change based on layout or design alternatives considered.

8.1 Design Phase

The primary objective of the design phase is to ensure that the development and any Wastewater Treatment Plant (WTP) layout, infrastructure, and treatment processes are planned in a way that avoids or minimises direct and indirect impacts on riparian systems through sound engineering and environmental planning. These mitigation measures include:

- The adoption and management of the recommended aquatic buffer zones between the development infrastructure and riparian systems.
- A stormwater management plan (including SUDS principles) must be developed by an engineer in the design phase, detailing the stormwater structures and management interventions that must be installed to manage the increase of surface water flows directly into any natural systems. The stormwater management infrastructure must be designed to ensure the runoff from the development is not contaminated before entering the surrounding area. The volume and velocity of water must be reduced sufficiently to prevent erosion of channels. Effective stormwater management must also include effective stabilisation of any exposed soil.
- The various units can be fitted with rainwater tanks to encourage rainwater harvesting and minimise the volume of runoff from the properties.
- Soft infrastructure must be considered where practical. For example, permeable surfaces can be done via permeable concrete block pavers (such as Amorflex), brick pavers, stone chip, and gravel and may contribute to slowing surface flows (especially if maintained). Baffles in the stormwater conduits are effective. Stormwater managed by the development could be discharged into porous channels / swales ('infiltration channels or basins') running near parallel or parallel to contours within and along the edge of the development. This will provide for some filtration and removal of urban pollutants (e.g. oils and hydrocarbons), provide some attenuation by increasing the time runoff takes to reach low points, and reduce the energy of storm water flows within the stormwater system through increased roughness when compared with pipes and concrete V-drains.
- Design discharge structures to avoid direct concentrated outflow into existing erosion gullies or unstable sections of any aquatic ecosystem.
- Design robust WWTP that will remain operation for the longest periods of time while ensuring the best treatment of sewage.

- If there are any sewerage pump stations required, reasonable measures must be taken to provide back-up for mechanical, electrical, operational or process failure and malfunction at pump stations. At a minimum there should be an alarm system to warn of an electrical failure and sufficient standby equipment to provide for reasonable assurance that the infrastructure can be fully functional within at least 24 hours. Emergency power shall be provided that will prevent overflows from occurring during any power outage. Installing permanent generators at each station is strongly advised.
- Sewerage pump stations (if required) will need to be placed within a suitably lined, impermeable concrete bunded area with the capacity to hold untreated waste water in an emergency and provide for sufficient time for maintenance staff to address any faults/ problems. This is to limit the risk of untreated sewage overflowing in the event of any leakage or accidental spillage at the pump station.

The draft civil engineering design report has integrated the above recommendations successfully. Technical details, such as the site-specific design and layout of the discharge outlet from the WTP, should follow these same principles and be approved by an aquatic specialist prior to implementation.

8.2 Construction Phase

Within the Construction Phase the aim of all role players is to implement site activities in a controlled and compliant manner that avoids disturbance to riparian zones, prevents erosion and pollution, and ensures short-term impacts are minimised through best practices and oversight. These mitigation measures include

- A construction method statement must be compiled and available on site. It must consider the buffer zones and include methods to avoid unnecessary disturbance and prevent material being washed into any of the wetlands.
- The edges of the development area relative to the aquatic habitat must be clearly staked-out and demarcated prior to construction commencing.
- Appointing an independent Environmental Control Officer (ECO) to monitor construction activities and ensure environmental compliance.
- Limit vegetation clearing to only those areas required for infrastructure installation; retain natural buffers where designed.
- Continuously monitor the area for newly established alien species during the contract and establishment period, which if present must be removed. Removal of these species shall be undertaken in a way which prevents any damage to the remaining indigenous species and inhibits the re-infestation of the cleaned areas. Any use of herbicides in removing alien plant species is required to be investigated by the ECO before use.
- Install erosion and sediment control measures (e.g., silt fences, sediment traps, berms, straw bales) on the downslope edges of disturbed areas within the development footprint.
- Stabilise exposed soils promptly using geotextiles, mulch, or indigenous grass seeding.
- Locate construction camps, laydown areas, and materials stockpiles outside of the riparian zone and buffer area.
- Implement temporary stormwater controls such as cut-off trenches, sediment basins or swales to prevent dirty water from entering watercourses.
- Keep spill kits on site, and ensure all workers are trained in emergency spill response.

- Conduct environmental inductions for all site workers, with emphasis on riparian system sensitivity and legal compliance.

The draft civil engineering design report has integrated much of the above recommendations. The Method Statement (and EMPr) should follow these same principles and be reviewed by an aquatic specialist prior to implementation.

8.3 Operational Phase

The operational phase is the most crucial in ensuring that the long term impacts of a development are minimised. Within the operational phase it is critical to maintain ongoing performance of any WWTP in a way that safeguards water quality, flow regimes, and riparian habitat integrity over the long term, while ensuring adaptive management and legal compliance of the overall development. These mitigation measures are recommended to be implemented

- Ensure that any treated effluent consistently meets the conditions of the relevant DWS water use authorisation.
- Regularly monitor water quality both upstream (if possible) and downstream of any discharge points, using parameters aligned with aquatic ecosystem health.
- Implement an adaptive management approach to modify operations based on monitoring results (e.g., improve treatment stages or adjust discharge volumes/timing).
- If required, maintain separation of clean and dirty water systems, especially during rainfall events, to prevent overloading of the treatment plant or discharge of untreated stormwater.
- Stormwater exit points must include a best management practice approach to trap any additional suspended solids and pollutants originating from the proposed development. Also include the placement of stormwater grates (or similar). The use of grease traps/oil separators to prevent pollutants from entering the environment from stormwater is recommended. To ensure the efficiency of these, they must be regularly maintained.
- Inlet protection measures to capture solid waste and debris entrained in storm water entering the storm water management system (inlet protection devices) will need to be incorporated into the design of the system and could include the use of either curb inlet/inlet drain grates and/or debris baskets/bags. These must be maintained during operational phases.
- It is also important to note that storm water infrastructure will likely require regular on-going maintenance in the form of silt, debris/litter clearing in order to ensure their optimal functioning.
- Rehabilitate and maintain vegetation to serve as a buffer between development or WWTP infrastructure and the natural drainage system.
- If a risk, use fencing and\or bollards to prevent unauthorised access (by vehicles, livestock, or people) to sensitive areas, except for management purposes.
- Continue alien invasive plant control throughout the site, particularly around discharge zones and disturbed banks.
- Develop an emergency response plan for spills, bypass events, or treatment failures, including clear responsibilities and communication chains. The Department of Water Affairs regional office should be notified, as soon as possible, of any significant chemical spill or leakage to the environment where there is the potential to contaminate surface water or groundwater.
- Ensure ongoing maintenance and servicing of any mechanical components and infrastructure to avoid untreated releases or failures.

The draft civil engineering design report has integrated much of the above recommendations. The final treatment plant design and monitoring plan should be reviewed by an aquatic specialist prior to implementation.

9 CONCLUSION

The field assessment confirmed that only two riparian units, HGM 1 and HGM 2, have any potential to be affected by the proposed development. Both systems are in a moderately high ecological condition (PES B) and hold a High Ecological Importance and Sensitivity rating, reflecting their biodiversity value and role as ecological corridors in the landscape.

Impact assessment results indicate that the No-Go alternative would maintain the current pressures on both systems, resulting in maintenance of ecosystem services in the medium to long term. The Preferred Alternative yields medium impacts without mitigation, primarily due to construction activities upslope of the buffers and the impacts of the package plant introducing sustained hydrological flows into HGM 1 during operation. With the application of the recommended mitigation measures, all impacts reduce to low significance because the development footprint avoids the delineated aquatic buffers and operational discharges can be controlled, monitored and stabilised over time (Table 12).

Table 12: Summary of impact significance assessment process

Impact	**Significance**		**After Mitigation**	
	Preferred Alternative	No-Go	Preferred Alternative	No-Go
Loss or disturbance of aquatic habitat and biota	Low Impact (20)	Low Impact (14)	Low Impact (4)	Low Impact (14)
Alterations to the hydrological regime	Medium Impact (48)	Low Impact (9)	Low Impact (22)	Low Impact (9)
Sedimentation and erosion	Medium Impact (39)	Low Impact (8)	Low Impact (18)	Low Impact (8)
Changes to surface water quality	Medium Impact (36)	Low Impact (7)	Low Impact (12)	Low Impact (7)
Cumulative impacts on the aquatic resources of the area	Medium Impact (36)	Low Impact (9)	Low Impact (13)	Low Impact (9)

Key for impact significant score

No significance or Negligible (N)	Low (L)	Medium (M)	High (H)

From an aquatic perspective the Preferred Alternative is acceptable, provided mitigation measures are correctly implemented. Long term monitoring should focus on hydrological behaviour, erosion risk, and water quality to ensure that both HGM 1 and HGM 2 remain stable and that no further degradation of ecological condition or ecosystem services occurs.

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APPENDIX 1 –DETAILED METHODOLOGY

DEFINITIONS

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

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 because of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

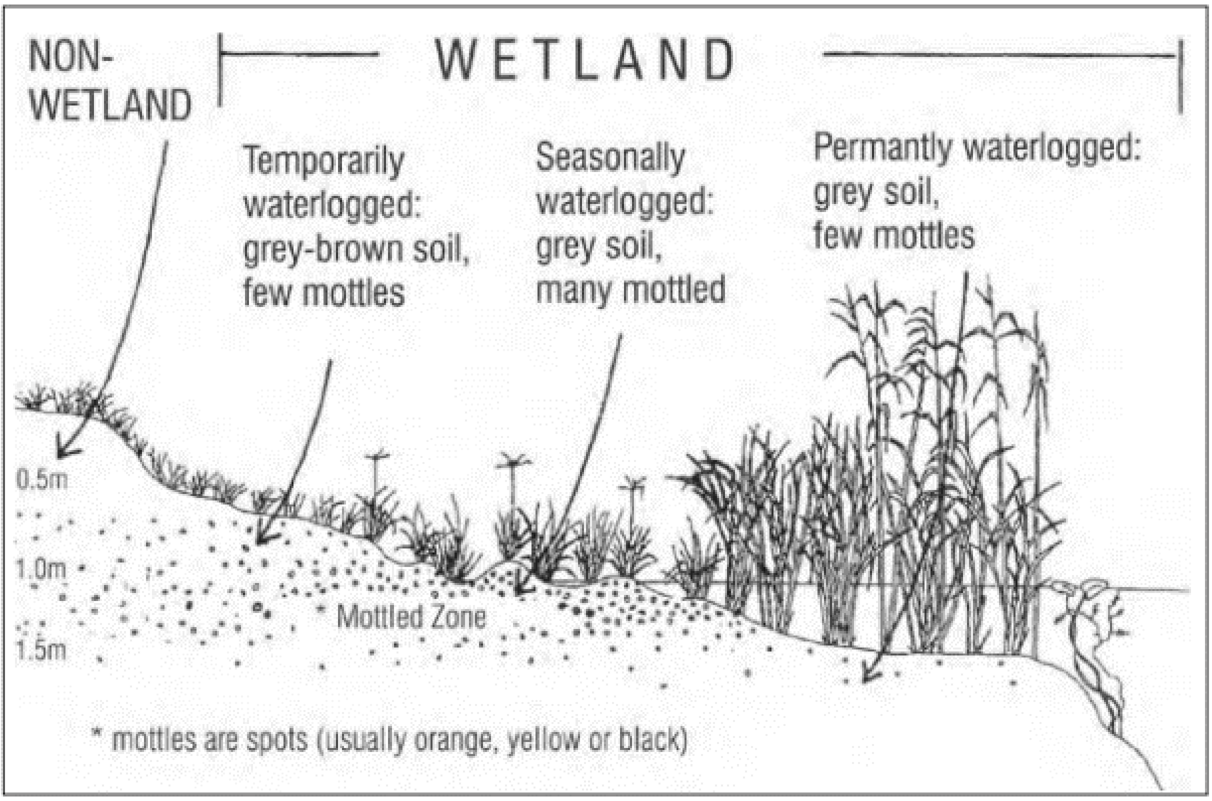

Figure A1.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one move along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

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 practice 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 A1.1a)

A1.1a: 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 A1.1b: 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 (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), 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

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 A1.1b).

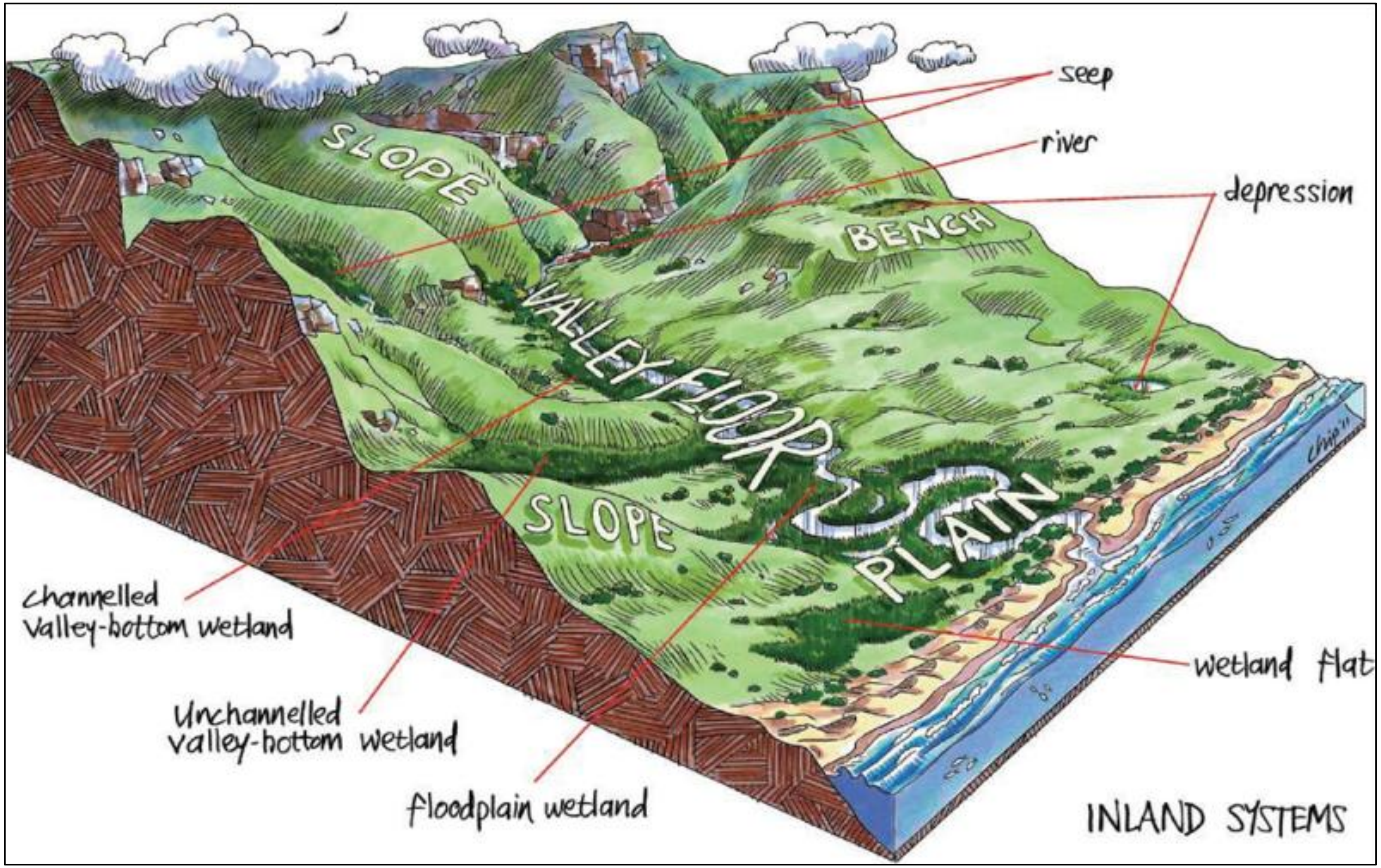

Figure A1.1b: Illustration of wetland types and their typical landscape setting (From Ollis et al. 2013)

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 A2.2a). 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 vigor or robustness of growth forms of species like 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.

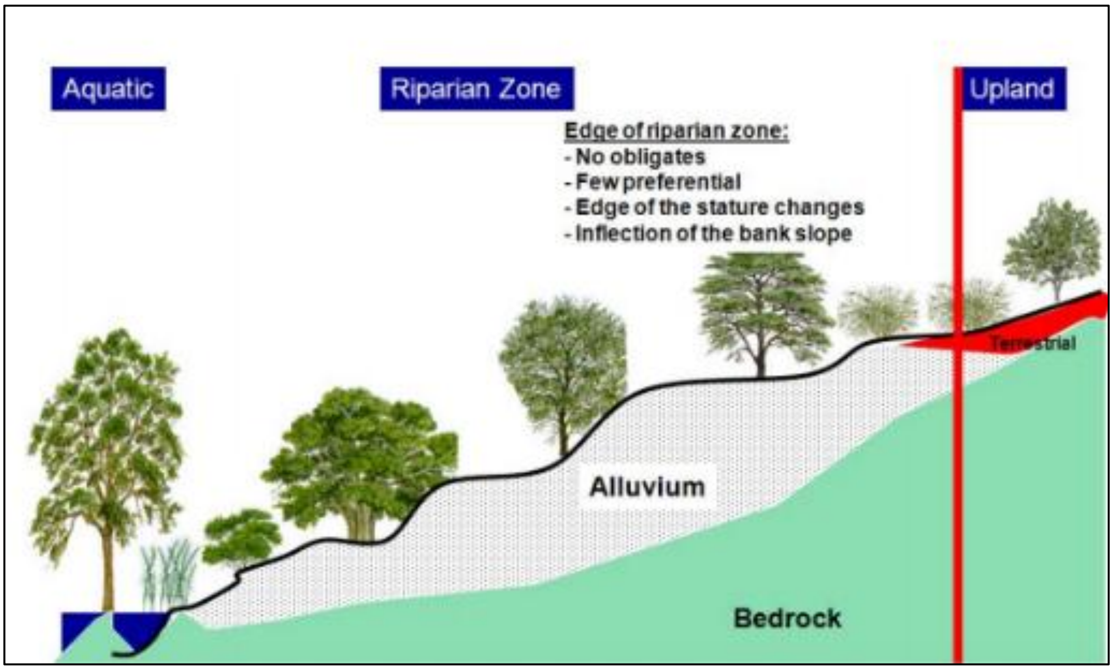

Figure A2.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF 2008).

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 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 because 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 (minerogenic) 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 because 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:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*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 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

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 characterize 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 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.

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

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

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 land uses / 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 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.

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

IMPACTS METHODOLOGY

Description and determination of the significance of the predicted impacts in terms of the criteria below to ensure a consistent and systematic basis for the decision-making process. Significance is numerically quantified on the basis score of the following impact parameters:

1. ***Extent* (E)** of the impact: The geographical extent of the impact on a given environmental receptor.
2. ***Duration* (D)** of the impact: The length of permanence of the impact on the environmental receptor.
3. ***Reversibility* (R) of the impact**: The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change
4. ***Magnitude* (M)** of the impact: The degree of alteration of the affected environmental receptor.
5. ***Probability* (P)** of the impact: The likelihood of the impact occurring.

A widely accepted numerical quantification of significance is the formula:

$S=(E+D+R+M)*P$

Where: *Significance=(Extent+Duration+Reversibility+Magnitude) * Probability*

The significance of environmental impacts is determined and ranked by considering the criteria presented in **Table 11.7A** below. All criteria are rank according to 'Very Low', 'Low', 'Moderate', 'High' and 'Very High' and are assigned scores of 1 to 5 respectively.

Table 12.7A*: Defining the significant in terms of the impact criteria.*

Impact Criteria	Definition	Score	Criteria Description
Extent (E)	Site	1	Impact is on the site only
	Local	2	Impact is localized inside the activity area
	Regional	3	Impact is localized outside the activity area
	National	4	Widespread impact beyond site boundary. May be defined in various ways, e.g. cadastral, catchment, topographic
	International	5	Impact widespread far beyond site boundary. Nationally or beyond
Duration (D)	Immediate	1	On impact only
	Short term	2	Quickly reversible, less than project life. Usually up to 5 years.

Impact Criteria	Definition	Score	Criteria Description
	Medium term	3	Reversible over time. Usually between 5 and 15 years.
	Long term	4	Longer than 10 years. Usually for the project life.
	Permanent	5	Indefinite
Magnitude (M)	Very Low	1	No impact on processes
	Low	2	Qualitative: Minor deterioration, nuisance or irritation, minor change in species/habitat/diversity or resource, no or very little quality deterioration. Quantitative: No measurable change; Recommended level will never be exceeded.
	Moderate	3	Qualitative: Moderate deterioration, discomfort, Partial loss of habitat /biodiversity /resource or slight or alteration. Quantitative: Measurable deterioration; Recommended level will occasionally be exceeded.
	High	4	Qualitative: Substantial deterioration death, illness or injury, loss of habitat /diversity or resource, severe alteration or disturbance of important processes. Quantitative: Measurable deterioration; Recommended level will often be exceeded
	Very High	5	Permanent cessation of processes
Reversibility (R)	Reversible	1	Recovery which does not require rehabilitation and/or mitigation.
	Recoverable	3	Recovery which does require rehabilitation and/or mitigation.
	Irreversible	5	Not possible, despite action. The impact will still persist, and no mitigation will remedy or reverse the impact.
Probability (P)	Improbable	1	Not likely at all. No known risk or vulnerability to natural or induced hazards
	Low Probability	2	Unlikely; low likelihood; Seldom; low risk or vulnerability to natural or induced hazards

Impact Criteria	Definition	Score	Criteria Description
	Probable	3	Possible, distinct possibility, frequent; medium risk or vulnerability to natural or induced hazards.
	Highly Probable	4	Highly likely that there will be a continuous impact. High risk or vulnerability to natural or induced hazards
	Definite	5	Definite, regardless of prevention measures.

The *significance* (s) of potential impacts identified according to the criteria above has been colour coded for the purpose of comparison. This colour coding will be used in impact tables.

Significance is deemed Negative (-)		
0 - 30	**31 - 60**	**61 - 100**
Low	**Medium**	**High**

APPENDIX 2 - SPECIALIST CV

CURRICULUM VITAE

COLIN JUSTIN FORDHAM

BSC (BOTANY, BIOCHEMISTRY)

BSC BOTANY HONOURS (ENVIRONMENTAL MANAGEMENT)

MSC ENTOMOLOGY (BIOLOGICAL CONTROL)

Colin Justin Fordham

25 Blommekloof Street, Denneoord, George• **Cell:**0827889739,
• **Email**: colin@upstreamconsulting.co.za

Personal Information

Professional profile:

A highly motivated, confident, and diligent professional with exceptional communication skills, passionate about solving complex challenges. Adept at leveraging technology and software solutions to enhance organizational systems and functionality. Well-presented, ambitious, and goal-oriented with a strong drive to achieve success.

Skills:

- Extensive experience managing budgets and complex teams of staff who vary in skillsets, experience and opinions.
- Extensive conservation expertise in managing, analysing, and implementing ecological monitoring projects of varying complexity across Marine, Estuarine, Freshwater and Terrestrial ecosystems within seven Nature Reserves in the Western Cape.
- Vast experience managing, compiling and implementing large scale conservation and environmental projects, such as BMPs, PAMPs, EIA's, BAR's and various specialist studies while working as a senior manager, environmental consultant, ecological specialist.
- Extremely respectful of different cultures, religious and ethnic beliefs and I enjoy interacting with a wide variety of people.
- Exceptional knowledge of South African ecosystems, conservation policy and legislation.
- Extensive Southern Africa botanical, coastal and freshwater habitat assessment skills as well as experience in alien plant removal and rehabilitation techniques.
- Excellent knowledge of Southern Africa, geographically and culturally.
- Highly computer literate and skilled, with knowledge of various Microsoft Office, QGIS, ArcGIS, ArcView (v3 & v9.1 &v10), Manifold (v7&v8) mapping systems and programs. I also have experience with working with Miradi Conservation software.
- Excellent verbal, report writing and presenting skills.

Date of birth: 8th December 1982

Marital status: Married, no dependants

Health: Excellent

Criminal record: None

Country of origin: South Africa

ID Number: 8212085221086

Languages: Fluent in English, Afrikaans and Xhosa

Driver's License: Code 14, EC

Skippers License: River boats up to 9m.

Summary of Employment and Tertiary Education:

- Landscape Conservation Intelligence Manager - CapeNature (2019 – 2025)
- Land Use Scientist – CapeNature (2016 – 2019)

- Wetland Specialist, KSEMS (August 2015 – June 2016)
- Environmental Consultant and Ecologist, AGES (January 2012 – August 2015)
- MSC at Rhodes University (March 2010 – December 2012)
- CES – (March 2008 – February 2010) Environmental Scientist, Botanical\GIS Specialist and Ecologist
- BSC and BSC Honours at Nelson Mandela University (2001-2007).

Work Experience

A list of Coastal Rehabilitation Project Specific Experience is provided in Appendix A

CapeNature Landscape Conservation Intelligence Manager (LCIM) (2019 – 2025)

The purpose of the LCIM is to provide strategic leadership and overall accountability for the management, conservation and the promotion of human, natural and heritage assets in a CapeNature Landscape through best practice, within relevant legislative frameworks and the provision of a professional knowledge generation, capacity building and information management service, that enables strategic adaptive biodiversity management. The LCIM forms part of the Landscape Management Team, with Landscape Ecologist, Ecological Coordinator, Ecological Technician, GIS Technician and Technical Assistant all reporting to the LCIM.

As a LCIM, my key responsibilities included:

- Ensuring that Managed data, knowledge, and information flowed to produce high-quality intelligence, facilitating strategic adaptive management across priority landscape projects.
- Providing ecological decision support to guide landscape conservation through the coordination and scientific analysis of data for management planning and assessments.
- Facilitating integrated landscape and protected area planning by ensuring the development and review of key documents, such as Protected Area Management Plans (PAMPs), species Biodiversity Management Plans and ecological monitoring protocols.
- Leading capacity-building efforts to support conservation management, ecosystem resilience, and the coordination of stakeholders to ensure effective landscape conservation.
- Ensuring performance, governance, and risk management of Landscape Conservation Intelligence (LCI) through effective leadership and strategic oversight.
- Developing and reviewing landscape intelligence products, including eco-matrices, biodiversity planning documents, and data management tools, ensuring their alignment with conservation goals.
- Providing expert ecological input into landscape assessments, including site-specific impact assessments, spatial biodiversity planning, and biodiversity offset strategies.
- Managing and optimising budget allocations, ensuring financial control over the expenditure related to biodiversity projects and landscape conservation activities.
- Coordinating biodiversity data collection and monitoring activities, ensuring accurate fieldwork for priority landscape monitoring projects and habitat/species assessments.

- Sustaining key partnerships with municipalities, biosphere partners, academic institutes, and stakeholders to advance landscape custodianship and biodiversity conservation.
- Providing formal and informal decision support on biodiversity planning, permit applications, and development proposals, ensuring compliance with environmental legislation.
- Monitoring and reviewing conservation actions, including eco-matrix updates and biodiversity management plans, and facilitated input into landscape planning and expansion initiatives.
- Facilitating the development of key strategic documents, including the annual Integrated Work Plans (IWP) and APO (Annual Planning Objectives), aligning conservation priorities with landscape-level planning.
- Contributing to the development and review of biodiversity management guidelines, protocols, and spatial planning tools to ensure effective conservation strategies across landscapes.
- Reviewing and approving Protected Area Management Plans (PAMPs), contributing to the strategic vision and operational planning for the expansion and management of protected areas.
- Managing team performance, including the implementation of performance agreements, appraisals, and staff development plans, fostering a high-performance culture in the landscape team.
- Representing CapeNature at forums, workshops, and conferences, providing expert contributions and expanding the network of stakeholders committed to biodiversity conservation.
- Providing scientific analysis of biodiversity data, interpreting landscape data sources and providing actionable recommendations for biodiversity management.
- Engaging in active governance and compliance oversight, ensuring that landscape conservation units adhered to corporate policies, standards, and environmental legislation.
- Optimising staff capacity by facilitating training programs, supporting GIS and ecological training for landscape teams, and enhancing skills to support landscape conservation goals.

<u>CapeNature Land Use Advice Scientist (June 2016 – 2019)</u>

The purpose of a CapeNature Land Use Advice Scientist is to provide specialised ecological expertise and guidance in land-use planning, development, and conservation. This role ensures that land-use decisions align with biodiversity conservation priorities, legal requirements, and sustainable environmental practices. Key responsibilities include evaluating the ecological impacts of proposed developments, reviewing specialist reports, advising on biodiversity offsets, and promoting the integration of conservation objectives into regional and local planning frameworks. The position also involves contributing to the development of biodiversity management tools, supporting research and monitoring programs, and fostering collaboration between stakeholders to protect and enhance natural ecosystems in the Western Cape.

As a Land Use Scientist, my key responsibilities included:

- Reviewing specialist reports and planning applications, providing ecological expertise to support land-use decision-making.
- Evaluating and advising on biodiversity offsets, ensuring compliance with conservation priorities and environmental regulations.
- Assessing site sensitivities and the potential ecological impacts of land-use applications, offering guidance to competent authorities.
- Developing biodiversity legislative tools, including Biodiversity Management Plans (BMPs), Alien Invasive Species (AIS) management plans, and spatial biodiversity plans.
- Identifying and recommending opportunities to expand the conservation estate through stewardship programs and other mechanisms.
- Attending site inspections, resolving development queries, and reporting non-compliance to relevant authorities.
- Representing CapeNature at conservation forums, workshops, and conferences, contributing scientific expertise.
- Supporting biodiversity research and monitoring efforts, publishing findings to inform conservation strategies.
- Maintaining an up-to-date database of land-use applications and biodiversity offsets to guide planning.
- Providing training and support to staff on environmental legislation and conservation guidelines.

Wetland Specialist, KSEMS (August 2015 – June 2016)

- Project Management and coordination of sub-consultants as well as budget control handling
- Compiling specialist wetland assessments, with specific reference to estuaries, riparian zones, wetlands, coastal forests, grasslands and savannahs.
- Compilation of maps using GIS systems and analysis of data, using GIS systems
- General assistance regarding administration, co-ordination, project management and report production activities related to business projects.

Environmental Consultant, AGES (January 2012 – August 2015) and CES (March 2008 –February 2010) Environmental Scientist, Botanical\GIS Specialist and Ecologist.

- Project Management and coordination of sub-consultants as well as budget control handling
- Assisting the compilation of Environmental Impact Assessment (EIA) and Botanical Survey reports, including Multivariate analysis.
- Assisting with specialist faunal and floral studies, with specific reference to estuaries, riparian zones, wetlands, coastal forests, grasslands and savannas.
- Compilation\assisting with the compilation of the following reports\studies; Environmental Impact Assessments (EIA), Basic Assessments, Scoping Reports, Environmental Management Plans, Baseline Surveys and Botanical Surveys.
- Compilation of maps using GIS systems and analysis of data, using GIS systems
- Also, general assistance regarding administration, co-ordination, project management and report production activities related to business projects.

Department of Botany, NMMU, (2005-2007)

Environmental Consultant:

- Assisted in the undertaking of an EIA, for the augmentation of a water supply for Nieu Bethesda, including the construction of a pump station and two water reservoirs. Was directly responsible for the compilation of a botanical species list from samples taken from the site.

Laboratory Technician\Teaching experience (2005 & 2006, 2010 and 2011 at Rhodes University):

- 1st year student demonstrator
    - Taught students weekly and assisted in smooth and safe operation of laboratory equipment during student practical sessions.

South African Railways Contract Work, (Spoornet), (2004-2007)

- Preformed alien plant removal contracts for family business as a supervisor of a team varying from 2 – 8 men.
- Was responsible for the identification and eradication of alien plant species, application of herbicide and preservation of protected species.

Qualifications

BSc subjects, (majored in Botany and Biochemistry, (2001-2005)

BSc Honours - Botany (Environmental Management), (2006-2007)

MSc Entomology (Biological Control) - Passed

A GIS analysis of the dominant aquatic alien macrophytes and a baseline assessment of the macroinvertebrates associated with *Myriophyllum spicatum* L. in the Vaal River.

The MSc was conducted on the *Myriophyllum spicatum* L. infestation in the Vaal River. It focused on the observed switch of Alternate Stable States, from a floating plant (water hyacinth) dominated state, to a submerged aquatic alien plant (*M. spicatum*) dominated stable state.

This study required GIS analysis of satellite imagery to determine when and where the switch in dominance occurred, and how this new state would impact the future control of water hyacinth and *M. spicatum* by Working for Water teams.

Additional analysis was conducted on how the water and sediment nutrient levels could have been affected by the change in dominance. An insect faunal survey was also conducted to determine how indigenous insects were impacting and limiting the spread of *M. spicatum*. It was envisaged that this baseline study would allow the Rhodes Department of Entomology to quantify the impact that future biological control agents would have on the existing *M. spicatum* population.

Additional Short Courses Completed

- Biological Control Short Course – Prof Martin Hill, Rhodes University February 2010.
- ArcGIS Short Course – Prof Gillian McGregor, Rhodes University, April 2010.
- Project Management Course – Chris Upfold - April 2008
- EIA Course – Rhodes University – Pass (Highly Competent) (Nov 2008)
- CES Courses
  - Financial Management of Projects (Oct 2008)
  - Basic Assessments (Oct 2008)
- Wetland Delineation and Assessment Short Course – Pass (Sep 2009)
- Biological Control Short Course – Pass (February 2010)
- Conservation Coaches Short Course – Pass (February 2018)

Presentations and Posters:

- Twenty-one presentations given on behalf of CapeNature while working as a Land Use Scientist and as a Landscape Conservation Intelligence Manager.
  - These were presented to a wide range of stakeholders, as well as fellow scientists and members of the public. Both in person and virtually on MS Teams and Zoom platforms.
  - Facilitated seventeen different large-scale workshops for various CapeNature conservation orientated products.
- Constructed wetlands and their efficiency for wastewater treatment, Nelson Mandela Metropolitan University. March 2006
- Mapping the *Myriophyllum spicatum* infestation in the Vaal River and its implications for biocontrol. Weeds Workshop Conference 30th August -3rd September 2010.
- A baseline study of the insects associated with an infestation of *Myriophyllum spicatum* L. in the Vaal River. Entomology Society (3rd – 6th July 2011)
- A GIS analysis of the macrophytes in the Vaal River and a baseline survey of the invertebrates associated with Myriophyllum spicatum. Weeds Workshop (6th – 9th July 2011)

References

Mr Garth Mortimer

CapeNature (now working for Caledonian Climate)

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Mr Mbulelo Jacobs

CapeNature

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Telephone Number: 0828236481

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Dr Ernst Baard

CapeNature

Position: Executive Director: Conservation Operations

Telephone Number: 082 414 0424

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APPENDIX 3 -SPECIALIST

DECLARATION

Specialist Company Name:	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.			
Physical address:	25 Blommekloof Street, George			
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Postal code:	6530	Cell:	0648575560	
Telephone:		Fax:		
E-mail:	colin@upstreamconsulting.co.za			

DECLARATION BY THE SPECIALIST

I, __Colin 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: 01/03/2026