ANCA Chicken Houses

Aquatic Biodiversity Assessment

FINAL REPORT

GroundTruth

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- There are no conflicting interests, and none shall be engaged in, during the undertaking of the assigned activity;
- GroundTruth undertakes to disclose to the applicant and the competent authority all material information it may be in possession of that reasonably has or may have the potential of influencing - any decision to be taken with respect to the outcome of the project by the competent authority; and - the objectivity of any report, plan or document to be prepared by GroundTruth for submission to the competent authority;
- All the particulars furnished by team members in this document are true and correct; and
- GroundTruth is aware that any person(s) is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of sub-regulation 48(1) (a) to (e) is liable to the penalties as contemplated in section 49B(1) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signed:

Date: 25 July 2025

Steven Ellery

Pr. Sci. Nat. (Ecology) Reg. No. 132408

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LIST OF ACRONYMS

Acronym	Explanation
CR	Critically Endangered
CVB	Channelled Valley-Bottom Wetland
DEDTEA	Department of Economic Development, Tourism and Environmental Affairs
DEP	Depression
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Eastern Cape
ECO	Environmental Control Officer
EIS	Ecological Importance and Sensitivity
EN	Endangered
ETS	Ecosystem Threat Status
FEPA	Freshwater Ecosystem Priority Area
GIS	Geographic Information System
GPS	Global Positioning System
Gs	Sub-Escarpment Grassland
Gs6	KwaZulu-Natal Highland Thornveld
HGM	Hydrogeomorphic
HSS	Hillslope Seep
IHI	Index of Habitat Integrity
LT	Least Threatened
MAP	Mean Annual Precipitation
NFEPA	National Freshwater Ecosystem Priority Areas
NP	Not Protected
NWA	National Water Act (No. 36. 1998)
MAP	Mean Annual Precipitation
PES	Present Ecological State
PET	Potential Evapotranspiration
RIP	Riparian Area
RFP	Relic Floodplain
SANBI	South African National Biodiversity Institute
UCVB	Unchannelled Valley-Bottom Wetland
VHS	Valley Head Seep Wetland
WT	Wetland Type

1. INTRODUCTION

GroundTruth were appointed by Indwe Environmental Consulting to conduct an aquatic biodiversity assessment for a proposed chicken broiler development on the Oakwood Farm within the Amahlathi Local Municipality, south of Stutterheim.

Local, regional, and national regulatory bodies, such as the Departments of Water and Sanitation (DWS) and the Department of Economic Development, Environmental Affairs and Tourism (DEDEAT), have adopted legislation, policies and guidelines that regulate the use of aquatic ecosystems (wetland and riverine systems) to protect and maintain these systems' benefits and services to society and the natural environment. To be regulated, these systems must first be identified, delineated and assessed.

The objective of the delineation procedure is to identify the boundary between the aquatic ecosystems and adjacent terrestrial areas. The process of aquatic ecosystem delineation identifies the extent of these ecosystems based on the following legal definitions:

- "Wetland means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."
- "Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas."

Hydrology is considered to be the primary biophysical driver of aquatic ecosystems, but due to its variability, it is not possible to efficiently and accurately delineate these systems based on water levels (Richardson and Vepraskas, 2001). The delineation of aquatic ecosystems, therefore, relies on indirect indicators, such as vegetation, topography and soils.

This study includes the delineation and assessment of the aquatic ecosystems that will be impacted upon by the proposed activities on ANCA Foods (Pty) Ltd.'s property, which is located 3.5 km south-east of Stutterheim, Eastern Cape. The client is undertaking an Environmental Impact Assessment (EIA) and applying for a Water Use License (WUL) for the proposed construction of 16 chicken houses across two sites along with a clean water reticulation system between the two broiler house sites. All aquatic ecosystems within a 500 m radius of the study site were delineated (**Figure 1-1**).

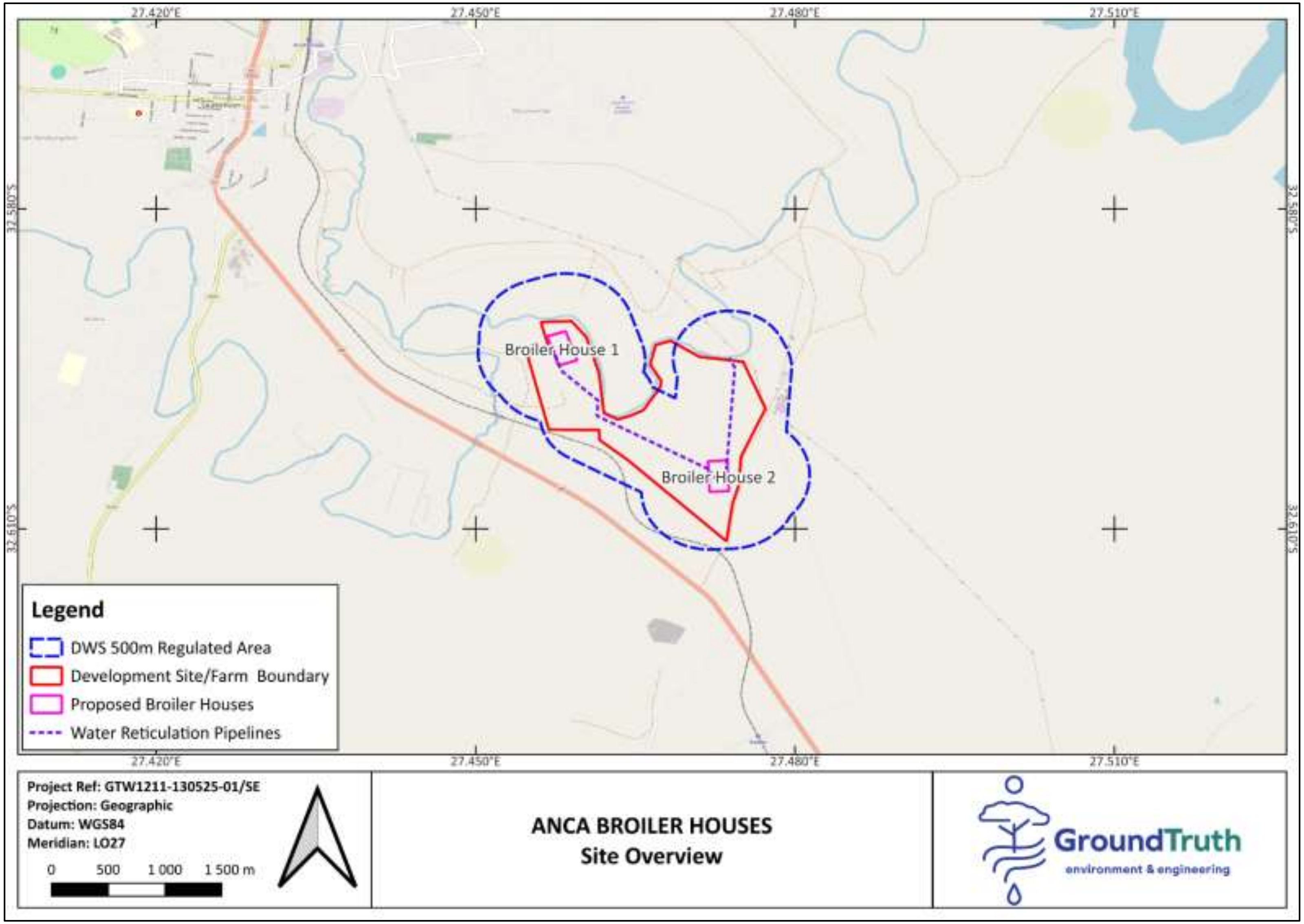

Figure 1-1 Overview of the general study site.

2. TERMS OF REFERENCE

The study area is located on the Oakwood Farm 3.5 km south-east of Stutterheim, Eastern Cape, and the development will occur on erven 546, 547, 548, 549, 550, 551, 552 and 2235. Based on information supplied by the client, the broiler houses will be utilised for the production of poultry and include two sites with the construction of eight broiler houses per site that comprise of ancillary buildings such as a staff eating and washing area and services (e.g. stormwater, water and sewerage). A clean water reticulation system will be established, drawing water from an authorised abstraction point from the Kubusi River and an authorised borehole. The water reticulation system will supply water to both broiler houses via 50mm diameter HDPE pipes. The proposed site of the chicken broiler houses (hereafter referred to as the proposed development) falls within 500 m of aquatic ecosystems[1], and as such that the client is required to undergo an aquatic ecosystem study to determine potential risks to aquatic ecosystems. Given this, the terms of reference for the study are as follows:

- In field delineation of the boundary of aquatic ecosystems that are hydrologically linked and potentially impacted by the proposed development, and within the DWS 500 m regulated area.
- Functional assessment[2] of the aquatic habitat hydrologically linked to the proposed developments along with their ecological importance and sensitivity.
- Description of the current and post-development state of the wetland systems hydrologically linked to the proposed developments.
- Description of the likely impacts (as per the NEMA and EIA regulations) and risks (as per the NWA and WUL regulations) associated with the proposed developments and appropriate mitigation measures to avoid unnecessary impacts to the aquatic ecosystems.
- Determining appropriate construction and operational phase buffer requirements for the aquatic ecosystems.
- Identification of other sensitivities and important issues not identified within the assessment process, if applicable.
- Specification of mitigation measures to reduce the impacts on aquatic biodiversity as far as possible.

1 Please note that the term 'aquatic ecosystems' is used to refer to riverine, wetland and estuarine ecosystems.
2 Functional assessments refer to the assessment of the delivery of ecosystem goods and services.

3. KNOWLEDGE GAPS

The following sections highlight the assumptions and limitations associated with this study that may influence the type of information collected and the accuracy of the data.

3.1 Assumptions

Studies relating to natural ecosystems and understanding historical conditions rely on various assumptions, with the following assumptions being made during the assessment of these particular systems:

- When undertaking a wetland delineation, three environmental indicators are generally considered namely, landscape position, soil properties and vegetation indicators. Wetlands seldom form on hill sides and scarp slopes and as such, assessing the landscape position can often preclude the need to assess the soil and vegetation indicators. As such, areas where there is a high chance that wetland conditions may exist were assessed in detail, whereas areas precluded by their position in the landscape were only briefly assessed for wetland conditions.
- Mapping and classification of the wetlands and watercourses that are hydrologically isolated from the study site within the 500 m radius should be considered preliminary as they were only briefly verified infield.
- Alien invasive plants would be maintained at low levels (<1% cover) within the wetland systems and its associated buffer for the operational phase of the development. It is acknowledged that construction activities often create prime habitat for alien invasive plants.
- The development layout that has been provided to GroundTruth by the client on the 16th of July 2025 are accurate and will not change once this report has been finalised and approved. Should the development layout change, the assessments in this report may need to be adjusted.
- The development activities will not extend beyond the proposed development boundary as illustrated on all maps as the 'Proposed Development Footprint'.
- The hectare equivalent calculations relating to the functional wetland area in the study site accounts for the entire extent of the hydrogeomorphic (HGM) unit in the landscape (i.e., including the wetland areas that extend beyond the study site and/or property boundary).
- An appropriate maintenance and management plan will be compiled and implemented, to ensure the effectiveness of the proposed activities are sustained into the future.
- Given that the risk assessment matrix only considers the mitigated scenario, it is assumed that all mitigation measures that are suggested in **Section 9** will be adopted during the construction and operational phases of the proposed development.
- An appropriate maintenance and management plan will be compiled and implemented, to ensure the effectiveness of the proposed activities are sustained into the future.
- The site assessment was conducted on 27 May 2025, during the winter season in the Eastern Cape. Consequently, it does not encompass the seasonal variations in site conditions. However, the specialist is of the opinion that this omission does not materially affect the validity or outcome of the assessment.

- The duration of the site visit was approximately 10 hours which was sufficient to delineate and assess the watercourses within the 500 m regulated area as well as the associated risks posed by the proposed developments.
- A single alternative development location was assessed for the Broiler House 2 as required by GNR 982 (as amended by GN 517). No alternatives were assessed for Broiler House 1.
- The watercourses were delineated using a Trimble Catalyst DA2 receiver connected to a phone with an expected accuracy of 60 cm or less. This is deemed sufficiently accurate in the opinion of the specialist.

3.2 Limitations

The following limitations apply to the studies undertaken for this report:

- Due to time constraints, soil descriptions are based on moist conditions, rather than the dry conditions stipulated in the DWS guidelines (DWAF, 2005). Generally, the recorded Munsell colour values would increase as soil is dried. This was taken into consideration during the infield studies.
- In some areas, the soils within the site were highly disturbed due to historical and current agricultural practices, erosional features within the landscape, and additional water inputs, making the interpretation of soil profiles difficult at times.
- The wetland assessment techniques are considered to be the most appropriate at the time of the compilation of the report, however in some instances, such as for systems that have been highly modified/transformed, they may have shortfalls. This technique, however, has been compiled based on international best practice, to apply to South African conditions, having undergone a peer-review process during their development. This assessment technique should, therefore, be seen as the most appropriate tool for wetland assessments at this time.
- The assessment of the wetland systems' ecological integrity includes catchment conditions, and it should be noted that changes in the HGM units' catchments may have an adverse effect on the systems' integrity.
- The assessments of the identified wetland systems were based on an individual site visit, i.e., a 'snap-shot' in time, due to budgetary and time constraints. As such, changes in the recorded features and/or characteristics within the aquatic ecosystems and their catchments, which may be subject to the influences of seasonality and/or land use changes, may not be accounted for in the assessments.
- The assessment of the wetland systems' ecological integrity includes catchment conditions, and it should be noted that changes in the HGM units' catchments may have an adverse effect on the system's integrity.
- Any hydrologically isolated aquatic ecosystems have not been delineated in detail and were based predominantly on desktop mapping and review, and limited infield verification. Therefore, the mapping of these systems would not be appropriate for the authorisation of any future unrelated developments within the study area.
- No formal vegetation sampling was conducted, but general observations pertaining to vegetation composition were recorded onsite.
- WET-EcoServices assists in identifying the importance and sensitivity of specific wetlands but is recognised as having limitations in terms of quantifying specific impacts linked to

development or changes within the landscape; and accounting for the size of the wetland and ecosystem services strongly associated with the size of the systems.

- All assessments undertaken were based on the impacts that were noted during the time of the site visit. Should conditions onsite change, the assessments may not necessarily reflect such changes.
- This study does not consider aquatic ecosystems beyond the 500 m study site radius.

The project deliverables, including the reported results, comments, recommendations, and conclusions, are based on the authors' professional knowledge as well as available information. This study is based on assessment techniques and investigations that are limited by time and budgetary constraints applicable to the type and level of survey undertaken. This study is, however, considered to be the most accurate and up-to-date assessment of the aquatic habitat associated with the study area, and should be used to inform the decision-making processes of the relevant authorities.

4. EXPERTISE OF THE SPECIALISTS

Due to the nature of the study, the project team included personnel with experience in mapping, delineation, and assessment of aquatic ecosystems, as well as personnel with experience in terrestrial faunal and floral assessments (**Table 4-1**).

Table 4-1 Team members, roles, experience levels and qualifications

Wetland Practitioner	Role in the Study	Experience Levels	Qualifications
Steven Ellery	• Compilation of the project report. • Conducting in field delineation	8 years' experience, with input into various wetland studies, including: • Delineation and Wetland Assessments • Rehabilitation planning; and • Rehabilitation monitoring and evaluation.	M.Sc. (Geography) Pr.Sci.Nat - Ecology
Caydon van Eck	• Compilation of the project report. • Desktop processing. • Conducting wetland assessments.	1 years' experience, with input into various wetland studies, including: • Rehabilitation monitoring and evaluation. • Delineation. • Assessments.	MSc (Geography)
Zaniel April	• Desktop processing. • Conducting wetland assessments.	1 years' experience with input into various wetland studies, including • Delineation • Water quality and biomonitoring	Ndip (Nature Conservation) SASS5 Accreditation
Juan Tedder	• Review of project report	17 years' experience, with input into various riverine studies, including: • Riverine water quality and biomonitoring assessments, • Impact assessments, • Aquatic ecosystem health and Index of Habitat Integrity assessments • Specialist input water quality, aquatic macroinvertebrates, dragonflies, and diatoms, for international, multinational, and local projects	B.Sc. Hons (Environmental Monitoring and Modelling)) Cert.Sci.Nat – Environmental SASS5 Accreditation
Fiona Eggers	• Review of project report	15 years' experience, with input into various wetland studies, including:	M.Sc. (Botany) Pr.Sci.Nat - Ecology

	• Delineation and wetland assessments • Created wetland projects • Rehabilitation planning; and • Rehabilitation monitoring and evaluation.	

5. STUDY SITE

The following section provides an overview of the study site, focusing on the regional context, climate, and ecosystem types.

5.1 Site Sensitivity Verification

The Department of Forestry, Fisheries and the Environment (DFFE) National Environmental Screening Tool has classified the aquatic biodiversity theme of the proposed site as having “Very High” sensitivity (**Figure 5-1**). This classification is informed by the presence of mapped watercourses and aquatic ecosystem support areas (ESAs) within the development footprint (Hawley & Desmet, 2020). The “Very High” sensitivity rating was substantiated during the site visit conducted in May 2025, primarily due to the identification of two wetland features located within 500 m of the proposed development area, both of which exhibit hydrological connectivity to Broiler House 2. The Kubusi River, which borders the northern boundary of the site, while not deemed highly sensitive, is designated as a low-priority Freshwater Ecosystem Priority Area (FEPA), as outlined in **Section 5.7** below.

In light of the presence of ecologically significant and sensitive natural watercourses, the “Very High” aquatic sensitivity classification has been reaffirmed, thereby necessitating a comprehensive aquatic biodiversity specialist assessment in accordance with the requirements of the National Environmental Management Act (Act No. 107 of 1998), as amended in 2020 (GNR 320 of 2020).

Figure 5-1 Aquatic biodiversity theme sensitivity map as extracted from the screening report on the DFFE screening website.

5.2 Regional context

South Africa is a semi-arid country, and thus rivers and wetlands are important features within the landscape as they provide ecosystem services directly related to water quantity and quality. It is estimated that over 50% of South Africa's wetlands have been lost (SANBI, 2018), and of the remaining systems, 48% are classified as Critically Endangered (SANBI, 2018). The country's river ecosystems are similarly under significant threat. The 2018 National Biodiversity Assessment highlighted that many rivers are in poor condition due to various pressures such as pollution, over-extraction of water, invasive species, and habitat destruction/transformation. For further information about the regional and biophysical context, please refer to the aquatic report

5.3 Climate

The study area falls under two distinct catchments, namely the S60B and S60A quaternary catchments (Midgley et al., 1994). The Mean Annual Precipitation (MAP) for S60A is 813 mm, and the Potential Evapotranspiration (PET) is 1650.1 mm (Schulze, 2007). This would suggest that any aquatic ecosystems within the S60A catchment would have a **Moderate** sensitivity to hydrological impacts (Macfarlane et al., 2020). On the other hand, the Mean Annual Precipitation (MAP) for S60B is 621.8 mm and the Potential Evapotranspiration PET for is 1680.5 mm (Schulze, 2007). This would suggest that any aquatic ecosystems within the S60B catchment would have a **Moderately High** sensitivity to hydrological impacts (Macfarlane et al., 2020).

5.4 Vegetation types

Under natural conditions, the surrounding landscape and study site would have been characterised by particular vegetation types. The historical dominant vegetation type present would have been the Amathole Montane Grassland (Gd1) under Drakensberg Bioregion group 1 (SANBI 2018; Mucina and Rutherford, 2006). Based on Mucina and Rutherford (2006), Amathole Montane Grassland is considered least threatened, with around 5% currently under statutory conservation in areas such as Mpofu Game Reserve, Fort Fordyce, Bosberg, and Kologha Forest Reserve. Some additional patches are protected in private reserves like Bushy Park and Oudekraal. Over 10% has been transformed by plantations and cultivation, and heavy grazing by cattle and horses has also contributed to its degradation. Alien species such as *Acacia mearnsii* and *A. dealbata* are also present. This grassland type is found in the Eastern Cape, mainly in the Amathole, Winterberg, Kologha, and Bosberg mountains, and on broken veld between Stutterheim and Komga, at altitudes between 650 and 1500 m.

5.5 Wetland classification

To allow for the differentiation between wetland systems and the prioritisation of systems either for conservation or management purposes, the wetlands were classified in accordance with the South African National Biodiversity Institute's (SANBI) wetland classification system (Ollis et al., 2013). However, for the purpose of assessing each Hydrogeomorphic (HGM) unit, Kotze et al., (2008) was used to classify the wetland systems as particular HGM units rather than Level 4 of the SANBI system. The HGM unit types defined by Kotze et al. (2007) differ from Ollis et al. (2013), with the river classification being excluded and flat wetlands being grouped with the depression wetlands. The HGM units identified within the study site are classified as a channelled valley-bottom and hillslope seep linked to a stream channel (**Table 5-1**).

Table 5-1 A description of the onsite wetlands based on the SANBI classification and Ollis. 2013

System (Level 1)	Bioregion (Level 2)	Landscape Unit (Level 3)	HGM Unit (Level 4)	Description of HGM Units (Ollis et al. 2013)
Inland systems	Drakensberg Grassland Bioregion (Gd1)	Hillslope landscape unit	Hillslope seep (SEEP)	A wetland area located on gently to steeply sloping land and dominated by colluvial (i.e., gravity-driven), unidirectional movement of water and material downslope. Seeps are often located on the side-slopes of a valley, but they do not typically extend onto a valley floor.
		Valley floor landscape unit	Channelled valley-bottom (CVB)	Valley-bottom areas with a clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition alongside the channel. Water inputs mainly from channel overtopping or from lateral seepage.

As described above, one channelled valley-bottom (UVB) and one hillslope seep (SEEP) wetland were identified within the study site that are hydrologically linked to the proposed development.

5.6 River classification

Rivers are classified into seven geomorphological zones, based on their characteristic gradient and diagnostic channel characteristics. These classes were used to define the type of riverine systems identified within the study site. The rivers were split into the following river zones according to the characteristics described (Rowntree et al., 2000):

- *Mountain Headwater Stream:* A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
- *Mountain Stream:* Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach type include cascades, bedrock fall, step-pool. Approximate equal distribution of vertical' and 'horizontal' flow compartments.
- *Transitional:* Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle, or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow floodplain of sand, gravel, or cobble often present.
- *Upper Foothills:* Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle, or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow floodplain of sand, gravel, or cobble often present.
- *Lower Foothills:* Lower gradient mixed bed alluvial channel with sand and gravel dominating bed, locally may be bedrock controlled. Reach types typically include pool-riffle or pool- rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.

- *Lowland River:* Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is increased silt content in bed or banks.

Based on the above characteristics, one riverine unit was identified onsite that was delineated and assessed. This riverine unit was classified as a Lower Foothill River commencing from a weir located approximately 1.6 km upstream of Broiler House 1. The river reach was artificially defined at a weir less than 100 m downstream of where the CVB joins the Kubusi River.

5.7 National wetland mapping (National Wetland Map 5) and the threat status of wetlands and rivers

Mapping of all wetlands within South Africa has been an ongoing exercise for many years, as data has been collated and improved upon over time. SANBI has recently released the latest National Wetland Map 5 (NWM5_AEA) in an attempt to improve the wetland inventory available to users at a national level (Van Deventer et al., 2018). This layer includes inland wetlands and estuaries; and has been determined through extensive consultation with many other datasets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018.

For the sake of this report, the development site has been contextualised within the broader landscape (**Figure 5-2**). Two distinct wetland types have been classified within the study area, namely Channelled valley-bottom wetlands (shown as CVB on the map), and seeps (shown as SEEP on the map). Channelled valley-bottom wetlands are considered to be Endangered, which is mostly related to the minimal protection this vegetation group receives and the level of transformation that has occurred. The seeps have received Least Concerned status and moderate protection. Deterioration in condition of the remaining healthy examples of these ecosystem types must be avoided, and the remaining healthy examples should be the focus of urgent conservation action.

While the NWM5_AEA identified a river, the NFEPA layer (Nel, 2011) was used to identify river status within the study. The Kubusi River, which passes through a portion of the 500 m DWS regulated buffer, has been flagged as a low-priority river for fish conservation. It is in a moderately modified condition (class C).

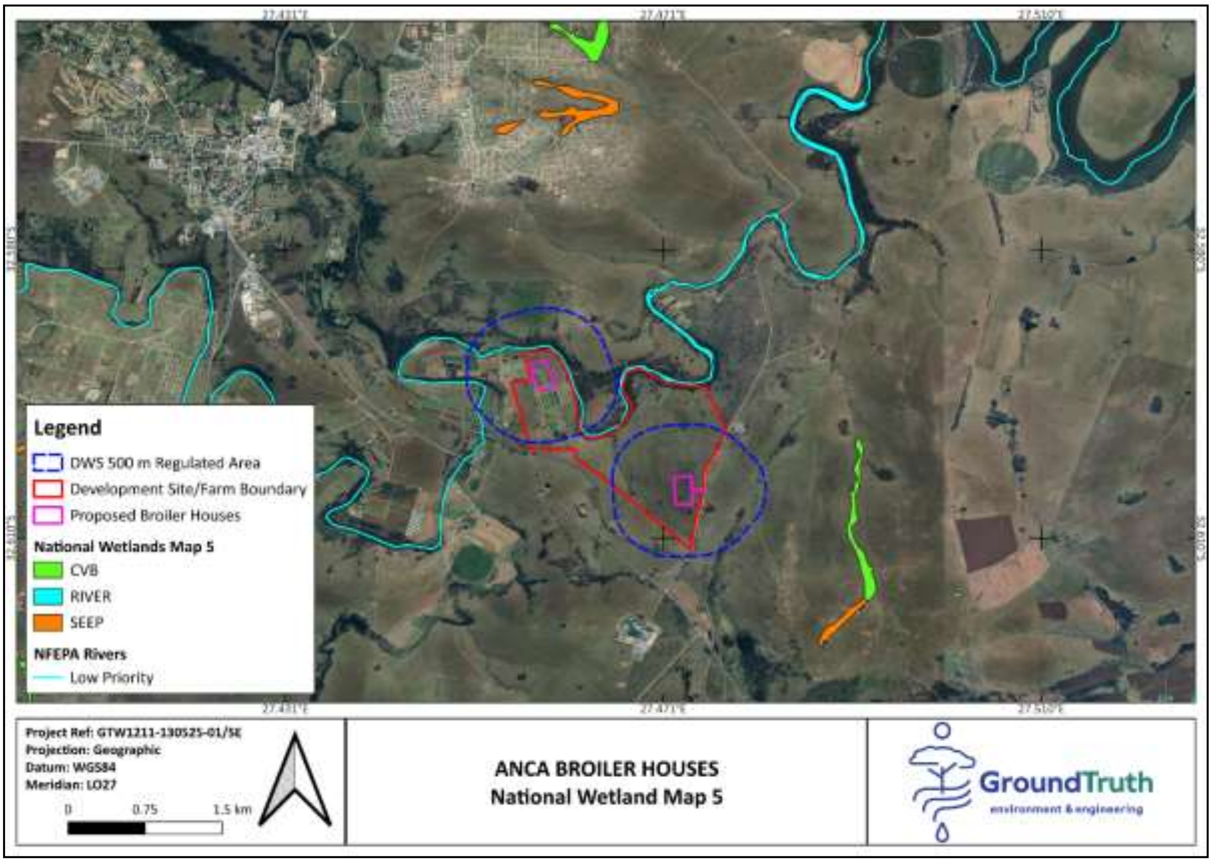

Figure 5-2 Overview of the National Wetland Map 5 coverage of the study area

6. LEGISLATIVE REQUIREMENTS

As noted in previous sections, the ANCA Broiler Houses will involve activities will trigger various legislative requirements. The key pieces of legislation that need to be taken into consideration from an aquatic biodiversity perspective are outlined below.

6.1 National Environmental Management Act (NEMA; Act No. 107 of 1998)

The National Environmental Management Act (NEMA, Act No. 107 of 1998) is the overarching framework legislation for environmental management in South Africa. Section 24 of the Act deals with Environmental Authorisations (EAs), establishing the framework for managing activities that may impact the environment and outlining the process for obtaining EAs, whilst the Environmental Impact Assessment (EIA) Regulations (Government Notice R982 of 2014, as amended) set out the detailed procedural requirements for obtaining an EA, including the different assessment processes: namely, Basic Assessments (BAs) for lower-risk activities and Scoping and Environmental Impact Reporting (S&EIR) for higher-risk activities. Under NEMA and the EIA regulations, listed activities specified in Listing Notices 1, 2, and 3 require either a BA or S&EIR, depending on the type and scale of the proposed development. The DFFE Screening Tool, mandatory since July 2021, is a web-based planning tool required by EIA Regulations. The screening tool identifies environmental sensitivities (themes) associated with a site and the specialist studies and protocol that may be required for a development, based on the site's sensitivity.

Government Notice No. 320 of 20 March 2020 (Government Gazette 43110) outlines the procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of Sections 24 (5)(a) and (h) and 44 of NEMA (1998). The requirements stipulated in the Notice supersede those of Appendix 6 of the EIA Regulations. The minimum report requirements as stipulated in GN No.320, and compliance with these requirements, is indicated below. Given that the environmental sensitivities associated with the site were identified as being "Very High", the requirements for an aquatic biodiversity specialist assessment are presented below.

Item Number	Reporting Requirement Description	Location in this report
2.2	The assessment must be undertaken on the preferred site and within the proposed development footprint	Sections 1 and 8
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 aquatic ecosystem types and presence, composition, habitat, distribution and movement patterns of aquatic species and communities.	Section 8.1
2.3.2	The threat status of the ecosystem and species as identified by the screening tool.	Section 5.1

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.	Section 5.7
2.3.4	A description of the ecological importance and sensitivity of the aquatic ecosystem, including the description of ecosystem processes that operate and the historic ecological condition as well as present ecological state of rivers, wetlands, and/or estuaries.	Section 8.2, 8.3, 8.4 and 8.5
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 8.10.2
2.5	*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?	Section 8.2
2.5.2	Is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?	Section 8.6
2.5.3	How will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site?	Section 8.4, 8.5 and 8.10
2.5.4	How will the proposed development impact on the functioning of the aquatic feature?	Section 8.2
2.5.5	How will the proposed development impact on key ecosystems regulating and supporting services especially flood attenuation, streamflow regulation, sediment trapping, phosphate assimilation, nitrate assimilation, toxicant assimilation, erosion control, and carbon storage?	Section 8.2
2.5.6	How will the proposed development impact community composition and integrity of the faunal and vegetation communities inhabiting the site?	Section 8.4 and 8.5
2.6	Where applicable, impacts to the frequency of estuary mouth closure should be considered.	N/A
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.	Page iv and Appendix 3

2.7.2	A signed statement of independence by the specialist.	Page iv
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.	Section 1, 2 and 3
2.7.4	The methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant.	Section 7
2.7.5	A description of the assumptions made, any uncertainties or gaps in knowledge or data.	Section 3
2.7.6	The location of areas not suitable for development, which are to be avoided during construction and operation, where relevant.	Section 8.8
2.7.7	Additional environmental impacts expected from the proposed development.	Section 8.10
2.7.8	Any direct, indirect and cumulative impacts of the proposed development on site.	Section 8.10
2.7.9	The degree to which impacts and risks can be mitigated.	Section 8.10
2.7.10	The degree to which the impacts and risks can be reversed.	Section 8.10
2.7.11	The degree to which the impacts and risks can cause loss of irreplaceable resources.	Section 8.10
2.7.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies.	Section 8.8
2.7.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr).	Section 9
2.7.14	A motivation must be provided if there were development footprints identified as per paragraph 2.4 above that were identified as having a "low" aquatic biodiversity sensitivity and that were not considered appropriate.	Section 8.10.2
2.7.15	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not.	Section 10
2.7.16	Any conditions to which this statement is subjected.	Section 9.2

6.2 National Water Act (NWA, Act No.36 of 1998)

The National Water Act (NWA, Act No. 36 of 1998) provides the framework for the sustainable management of South Africa's water resources, in line with the constitutional right of access to water and the equitable allocation of water. The Act regulates the use of water and activities which may impact water resources, outlining the circumstances under which water use authorisations may be required. Section 21 of the NWA identifies the activities that constitute a water use and require authorisation.

Given the nature of the development, a Water Use Licence (WUL) will likely be required. A mandatory requirement for obtaining a WUL is a Risk Assessment. This is a key tool for determining the likelihood and significance of potential impacts of a proposed activity of water resources, including watercourses and wetlands. In light of this, a Risk Assessment is included in this study.

7. METHODS

7.1 Site visit

A site visit was conducted on 27 May 2025 to verify the extent of the aquatic ecosystems within the study site and to delineate the aquatic ecosystems hydrologically linked to the proposed developments and within the DWS 500 m regulated area.

7.2 Aquatic Ecosystem Assessment

Local, regional and national regulatory bodies, such as the Department of Water and Sanitation (DWS) and the Department of Economic Development, Environmental Affairs and Tourism (DEDEAT), have adopted legislation, policies and guidelines that regulate the use of aquatic ecosystems to protect and maintain these systems' benefits and services to society and the natural environment. In order to be regulated, these systems must first be identified, delineated and assessed.

7.2.1 *Aquatic ecosystem identification and mapping*

The preliminary identification and mapping of all aquatic ecosystems within a 500 m radius of the proposed development was undertaken at a desktop level utilising available aerial imagery and contour data. The aquatic ecosystems that are hydrologically linked to the study site were also verified infield in accordance with the DWS guideline documents (DWAF, 2005 & 2008). The derived boundaries were determined at appropriate intervals within the study area and recorded using a mapping grade Global Positioning System (GPS)[3]. The subsequent information was used to inform the production of a Geographic Information System (GIS) spatial coverage of the boundaries of the identified features. In accordance with the preferences of the regional DWS, the study also attempted to identify and/or describe the zones of wetness of the wetland habitat within the study area (**Figure 7-1**) and classify the riverine and riparian habitat refer to **Section 5.6** and **Figure 7-2**.

[3] Trimble Catalyst DA2 receiver connected to a handheld unit, a professional sub-meter accurate receiver.

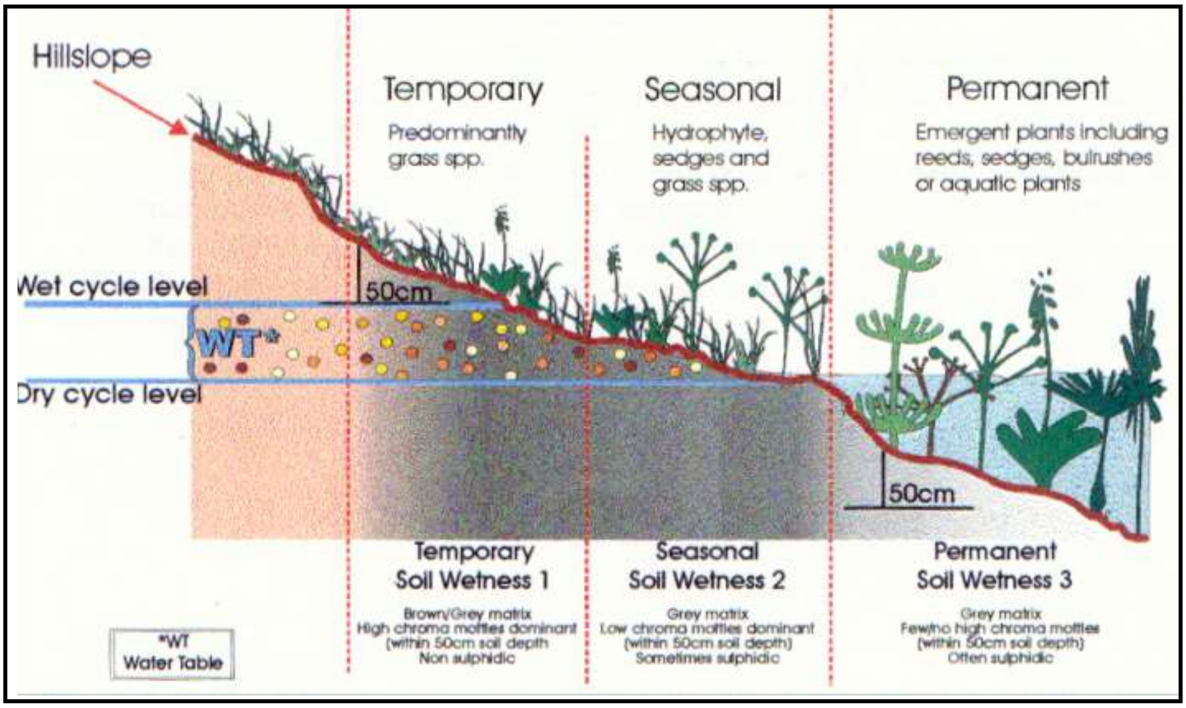

Figure 7-1 Wetness zones within wetland ecosystems
(DWAF, 2005, p.6)

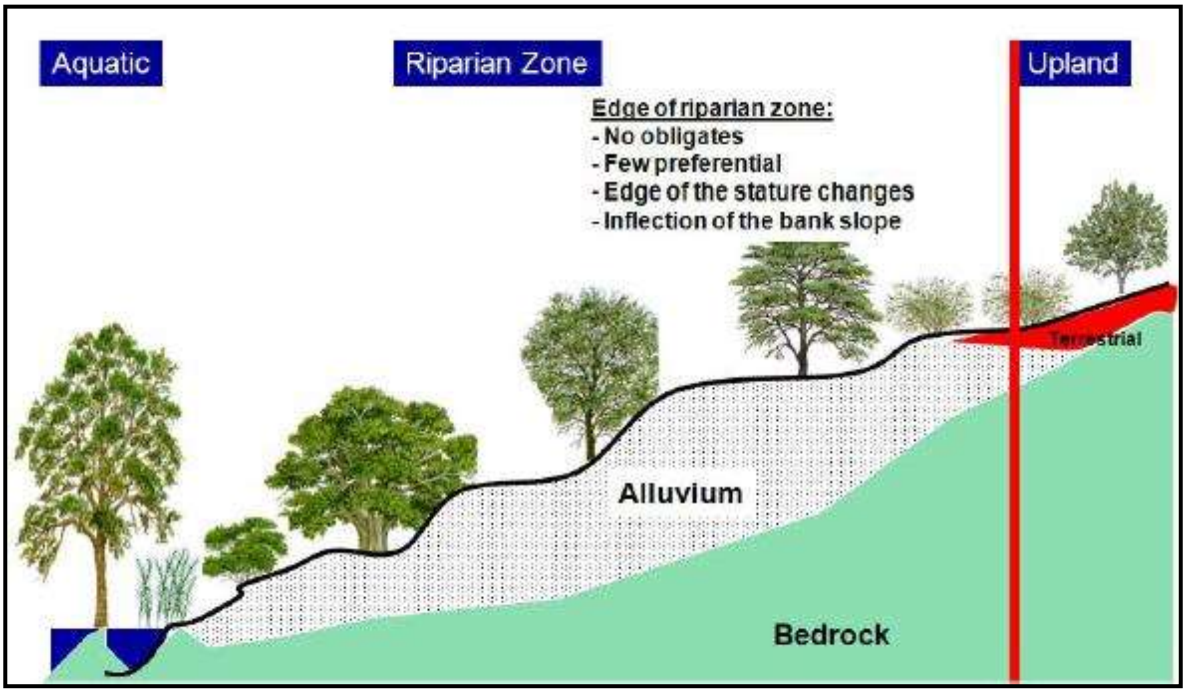

Figure 7-2 A schematic diagram illustrating the edge of the riparian zone on one bank of a large river
(DWAF, 2008, p.54)

7.2.2 *Assessment of wetland functioning and ecological condition*

The two wetlands that have been identified within the study site were classified as a hillslope seep wetland and a channelled valley-bottom wetland. In order to provide a comprehensive and up-to-date assessment report for the wetlands within the study site, the assessment of the wetland functioning and condition were updated using the most recent assessment methods for the **current** and **post-development** scenarios as outlined in the following sections.

7.2.2.1 *Assessment of wetland functioning*

A WET-EcoServices Version 2 (Kotze et al., 2021) assessment was performed for the wetland systems associated for the proposed development to quantify the level of functionality of the wetland systems, and to highlight their relative importance in providing ecosystem benefits and services at a landscape level. The assessment provides a method to measure the ability of a wetland or riparian area to provide sixteen (16) ecosystem services.

The WET-EcoServices assessment technique focuses on assessing the extent to which a benefit is being supplied by each aquatic ecosystem, based on both:

- The supply of the wetland to provide the benefits; and
- The demand of the particular wetland in providing the benefit.

The ecosystem services mentioned above, include an assessment of direct and indirect benefits to society and the surrounding landscape, by rating various characteristics of the wetlands and their surrounding catchments based on the categories shown in **Table 7-1** as presented within Kotze et al. (2021).

It should be noted that WET-EcoServices assists in identifying the importance and sensitivity of specific wetlands, but is recognised as having limitations in terms of:

- Quantifying specific impacts linked to development or changes within the landscape; and
- Accounting for the size of the wetland and ecosystem services strongly associated with the size of the systems.

Table 7-1 Ecosystem services supplied by wetlands.
(Kotze *et al.*, 2021, p3)

Services contributing to indirect benefits	Regulating and supporting services		Flood attenuation	The spreading out and slowing down of floodwaters in the wetland/riparian area, thereby reducing the severity of floods downstream
Services contributing to indirect benefits	Regulating and supporting services		Stream flow regulation	Sustaining streamflow during low flow periods
Services contributing to indirect benefits	Regulating and supporting services	Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland/riparian area of sediment carried by runoff waters
Services contributing to indirect benefits	Regulating and supporting services	Water quality enhancement benefits	Phosphate assimilation	Removal by the wetland/riparian area of phosphates carried by runoff water, thereby enhancing water quality
Services contributing to indirect benefits	Regulating and supporting services	Water quality enhancement benefits	Nitrate assimilation	Removal by the wetland/riparian area of nitrates carried by runoff water, thereby enhancing water quality
Services contributing to indirect benefits	Regulating and supporting services	Water quality enhancement benefits	Toxicant assimilation	Removal by the wetland/riparian area of toxicants (e.g. metals, biocides and salts) carried by runoff water, thereby enhancing water quality
Services contributing to indirect benefits	Regulating and supporting services	Water quality enhancement benefits	Erosion control	Controlling of erosion at the wetland/riparian area, principally through the protection provided by vegetation
Services contributing to indirect benefits	Regulating and supporting services		Carbon storage	The trapping of carbon by the wetland/riparian area, principally as soil organic matter
Services contributing to direct benefits	**Biodiversity maintenance[4]**			Through the provision of habitat and maintenance of natural process by the wetland/riparian area, a contribution is made to maintaining biodiversity
Services contributing to direct benefits	Provisioning services		Provision of water for human use	The provision of water which is taken directly from the wetland/riparian area for domestic, agricultural or other purposes
Services contributing to direct benefits	Provisioning services		Provision of harvestable resources	The provision of natural resources from the wetland/riparian area - including craft plants, fish, wood etc.
Services contributing to direct benefits	Provisioning services		Food for livestock	The provision of grazing for livestock
Services contributing to direct benefits	Provisioning services		Provision of cultivated foods	The provision of cultivated foods from within the wetland/riparian area
Services contributing to direct benefits	Cultural (non-material) benefits		Cultural heritage	Places of special cultural significance in the wetland/riparian area - e.g. for baptisms or gathering of culturally significant plants
Services contributing to direct benefits	Cultural (non-material) benefits		Tourism and recreation	Sites of value for tourism and recreation in the wetland/riparian area, often associated with scenic beauty and abundant birdlife[5]
Services contributing to direct benefits	Cultural (non-material) benefits		Education and research	Sites of value in the wetland/riparian area for education or research (McInnes and Everard 2017)

7.2.2.2 *Ecological Importance and Sensitivity*

In accordance with (Rountree et al., 2013), the ecological importance of a water resource provides an expression of its importance to the maintenance of ecological diversity and functioning at local and wider scales. As WET-EcoServices does not provide a consolidated score that can be used as a target, the assessment scores were incorporated into the Ecological

4 It is recognised that biodiversity maintenance is not an ecosystem service in the strict sense and is framed in less anthropocentric terms than all of the other services, but it underpins many other services and is widely acknowledged as having high value to society broadly, even in the absence of any local or downstream beneficiaries.

5 WET-EcoServices focusses on recreational services which are specifically nature-based, e.g. bird watching. It does not account specifically for recreational services from wetland/riparian areas that have been converted into sports grounds, children's playgrounds, or other built infrastructure.

Importance and Sensitivity (EIS) assessment framework to provide an EIS score based on scores for ecological importance and sensitivity, hydro-functional importance, and direct human benefits (Rountree et al., 2013). It should be noted that the EIS categories have been slightly modified in accordance with approach adopted by the Department of Water and Sanitation (2023), in which all the categories now reflect a range of scores. This was described as a crucial amendment, as only systems scoring a 4 and/or 100% could be classified as being of 'Very High' importance, which is considered to be largely impossible to attain thereby, excluding systems of significance from scoring in the 'Very Important' category despite their high importance. Allowing for range in this upper category means that some systems that did not score a 4 on all indicators of the EI/ES rating system are now considered to be of 'Very High' importance. Additionally, including a range for the EIS scores is consistent with the PES scoring range (Department of Water and Sanitation, 2023b). **Table 7-2** provides an overview of the ratings used to interpret the derived EIS scores.

Table 7-2 Ecological Importance and Sensitivity Classes
(DWA, 2013, p43)

Category	EIS Description	Range of EIS Score
A	Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers	≥3.5
B	High Wetlands that are ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quality and quantity of water in major rivers.	>2.5 and <3.5
C	Moderate Wetlands that are ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major river	>1.5 and ≤2.5
D	Low/Marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers	>0.5 and ≤1.5
E	None Wetlands that are rarely sensitive to changes in water quality/hydrological regime	≤0.5

7.2.2.3 *Assessment of wetland condition/integrity*

The assessment of ecosystem integrity was undertaken using the assessment framework, WET-Health level 1B (Macfarlane et al., 2020), which was performed for the HGM Units primarily affected by the proposed project. The WET-Health assessment technique gives an indication of the deviation of the systems from the wetlands' natural reference condition for the following biophysical drivers:

- **Hydrology** – defined as the distribution and movement of water through a wetland its soils.
- **Water quality** – defined as the physio-chemical attributes of the water in the wetland.
- **Geomorphology** – is defined as the physical processes that are currently shaping and modifying wetland evolution as well as the three-dimensional shape (structure) of sediment deposits on which wetland habitat is established.
- **Vegetation** – defined as the structural and compositional state of the vegetation within a wetland.

The impacts on the wetland, determined by features of the wetlands and their catchments, were scored based on the extent and intensity of the disturbance units. These disturbance units, derived for each of the components, were scored based on a suite of sub-categories using a scale of 0-10, prior to being combined to determine the overall magnitude-of-impact scores. From these scores, the overall impact score and Ecological Categories (**Table 7-3**) were determined, which reflects the extent to which anthropogenic changes have impacted the wetland from the benchmark/desired state.

Table 7-3 Description of the Ecological Categories typically used for PES assessments of inland aquatic ecosystems in South Africa, together with the applicable range of Impact Scores and PES Scores for each category (after Kleynhans, 1996; Macfarlane et al., 2008)
(Macfarlane et al., 2020, p.30)

Impact Category	Description	Impact Score Range (0-10)	PES Score	Ecological Category
None	Unmodified, natural.	0-0.9	**90-100**	**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	**80-89**	**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	**60-79**	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	**40-59**	**D**
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	**20-39**	**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	**0-19**	**F**

The scores for hydrology, geomorphology, water quality and vegetation were simplified into a composite impact score. The combined impact score provided the basis for the calculation of the hectare equivalents (also referred to as a functional area), which can be described as the health of a wetland expressed as an area. The hectare equivalents calculation is a means of deriving a common unit of "currency" to measure the losses and gains, and how the ecosystem integrity has changed in response to anthropogenic impacts, based on the WET-Health results for the biophysical drivers.

7.2.3 *Riverine habitat assessments*

The methodology that was applied drew on the latest available tools within South Africa for the assessment of the Present Ecological State (PES) of aquatic and riparian habitats. The appropriate selection of the various tools used was informed by the available habitat on site, the flow conditions at the time of sampling and any other biophysical limitations.

7.2.3.1 *Benthic diatoms (algae)*

Diatoms are one of the algal groups and are distinguished from other algae by the silica shells that they form. These shells are unique to each species of diatom. Diatoms (as primary producers) are also a component at the base of the aquatic food web and disruption to their "natural" functioning has the potential to cascade up the food chain to all other trophic levels - hence their importance at the fundamental level of assessment.

Benthic diatom samples were collected to provide an indication of the integrated water quality situation for the Kubusi River (**Table 7-4**). Diatoms have been shown to be reliable indicators of specific water quality problems such as organic pollution, eutrophication, as well as for general water quality (Taylor et al., 2007). Round (1993) lists why diatoms are useful indicators for biomonitoring:

- Diatoms have a universal occurrence throughout all rivers;
- Field sampling is rapid and easy;
- The cell cycle is rapid and they react quickly to perturbation;
- Diatoms are relatively insensitive to physical features in the environment (although sensitive to chemical water quality parameters);
- Cell counting by microscopic techniques is relatively rapid and accurate (although requires the unique skills of a diatom specialist);
- Cell numbers per unit area of substratum are enormous, making random counts excellent assessments of diatoms;
- The ecological requirements of diatoms are in many cases better known than those of other groups of riverine organisms;
- Permanent records can be made from every sample; and
- Diatoms do not have specific food requirements, specialised habitat niches, and are not governed to a major extent by stream flow.

Table 7-4 Diatom SPI and IHI score values for river health/water quality classes derived from Taylor et al., (2007) and Kleynhans et al., (2008) respectively

River health		Benthic diatoms SPI	Instream and riparian IHI
Natural	≥	17.0	90
Good	≥	13.0	80
Fair	≥	9.0	60
Poor	≥	5.0	40
Seriously Modified	≤	5.0	40

7.2.3.2 *Index of Habitat Integrity (IHI)*

The Index of Habitat Integrity (IHI) assessment was used to establish the condition of the riparian habitat's integrity (**Table 7-5**). The IHI assessment forms part of the published methods for the eco-classification of South African rivers (Kleynhans et al., 2008). The rapid version of the IHI method based on Kleynhans (1996) was applied, which takes into account impacts within river buffer areas (500 m) associated with the upstream quaternary catchment.

Table 7-5 Scores used to define river health class boundaries for IHI (Kleynhans et al. 2008)

River health classes	Ecological perspective	Management perspective
Natural	No or negligible modification of in-stream and riparian habitats and biota.	Protected rivers; relatively untouched by human hands; no discharges or impoundments allowed.
Good	Ecosystems essentially in good state; biodiversity largely intact.	Some human-related disturbance but mostly of low impact potential.
Fair	A few sensitive species may be lost; lower abundances of biological populations may occur.	Zones of competing uses; developmental pressures are dominant feature.
Poor	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer breed, or alien species have invaded the ecosystem).	Often characterised by high human densities or extensive resource exploitation. Management intervention is needed to improve river health – e.g. to restore flow patterns, river habitats or water quality.
Seriously Modified	Loss of habitat availability and high levels of pollution, result in few families being present due to the loss on most intolerant forms.	Often characterised by high human densities, pollution or extensive resource exploitation and modification. Management intervention is needed for improvement to occur.

7.3 Recommended Ecological Category

The method for determining the Recommended Ecological Category (REC) for water resources is outlined by Rountree et al. (2013). The REC is established after assessing both the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of the wetland. Its purpose is to guide the appropriate management objective for the wetland, based on the following principles:

- Wetlands classified as PES Category A (unmodified) cannot undergo rehabilitation. As such, the management goal is always to maintain this existing ecological state.
- Wetlands falling into PES Categories B, C, or D that have a "Low-marginal" or "Moderate" EIS score must also be maintained in their current (pre-development) ecological condition.
- Wetlands in PES Categories B, C, or D with a "High" or "Very High" EIS score should be rehabilitated, where practically possible, to an ecological category one level higher than the current (pre-development) PES. For example, a wetland currently at PES Category C with a "High" EIS score should be improved to PES Category B.

- If such rehabilitation is not feasible, the management objective becomes maintaining the existing PES category.
- Wetlands in PES Categories E or F are regarded as unsuitable in their current state and must be rehabilitated to at least PES Category D.

7.4 Buffer assessment

To protect aquatic ecosystems from impacts linked to adjacent land uses, appropriate buffer zones should be adopted. Aquatic buffer zones should therefore be determined for all water resources in close proximity to a particular land use, during the construction and operational phases thereof, thereby limiting negative impacts. According to (Macfarlane & Bredin, 2017), aquatic buffer zones offer a range of functions that protect the water resource and associated biodiversity, including inter alia:

- Maintaining aquatic processes such as infiltration of surface water, promoting diffuse flow of water into the water course, stream bank stability and flood control;
- •Reducing impacts from upstream and adjacent land uses through sediment control and the removal of pathogens, toxicants and nutrients;
- Providing habitat for aquatic, semi-aquatic and terrestrial species; and
- Providing societal benefits such as reducing flood risk, noise control, improved air quality and recreational prospects.

It is, however, important to emphasise that buffers zones are limited with respect to addressing certain impacts (Macfarlane & Bredin, 2017) which include but are not limited to:

- Streamflow regulation;
- Mitigating point source impacts such as sewage discharges; and
- Prevention of groundwater contamination.

The newly developed buffer guideline document for rivers, wetlands and estuaries derives two variable-width buffers for the construction and operational phases of the development, with the greater buffer distance being selected as the appropriate buffer distance. It should be noted that in order to account for the practical management of the buffer zone and to protect the aquatic ecosystems from direct disturbances, a minimum buffer distance of 15m has been defined within the guideline document.

To determine the buffer distance to be adopted for the study site, a rapid infield assessment was undertaken for the identified aquatic ecosystems, and the adjacent landscape in accordance with the guideline document. The infield assessment included determining the slope, soil texture, vegetation, and microtopography characteristics of the buffer and incorporated the findings of the aquatic ecosystems assessments. This information was then captured into the buffer model, whereby the appropriate buffer distances were derived. It should be noted that even though a buffer distance may be prescribed, it is assumed that the development will be a medium-density and medium-impact development, which could include small shopping centres, moderate-density housing, small-scale industrial or similar.

7.5 Aquatic ecosystem risk and impact assessment

7.5.1 *Risk assessment*

The risk assessment matrix (Department of Water and Sanitation, 2023a) assesses the likely impact the proposed development may have on the aquatic ecosystems hydrologically linked to the broiler houses. A broad outline of the criteria considered are as follows:

- Nature of the impact;
- Scale/extent of the impact;
- Duration of the impact;
- Intensity/severity of the impact; and
- Probability/likelihood of the impact occurring.

Identified risks were evaluated according to the above-mentioned criteria. The significance of impacts was derived through a synthesis of ratings of all criteria in the following calculations:

Intensity + Spatial Scale + Duration = Severity
Severity x Importance Rating (i.e. EIS rating) = Consequence
(Consequence x Probability) x (100/75) = Significance or Risk

The significance of a potential risk on decision-making was indicated through significance points, which are described in **Table 7-6**.

Table 7-6 List of descriptors for the significance score of a risk. (Department of Water and Sanitation, 2023)

Rating	Class	Management description	Authorisation
1 – 29	(L) Low Risk OR (+) Positive	Acceptable as is or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.	GA
30 – 60	(M) Moderate Risk	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and requires specialist input.	WUL
61-100	(H) High Risk	Watercourse(s) impacted by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.	WUL

7.5.2 *Impact assessment*

To assess the significance of environmental impacts associated with the proposed development, in compliance with the NEMA EIA regulations, the following methodology was applied. The consequence (C) of a specific impact is calculated by considering the following factors using the equation presented below:

- Consequence (C)
- Nature (N): either positive or negative
- Extent (E): Spatial scale of the impact
- Duration (D): Temporal scale
- Magnitude (M): Severity of impact
- Reversibility (R): Ease of recovery

$$\mathrm{C} = \frac{(E + D + M + R)\,N}{4}$$

Environmental risk is calculated by evaluating the consequence (C) of an impact and its probability (P) of occurrence using the following equation:

$$\mathrm{ER} = \mathrm{CP}$$

The ER score is then refined to give an overall environmental significance (S) based on the public response (PR), the potential for cumulative impacts (CI) and the likelihood of the impact resulting in the irreplaceable loss of resources (LR):

$$\mathrm{S} = (\mathrm{PR} + \mathrm{CI} + \mathrm{LR})ER$$

The resulting S score was then given an impact class based on the classes presented in **Table 7-7**. This process was undertaken for both a poor mitigation scenario and a realistic 'good' mitigation scenario.

Table 7-7 List of descriptors and associated classes and rating system for the impact assessment method that was used for the impact assessment

Rating	Class	Description
<10	Very Low	The potential impact is negligible and should not have an influence on the decision regarding the proposed activity.
≥10; <20	Low	The potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity.
≥20; <30	Moderate	Where this impact would not have a direct influence on the decision to develop in the area
≥30; <40	High	Where the impact could influence the decision to develop in the area unless it is effectively mitigated
≥40	Very High	Where the impact must have an influence on the decision process to develop in the area

8. RESULTS

The results of the investigations undertaken to inform the aquatic ecosystem study are outlined in the following sections.

8.1 Aquatic ecosystem delineation

8.1.1 *Onsite systems*

The delineation of the aquatic ecosystems that are hydrologically linked to two proposed broiler houses identified four aquatic ecosystems namely a riverine system, two hillslope seep wetlands, and a channelled valley-bottom wetland (**Figure 8-1**).

The riverine system defines the northern boundary of the Oaklands Farm and is located in relative proximity to Broiler House 1 on the western side of the property (**Figure 8-2B**). This riverine reach is part of the Kubusi River and has been artificially defined upstream by a weir across its channel. This river reach is approximately 4.9km long and is considered a suitable reach for an IHI assessment. The riverine system is defined as a lower foothills river because it is dominated by large pools with minor riffles and rapids between larger pools. The bed is dominated by sand and gravel with occasional rock outcrops which result in the formation of rapids. The riparian habitat associated with the river is generally quite narrow and is broadly characterised by extensive *Acacia mearnsii* and *Eucalyptus sp* growth along riverbanks. However, some indigenous herbaceous species such as *Cyperus sexangularis, Agrimonia sp* and *Cyperus textilis* were noted within the macro channel of the river. Of concern, is the extensive presence of *Pontederia crassipes* (water hyacinth) within the Kubusi River, which will likely all be washed down into the Wriggleswade Dam downstream (**Figure 8-2A**). The riverbanks have also experienced some erosion and bank collapse was noted in a number of places along the length of the river.

The channelled valley-bottom wetland (CVB) is a small tributary of the Kubusi River and flows into the Kubusi River directly upstream of the bottom weir which defines the studies riverine reach. The CVB is situated in a narrow valley-bottom feature and is characterised by a small and moderately sinuous channel which is fed laterally by extensive areas of seepage. The channel itself is incised in some along its length, and not incised in others and is therefore thought to be establishing an appropriate grade for its discharge. The CVB wetland is partially fed by a large valley-head seep wetland, which is hydrologically isolated from the proposed development, as well as a small tributary stream which is hydrologically isolated as well. There are a number of small *Acacia mearnsii* clumps along the length of the CVB as well as an old dam, which has been breached (**Figure 8-3B**). Generally, the vegetation within the wetland is moderately intact. While it shows signs of overgrazing, there are some core portions of the wetland that are characterised by a healthy assemblage of wetland-dependent species, including but not limited to *Fuirena pubescens, Fimbristylis complanata, Fimbristylis dichotoma, Schoenoplectus sp, Cyperus denudatus, Kyllinga cf melanosperma* and *Ischaemum fasciculatum* (**Figure 8-3A**). The areas of the wetland that have been grazed more heavily are predominantly characterised by disturbance tolerant grass species such as *Eragrostis plana, Sporobolus africanus, Cymbopogon sp, Digitaria eriantha* and *Miscanthus capensis*.

The first hillslope seep wetland (SEEP 1) similarly flows into the Kubusi River and is located to the north of Broiler House 2 (**Figure 8-3C**). The SEEP 1 wetland can be split into two distinct portions, the narrow and seasonal/temporary area to the south that is characterised by shallow soils and the wide seasonal/permanent area to the north. The southern portion of the SEEP 1 wetland appears to exist due to the presence of a shallow bedrock/saprolite layer, which is semi-impermeable and forces shallow groundwater to the ground surface. The saprolite layer is comprised of soft plinthite, which has a grey matrix colour (10YR 4/1 and 10YR 5/1; Munsell Color (Firm), 2013) and high chroma mottles and concretions, indicating the seasonal presence of water. This segment of the wetland is characterised by secondary grassland species such as *Sporobolus africanus, Eragrostis plana* and *Cymbopogon sp*, but species such as *Imperata cylindrica, Fimbristylis dichotoma* and *Sporobolus pyramidalis* were noted in this portion of the wetland, indicating wetland habitat. The northern segment of the SEEP wetland is lower lying and is likely characterised by a more substantial groundwater discharge point as it is characterised by permanent wetness in its centre. It is dominated by *Fuirena pubescens* and *Fimbristylis dichotoma*, with *Cyperus denudatus, Imperata cylindrica* and other wetland-dependent plant species present. While the wetland appeared to be in a relatively good ecological state, abundant cattle paths cross the lower wetland, and it is clearly used for winter grazing as trampling of the wetland is widespread.

The second hillslope wetland (SEEP 2) also flows into the Kubusi River and is located in a small valley between the two broiler house sites. SEEP 2 is a small wetland system that is comprised of two hillslope seep wetlands that have been lumped together for the sake of this assessment. The SEEP 2 wetland is a gently sloping wetland that is characterised by secondary grassland species with a scattered distribution of wetland plants species such as *Juncus effuses* and *Schoenoplectus sp*. These two SEEP wetlands are located close to the farm house and the fields where cattle are kept. As such, these SEEP wetlands are subjected to heavy trampling as the herds of cattle are moved to and from their enclosure.

In addition to the four aquatic ecosystems that are hydrologically linked to the proposed developments, there are several other aquatic ecosystems that are hydrologically isolated (**Figure 8-1**). Since all significant impacts from the proposed developments will stem from hydrological factors, it was unnecessary to delineate and evaluate these isolated ecosystems, as they will not be affected.

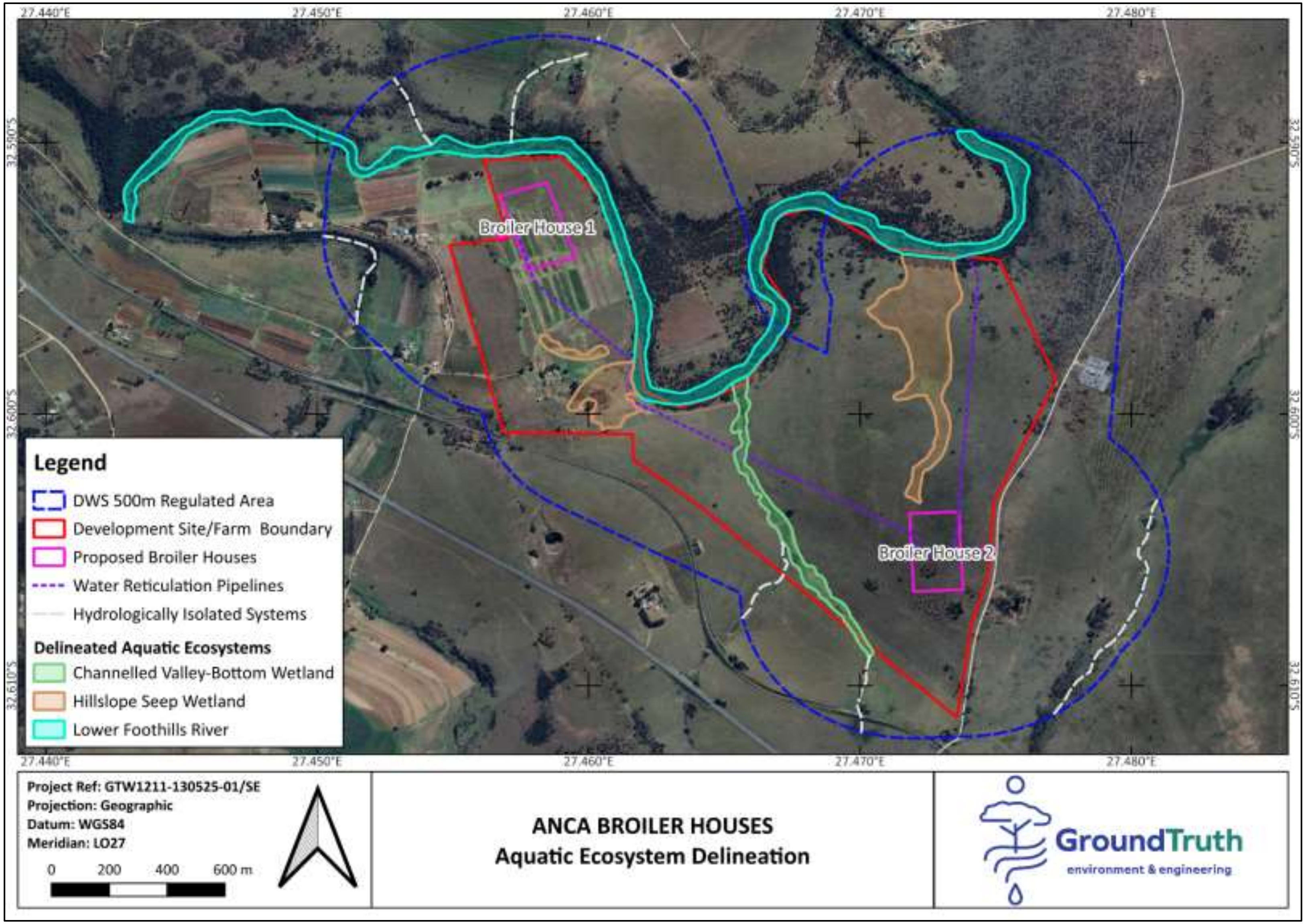

Figure 8-1 Aquatic ecosystems and hydrologically isolated features within 500 m of the proposed developments.

Figure 8-2 **A) Riverine system characterised by a heavily invasive alien plant infested riparian habitat. Note the *Pontederia crassipes* present within the channel, trapped by the *Acacia* tree across the channel shown in red oval. B) Aerial view of the proposed location of Broiler House 1. Approximate extent of the development shown in pink outline.**

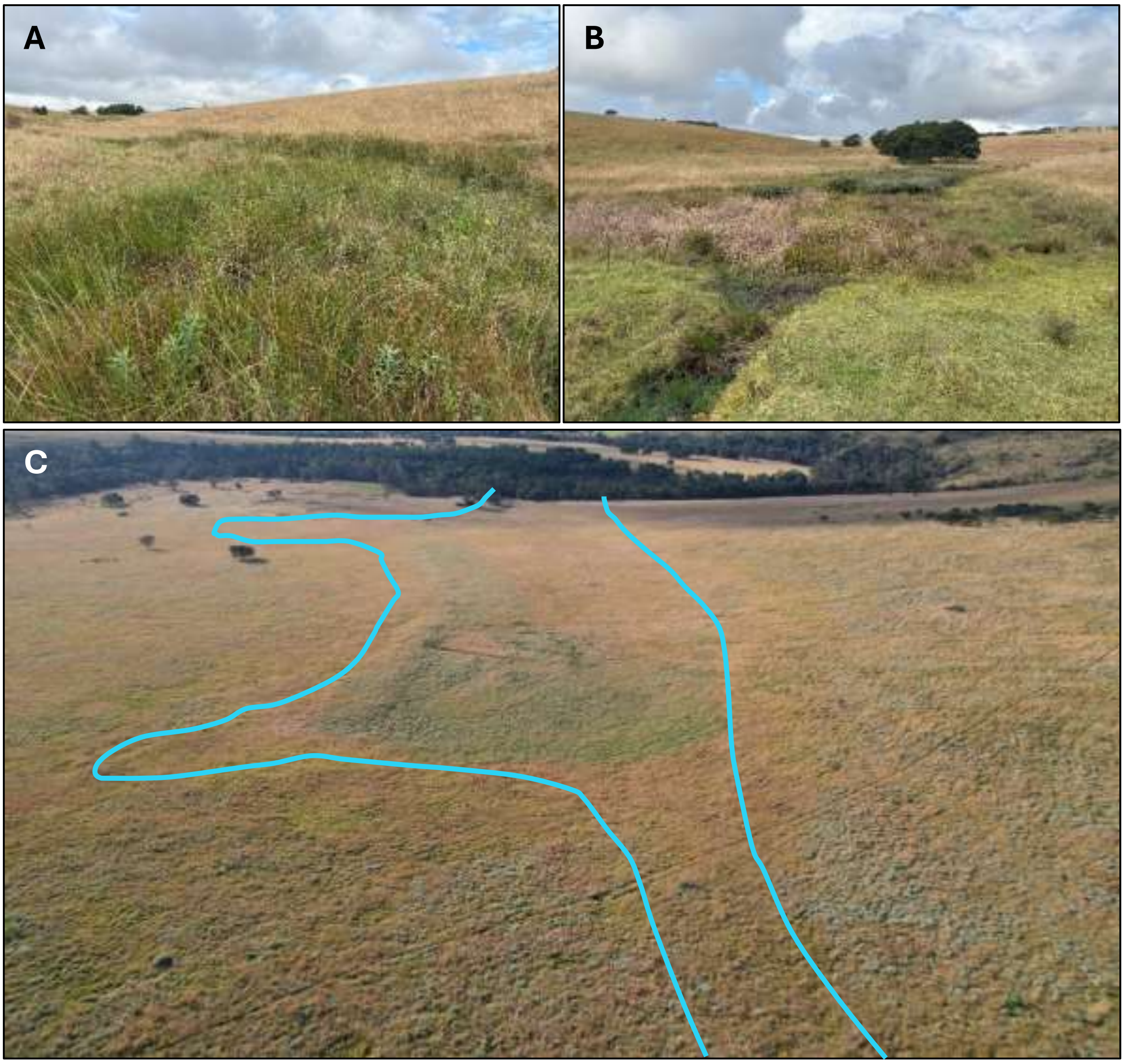

Figure 8-3 **A) Relatively intact portion of the CVB wetland adjacent to the channel. B) Photo taken from the breached dam wall looking upstream at the old dam basin. C) Aerial image of the SEEP wetland looking down towards the Kubusi River, the approximate extent of some of the SEEP wetland shown in blue.**

8.2 Assessment of aquatic ecosystem functioning

The general features of the aquatic ecosystems hydrologically linked to the proposed development were assessed in terms of their ecosystem functioning at a landscape level of the **current** and **post-development** scenario using a Level 2 WET-EcoServices assessment. The score for the ecosystem services represents the likely extent to which that benefit is being supplied by the aquatic ecosystems, based on the demand for said benefit, rated from 0-4, which informs the overall importance score. These are based on the following categories as presented in (Kotze et al., 2021):

- 0-0.79 Very Low;
- 0.8-1.29 Low;
- 1.3-1.69 Moderately Low;
- 1.7-2.29 Moderate;

- 2.3-2.69 Moderately High;
- 2.7-3.19 High; and
- 3.2-4.0 Very High.

8.2.1 *Riverine ecosystem*

Generally, the values recorded for the regulating and supporting services for the riverine system for the current and post-development scenarios ranged from ***Very Low*** to ***Moderate*** (**Table 8-1**). The values recorded for the water quality enhancement services (i.e. phosphate, nitrate and toxicant assimilation and removal) are all ***Low*** in the current and post-development scenarios. A slight increase in the overall importance score of the toxicant removal ecosystem service is noted in the post-development scenario due to the increased demand for this ecosystem service with the chicken broiler houses in the landscape. The overall importance score for harvestable resources for both the current and post-development scenarios are ***Moderate*** due to the abundance of invasive alien trees along the banks of the riverine and riparian habitat, which would provide an abundance wood for burning and building. There are no substantial changes between the current and post-development scenarios for the riverine ecosystem.

8.2.2 *Channelled valley-bottom wetland*

Similar to the riverine ecosystem, the scores for the CVB system did not differ significantly between the current and post-development scenarios. However, in the current scenario, all regulating and supporting ecosystem services are scored as being of ***Very Low*** importance, with all the water quality enhancement services increasing in their overall importance rating in the post-development scenario due to the increased demand for water quality enhancement services (**Table 8-2**). Notably, the CVB system scored ***High*** for the food for livestock ecosystem service, given the extent of grazeable plants within the wetland and the current use of the wetland is for grazing, thereby giving weight to the demand score for the food for livestock ecosystem service.

8.2.3 *Hillslope seep wetlands*

The SEEP 1 wetland has a similar trend, but given the proximity of the SEEP 1 wetland to broiler house 2, the post-development impacts on the wetland are likely to be slightly more pronounced than on the CVB and riverine systems (**Table 8-3**). The current scenario for the SEEP shows that the regulating and supporting services are of ***Very Low*** or ***Low*** importance, but the sediment trapping, phosphate trapping, and toxicant assimilation all increase from ***Low*** to ***Moderately Low*** in the post-development scenario. It should be noted that this is not due to the fact that the wetland improves in condition, but rather the demand for these ecosystem services increases with the presence of the broiler houses in the immediate catchment. The food for livestock and water for human use ecosystem services are rated as being of ***Moderate*** importance in both the current and post-development scenarios.

The SEEP 2 wetland provides a similar suite of ecosystem services to that of SEEP 1, ranging from ***Very Low*** to ***Moderate***. Because the SEEP 2 wetland will not be directly or indirectly affected by either of the broiler houses, but rather by the reticulation pipeline, there is negligible difference between the current and post-development scenarios (**Table 8-4**).

Table 8-1 Summary of current ecosystem services scores for the riverine ecosystem for the current and post-development scenarios[6].

ECOSYSTEM SERVICE		RIP - Current				RIP – post-development			
		Supply	Demand	Importance Score	Importance	Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	2.3	0.1	0.8	Very Low	2.3	0.1	0.8	Very Low
	Stream flow regulation	-	-	N/A	N/A	-	-	N/A	N/A
	Sediment trapping	1.6	1.5	0.9	Low	1.6	1.5	0.9	Low
	Erosion control	1.8	1.0	0.8	Low	1.8	1.0	0.8	Low
	Phosphate assimilation	1.7	1.5	0.9	Low	1.7	1.5	0.9	Low
	Nitrate assimilation	1.7	1.5	0.9	Low	1.7	1.5	0.9	Low
	Toxicant assimilation	1.7	1.1	0.7	Very Low	1.7	1.5	0.9	Low
	Carbon storage	0.8	2.7	0.7	Very Low	0.8	2.7	0.7	Very Low
	Biodiversity maintenance	0.0	1.0	0.0	Very Low	0.0	1.0	0.0	Very Low
PROVISIONING SERVICES	Water for human use	0.0	0.7	0.0	Very Low	0.0	0.7	0.0	Very Low
	Harvestable resources	3.0	1.3	2.2	Moderate	3.0	1.3	2.2	Moderate
	Food for livestock	2.0	0.7	0.8	Low	2.0	0.7	0.8	Low
	Cultivated foods	2.8	0.0	1.3	Low	2.8	0.0	1.3	Low
CULTURAL SERVICES	Tourism and Recreation	1.3	0.0	0.0	Very Low	1.3	0.0	0.0	Very Low
	Education and Research	0.0	0.0	0.0	Very Low	0.0	0.0	0.0	Very Low
	Cultural and Spiritual	0.0	0.0	0.0	Very Low	0.0	0.0	0.0	Very Low

6 Please note that **Table 8-1** is a summary developed for reporting purposes. Full data can be made available upon request.

Table 8-2 Summary of current ecosystem services scores for the channelled valley-bottom wetland ecosystem for the current and post-development scenarios[7].

ECOSYSTEM SERVICE		CVB - Current				CVB – post-development			
		Supply	Demand	Importance Score	Importance	Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1.2	0.0	0.0	Very Low	1.2	0.0	0.0	Very Low
	Stream flow regulation	1.3	1.0	0.3	Very Low	1.3	1.0	0.3	Very Low
	Sediment trapping	2.0	0.0	0.5	Very Low	2.0	0.0	0.5	Very Low
	Erosion control	1.8	0.5	0.6	Very Low	1.8	0.5	0.6	Very Low
	Phosphate assimilation	2.0	0.0	0.5	Very Low	2.0	0.8	0.9	Low
	Nitrate assimilation	1.7	0.0	0.2	Very Low	1.7	0.8	0.5	Very Low
	Toxicant assimilation	1.8	0.8	0.7	Very Low	1.8	1.1	0.9	Low
	Carbon storage	1.2	2.7	1.1	Low	1.2	2.7	1.1	Low
	Biodiversity maintenance	2.3	2.5	2.1	Moderate	2.3	2.5	2.1	Moderate
PROVISIONING SERVICES	Water for human use	2.4	0.7	1.2	Low	2.4	0.7	1.2	Low
	Harvestable resources	1.5	0.0	0.0	Very Low	1.5	0.0	0.0	Very Low
	Food for livestock	4.0	0.7	2.8	High	4.0	0.7	2.8	High
	Cultivated foods	2.3	0.0	0.8	Very Low	2.3	0.0	0.8	Very Low
CULTURAL SERVICES	Tourism and Recreation	0.5	0.0	0.0	Very Low	0.5	0.0	0.0	Very Low
	Education and Research	0.0	0.0	0.0	Very Low	0.0	0.0	0.0	Very Low
	Cultural and Spiritual	1.0	0.0	0.0	Very Low	1.0	0.0	0.0	Very Low

7 Please note that **Table 8-2** is a summary developed for reporting purposes. Full data can be made available upon request.

Table 8-3 Summary of current ecosystem services scores for the SEEP 1 wetland ecosystem for the current and post-development scenarios[8]

ECOSYSTEM SERVICE		SEEP 1 - Current				SEEP 1 – post-development			
		Supply	Demand	Importance Score	Importance	Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0.8	0.1	0.0	Very Low	0.8	0.1	0.0	Very Low
	Stream flow regulation	1.7	1.0	0.7	Very Low	1.7	1.0	0.7	Very Low
	Sediment trapping	2.4	0.0	0.9	Low	2.4	0.8	1.3	Moderately Low
	Erosion control	1.9	0.0	0.4	Very Low	1.9	0.0	0.4	Very Low
	Phosphate assimilation	2.6	0.0	1.1	Low	2.6	0.8	1.5	Moderately Low
	Nitrate assimilation	2.4	0.0	0.9	Low	2.4	0.8	1.3	Low
	Toxicant assimilation	2.7	0.0	1.2	Low	2.7	0.8	1.5	Moderately Low
	Carbon storage	1.5	2.7	1.3	Moderately Low	1.5	2.7	1.3	Moderately Low
	Biodiversity maintenance	2.3	1.0	1.3	Moderately Low	2.3	1.0	1.3	Moderately Low
PROVISIONING SERVICES	Water for human use	3.2	0.7	2.0	Moderate	3.2	0.7	2.0	Moderate
	Harvestable resources	1.0	0.0	0.0	Very Low	1.0	0.0	0.0	Very Low
	Food for livestock	3.0	1.3	2.2	Moderate	3.0	1.3	2.2	Moderate
	Cultivated foods	1.7	0.0	0.2	Very Low	1.7	0.0	0.2	Very Low
CULTURAL SERVICES	Tourism and Recreation	0.5	0.0	0.0	Very Low	0.5	0.0	0.0	Very Low
	Education and Research	1.0	0.0	0.0	Very Low	1.0	0.0	0.0	Very Low
	Cultural and Spiritual	1.0	0.0	0.0	Very Low	1.0	0.0	0.0	Very Low

8 Please note that **Table 8-3** is a summary developed for reporting purposes. Full data can be made available upon request.

Table 8-4 Summary of current ecosystem services scores for the SEEP 2 wetland ecosystem for the current and post-development scenarios[9]

ECOSYSTEM SERVICE		SEEP 2 - Current				SEEP 2 – post-development			
		Supply	Demand	Importance Score	Importance	Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1.0	0.1	0.0	Very Low	1.0	0.1	0.0	Very Low
	Stream flow regulation	0.4	1.0	0.0	Very Low	0.4	1.0	0.0	Very Low
	Sediment trapping	2.1	0.0	0.6	Very Low	2.1	0.0	0.6	Very Low
	Erosion control	1.9	0.3	0.6	Very Low	1.9	0.3	0.6	Very Low
	Phosphate assimilation	2.1	0.8	1.0	Low	2.1	0.8	1.0	Low
	Nitrate assimilation	2.0	0.8	0.9	Low	2.0	0.8	0.9	Low
	Toxicant assimilation	2.2	0.8	1.0	Low	2.2	0.8	1.0	Low
	Carbon storage	1.4	2.7	1.3	Low	1.4	2.7	1.3	Low
	Biodiversity maintenance	2.3	1.0	1.3	Moderately Low	2.3	1.0	1.3	Moderately Low
PROVISIONING SERVICES	Water for human use	3.2	0.7	2.0	Moderate	3.2	0.7	2.0	Moderate
	Harvestable resources	2.0	0.0	0.5	Very Low	2.0	0.0	0.5	Very Low
	Food for livestock	2.3	1.3	1.4	Moderately Low	2.3	1.3	1.4	Moderately Low
	Cultivated foods	1.7	0.0	0.2	Very Low	1.7	0.0	0.2	Very Low
CULTURAL SERVICES	Tourism and Recreation	0.3	0.0	0.0	Very Low	0.3	0.0	0.0	Very Low
	Education and Research	1.0	0.0	0.0	Very Low	1.0	0.0	0.0	Very Low
	Cultural and Spiritual	0.0	0.0	0.0	Very Low	0.0	0.0	0.0	Very Low

9 Please note that **Table 8-4** is a summary developed for reporting purposes. Full data can be made available upon request.

8.3 Ecological Importance and Sensitivity

According to the DWS Manual for Rapid Ecological Determination of Inland Wetlands (Rountree et al., 2013), the current ecological importance and sensitivity (EIS) categories for the three wetland systems were derived from their ecological importance scores. All wetlands are considered to be in a ***Moderate*** category for both the current and post-development scenarios (**Table 8-5**). The scores for both the SEEP and the CVB wetlands are derived from the fact that they receive some protection due to their location on private land which limits their use and potential degradation. All wetlands are in a **C** PES category, which also elevates their ecological importance at a landscape scale and they are characterised by a moderate level of ecological diversity which contributes to their overall ecological importance score. The only change in the post-development scenario is related to their hydro-functional importance, which increases slightly due to the increased demand for ecosystem service delivery. This does not affect their overall EIS score.

Table 8-5 Ecological importance and sensitivity score for the wetland systems for the current and post-development scenarios for the CVB and SEEP wetlands[10].

Ecological Importance and Sensitivity Categories	CVB		SEEP 1		SEEP 2	
	Current	Post-dev	Current	Post-dev	Current	Post-dev
Ecological Importance and Sensitivity	2.2	2.2	2.4	2.4	2.4	2.4
Hydro-functional Importance	0.5	0.6	0.8	1.0	0.5	0.5
Direct Human Benefits	0.7	0.7	0.7	0.7	0.7	0.7
Overall Importance and Sensitivity Score	2.2	2.2	2.4	2.4	2.4	2.4
Overall Importance and Sensitivity Category	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

8.4 Wetland ecological condition assessment results

The ecological integrity or Present Ecological State (PES) of the CVB and SEEP wetlands were assessed for the hydrology, geomorphology, vegetation and water quality components for the current and post-development scenarios (see **Table 8-6** and **Table 8-7** respectively). The results of these assessments are outlined in the following sections.

8.4.1 *Current scenario*

Assessment of impacts on hydrology

The impact score recorded for the hydrological component of the CVB and the SEEP wetlands was **2.3** and **3.2,** respectively, which translates into a present hydrological state (PHS) category of **C**. The change in ecosystem processes and loss of natural habitat is considered to be

10 Please note that **Table 8-5** is a summary developed for reporting purposes. Full data can be made available upon request.

'Moderate', with modifications to the wetland's PHS being linked primarily to the following factors:

- In both the CVB and the SEEP wetlands, the most dominant driver of change to the hydrology is the change in the patterns of water retention and distribution. This is largely due to the presence of cattle in all wetlands, which have created small paths within each wetland which have become concentrated and preferential flow paths. This changes the retention time of water in the wetlands and also changes the way that water flows through and across the wetland systems.
- In all wetlands, but most predominantly SEEP 2, the presence of invasive alien plants (IAPs), specifically *Acacia mearnsii* and *Eucalyptus grandis*, use more water than the herbaceous species, which naturally occur in these wetlands.
- The catchment of the CVB wetland has several hardened surfaces that either reduce infiltration or divert flows away from the wetland unit. These hardened surfaces include the N6 road, the railway and associated embankments, farmhouses and a mine.

Assessment of impacts on geomorphology

The impact score recorded for the geomorphic component of the CVB and the SEEP wetlands ranged between **1.7** and **2.4**, which translates into a present geomorphic state (PGS) category of **B** or **C**. The change in ecosystem processes and loss of natural habitat is considered to be 'Minor' or 'Moderate', with modifications to the wetland's PGS being linked primarily to the following factors:

- Catchment conditions for all wetlands result in changes in the volume and rate of sediment input into the HGM units. All wetlands are characterised by agricultural land (mostly grazing land), which is characterised by slightly decreased vegetation cover and is therefore more prone to sediment mobilisation into the wetlands than natural land.
- The presence of cattle paths within all wetlands, but most prominently in SEEP 2, results in the unnatural movement of sediment within the wetlands.

Assessment of impacts on water quality

The impact score recorded for the water quality component ranged from **0.6** to **1.5**, which translates into a present water quality state (PWQS) category of **A** and **B** respectively. This is considered to be 'Largely Natural' or 'Negligibly' modified and only minor changes to ecosystem processes are present:

- Catchment conditions for all wetlands result in changes in the volume and rate of sediment input into the HGM units. Some pollutants are bound to sediment and therefore, an increase in sediment inputs into a wetland can also be associated with a decline in the PWQS.
- The CVB wetland has both a mine and a small farm in it's catchment which means that there is a higher chance of pollutants entering the CVB wetland which originate from one or both of these land uses.

Assessment of impacts on vegetation

The impact score recorded for the vegetation component of the wetlands ranged between **3.5** and **6.0,** which translates into a present vegetation state (PVS) category ranging between **C** and

E. The change in ecosystem processes and loss of natural habitat is considered to be 'Large' to 'Serious', with modifications to the wetland's PVS being linked primarily to the following factors:

- All wetlands are characterised by widespread grazing pressure, which has resulted in a shift in vegetation composition towards secondary grassland and secondary wetland vegetation. Species such as *Sporobolus africanus* and *Eragrostis plana* have increased in abundance due to their relative unpalatability and tolerance to disturbance. Cattle preferentially graze certain species which then allows for other less frequently grazed species to become more dominant. This has occurred in all three wetland units and has resulted in an unnatural shift in vegetation composition.
- Both the CVB and SEEP 1 wetlands have low levels of IAPs within their delineated boundaries, which have a negative impact on the PVS of both wetlands. SEEP 2 has approximately 15% of its entire land area invaded by IAPs.
- In the case of the CVB wetland, there is an old dam basin in the wetland along with an old dam wall. The dam wall itself has displaced a small area of vegetation and the dam basin is full of disturbance tolerant and invasive species, resulting in a reduced PVS.

Table 8-6 Summary of the overall ecological condition of the wetlands for the current scenario[11].

Current Scenario						
Wetland	**Descriptor**	**Hydrology**	**Geomorphology**	**Water quality**	**Vegetation**	**Overall PES**
CVB	Impact Score	2.4	1.7	0.7	4.0	2.2
	PES Category	C	B	A	D	C
SEEP 1	Impact Score	2.3	1.7	0.6	3.5	2.0
	PES Category	C	B	A	C	C
SEEP 2	Impact Score	3.2	2.4	1.5	6.0	3.3
	PES Category	C	C	B	E	C

8.4.2 *Post-development scenario*

The PES scores of the CVB and SEEP wetlands were assessed for the hydrology, geomorphology, water quality and vegetation components comprising wetland health for the post-development scenario. The development layout provided illustrated that the proposed developments, specifically broiler house 2, would be located within the catchments of these two wetlands.

11 Please note that **Table 8-6** is a summary developed for reporting purposes. Full data can be made available upon request.

However, given that the broiler houses would occupy a negligible proportion of the overall catchments, the impact on the overall PES of the two wetlands will be negligible. The only component of the ecological condition that would change in the post-development scenario is the PWQS, which changes from a score of **0.7** to a **0.9** in the CVB wetland and changes from a **0.6** to a **1.0** in the SEEP wetland. The larger change in the SEEP wetland is due to the relative proximity of the proposed broiler houses to it in comparison to the CVB. This change assumes a 'poor' mitigation scenario and could likely be improved with the mitigation measures in the following sections. The PES for SEEP 2 does not change in the post-development scenario given that the only impact will be associated with the excavation of a small trench to bury the water reticulation pipe, which will have a negligible impact on the PES of the wetland.

Table 8-7 Summary of the overall ecological condition of the wetlands for the post-development scenario[12].

Post-development Scenario						
Wetland	**Descriptor**	**Hydrology**	**Geomorphology**	**Water quality**	**Vegetation**	**Overall PES**
CVB	Impact Score	2.4	1.7	0.9	4.0	2.3
	PES Category	C	B	A	D	C
SEEP	Impact Score	2.3	1.7	1.0	3.5	2.1
	PES Category	C	B	B	C	C
SEEP 2	Impact Score	3.2	2.4	1.5	6.0	3.3
	PES Category	C	C	B	E	C

8.4.3 *Overall ecosystem condition for the current and post-development scenarios*

For ease of interpretation, the scores for hydrology, geomorphology, vegetation and water quality are able to be simplified into a composite impact score for the HGM units by weighting the scores obtained as outlined in Macfarlane et al. (2020). These scores were then used to derive hectare equivalents, which were used as the 'currency' for assessing the loss and gains in wetland integrity (Cowden et al., 2008). Based on the PES scores for the assessment unit within the study area recorded for the current scenario, approximately **21.6** ha of wetland habitat is considered to be the equivalent to **16.5** ha of intact wetland habitat, which can also be expressed as functioning approximately 76%. However, in the post-development scenario, approximately **21.6** ha of wetland habitat will be considered to be the equivalent of **16.4** ha of intact wetland habitat. This indicates that there will be a loss of approximately **0.1** ha of intact wetland habitat (**Table 8-8**).

12 Please note that **Table 8-7** is a summary developed for reporting purposes. Full data can be made available upon request.

Table 8-8 Overall area-weighted ecological integrity for the wetlands for the current and post-development scenarios[13].

Current scenario				
Wetland	**Hydrology**	**Geomorphology**	**Water quality**	**Vegetation**
Current Area Weighted Impact Scores	2.5	1.9	0.8	4.2
Current PES Categories	C	B	A	D
Current Overall Area Weighted Impact Score	3.0			
Current Overall PES	C			
Total Area	21.6 ha			
Current Hectare Equivalents	**16.5 ha**			
Post-development scenario				
Wetland	**Hydrology**	**Geomorphology**	**Water quality**	**Vegetation**
Post-development Area Weighted Impact Scores	2.5	1.9	1.1	4.2
Post-development PES Categories	C	B	B	D
Post-development Overall Area Weighted Impact Score	3.1			
Post-development Overall PES	C			
Total Area	21.6 ha			
Post-development Hectare Equivalents	**16.4 ha**			

8.5 River health assessment

The ecological condition of the riverine ecosystem was assessed separately to the wetland habitats (as per the following sections) given that different tools and methods are typically applied for riverine ecosystems. Benthic diatom samples were used to infer water quality impacts, with instream and riparian habitat metrics providing an indication of river habitat functioning in proximity to the site. **Figure 8-4** shows the location of the benthic diatom sample sites.

13 Please note that **Table 8-8** is a summary developed for reporting purposes. Full data can be made available upon request.

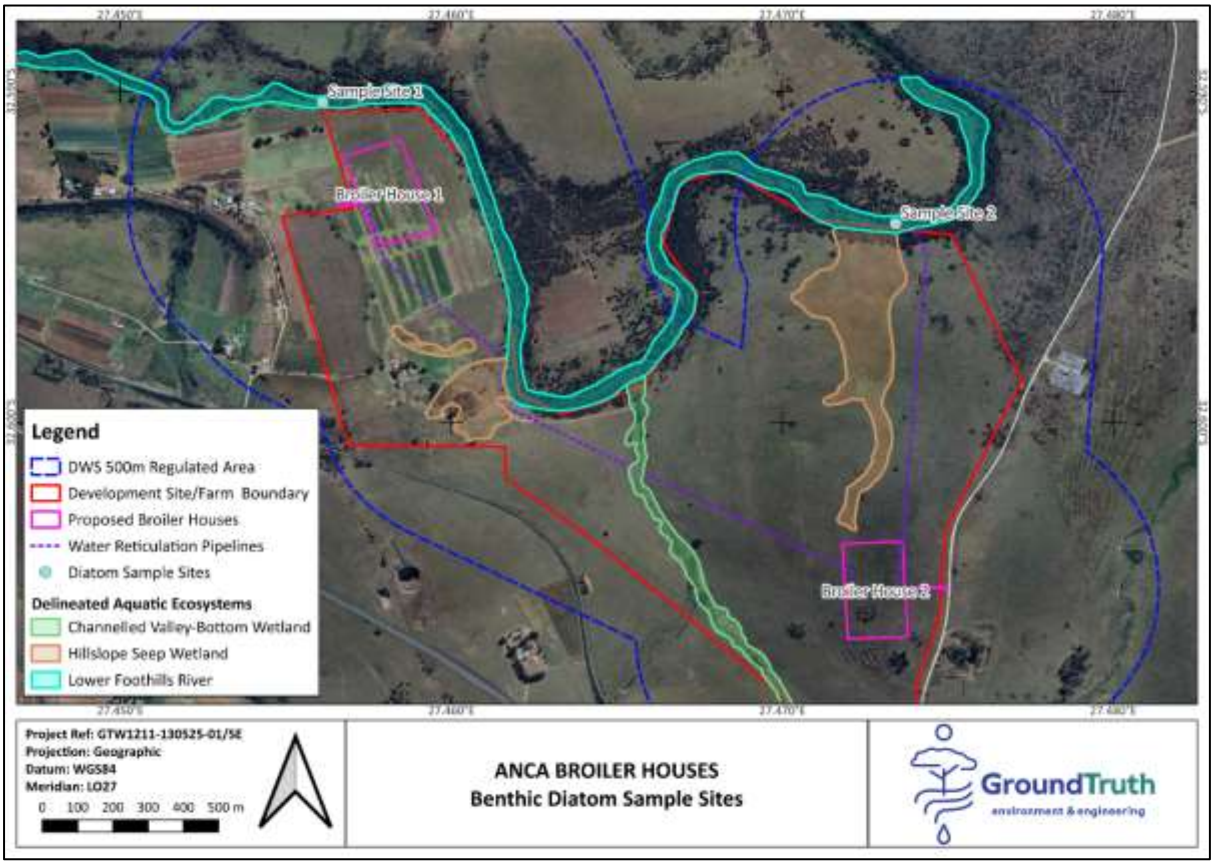

Figure 8-4 **Map showing where benthic diatom samples were collected. Sample site 1 represents an upstream site and sample site 2 is a downstream site.**

8.5.1 *Benthic diatoms*

Table 8-9 summarises the diatom results from the samples collected from the Kubusi River at the upstream and downstream sites. With reference to the Specific Pollution Sensitivity Index (SPI), the Kubusi River is in a fair to poor condition, with the downstream site being in a more natural condition than the upstream site. Site 1 was dominated by species from the *Nitzschia* genus of diatoms (30.7%), which are typically cosmopolitan diatoms that can tolerate variable water quality conditions and can survive in moderate to highly polluted waters. Site 2 was dominated by species from the *Navicula* genus (66%), with high abundances of *Navicula symmetrica* and *Navicula radiosa* Kutzing which are both tolerant of eutrophic, electrolyte and strongly polluted conditions.

Table 8-9 Benthic diatom results from samples collected from an upstream and a downstream site on the Kubusi River in relation to the ANCA broiler house development[14].

Site	Number of Species	Specific Pollution Sensitivity Index (SPI)	% Pollution Tolerant Valves (% PTV)	% Deformed Cells	River Health Category
Site 01 upstream	54	8.6	33.0	0.0	**Poor**
Site 02 downstream	43	12.4	17.6	1.0	**Fair**

8.5.2 *Habitat integrity*

The integrity of the riparian habitat for the riverine ecosystem is currently in a D category (i.e. moderately to highly modified). This is largely as a result of the high infestation of IAPs that are very problematic along the entire reach that was assessed. Other impacts include channel modification caused by the incision of the channel which has a knock-on effect of having caused some bank erosion, which creates more habitat for the proliferation of IAPS. A summary of the results of the riparian habitat assessment are presented in **Table 8-10**.

Table 8-10 Habitat integrity assessment scores for the riparian zone[15]..

Riparian Zone Habitat Integrity	Impact rating (1-25)	Comment
Vegetation removal	**6**	Small to moderate removal of riparian vegetation, largely from roads and historic agricultural activities
Exotic vegetation	**19**	High invasive alien plant infestation within in the riparian zone
Bank erosion	**8**	Moderate levels of bank erosion throughout the system
Channel modification	**12**	Moderately high modification of the system due to channel incision
Water abstraction	**9**	Heavy abstraction occurring upstream and from the site itself, modifying the accessibility of water to the riparian zone
Inundation	**0**	No impact to riparian vegetation
Flow modification	**7**	Some alteration of natural flows from dams upstream and land use
Water quality	**12**	Moderate water quality impacts on riparian vegetation with an increase in disturbance tolerant and IAP species
Riparian vegetation integrity score	**47**	
Riparian vegetation integrity category	**D**	

14 Please note that **Table 8-9** is a summary developed for reporting purposes. Full data can be made available upon request.
15 Please note that **Table 8-10** is a summary developed for reporting purposes. Full data can be made available upon request.

8.6 Resource Quality Objectives and the Recommended Ecological Category

The management objective for any watercourse is set by considering the pre-development PES and the EIS of the given watercourse. The Kubusi River and the catchments wherein the CVB and SEEP wetlands lie do not have resource quality objectives prescribed for them. Therefore, individual REC's will be set for the three aquatic ecosystems located onsite. Following the Rountree et al. 2013) method, all the systems will have to be maintained in their current PES category, considering that their EIS categories are all ***Moderate***. Therefore, the CVB wetland has a REC of **C**, the SEEP wetlands have a REC of **C** and the Kubusi River has a REC of **D**.

8.7 Potential impacts associated with the development

It is important to understand the potential impact on the aquatic ecosystems associated with any form of development. The proposed development indicated in **Figure 8-1**, includes the construction of a total of sixteen chicken broiler houses between two sites (i.e., eight broiler houses at each site). Each broiler house will be able to house a maximum of 42 000 chickens. These sites will also contain ancillary infrastructure including staff eating and washing areas, access roads and other services which include stormwater management, septic tanks and water reticulation. Each site will require the clearance of approximately 6 ha (adding up to a total of 12 ha) of agricultural land. In terms of waste management, after each cycle, the broiler houses will be washed down, with the solid waste collected and removed offsite and the wash water stored in an earthen pond onsite to allow for evaporation. Clean water will be pumped to each broiler facility via a 50mm diameter HDPE pipe.

The onsite aquatic ecosystems are all located at least 40 m away from the nearest proposed broiler houses, and therefore no direct impacts are envisaged from the construction of the broiler facilities. There are direct impacts envisaged as a result of the construction of the water reticulation pipelines. The potential impacts to the hydrologically linked aquatic ecosystems are numbered and listed below:

Construction Phase Impacts

1. Water contamination from the operation and washing of machinery in the catchments of the aquatic ecosystems.
2. Siltation in the aquatic ecosystems due to vegetation clearing and extensive earthworks that will be undertaken in the catchments of the aquatic ecosystems.
3. Spread of invasive alien plants into the aquatic ecosystems as a result of the disturbance during construction.
4. Direct loss of wetland habitat due to excavation and installation of water reticulation pipelines.

Operational Phase Impacts

5. Increased flood peaks, runoff velocity and water quantity due to the increase in hardened surfaces in the catchments, thereby causing increased water inputs (flow modification).
6. Increased flood peaks, runoff velocity and water quantity due to the increase in hardened surfaces in the catchments, thereby causing increased water inputs (erosional and sediment flux modification).
7. Polluted stormwater generated from the development site (water quality modification).

8. Operation of septic tanks in the catchment of the aquatic ecosystems (water quality modification).
9. Increased hydrological inputs into aquatic ecosystems from a leaking water main (flow modification)

These potential impacts are what were considered when carrying out the buffer assessment, the risk assessment and the impact assessment in the sections below.

8.8 Buffer determination results

Generally, buffers are adopted to protect aquatic ecosystems from physical disturbance and to protect the water resource from pollution from the adjacent landscape. The aquatic ecosystems within the study site have generally been modified, with the alteration of the systems' integrity associated with current and historical disturbances. As such, the buffer distances are largely associated with the buffer functions that contribute towards protecting the water resource rather than biodiversity. The width of a buffer is determined by the type of development proposed, which in this case has been classified as an intensive livestock operation – specifically a poultry operation.

It has been widely shown that a buffer distance of 32 m (from 100 feet in the United States of America) can process up to 80% phosphorus and sediment-derived impacts. However, buffer zones for dealing with nitrogen-related pollutants and providing wildlife with sufficient space and habitat generally need to be wider than 32 m (Mcelfish et al., 2008). It should be noted that a core assumption about buffer zones is that *they will not be utilised for anything other than providing buffering capacity.* Initially, the buffers were derived for the onsite aquatic ecosystem habitat using 'The Estuary, River and Wetland Buffer Guidelines' model (McFarlane & Bredin, 2017) and were based on the characteristics of the aquatic ecosystems, the potential impacts associated with the proposed development and the characteristics of the derived buffer zones. An unmitigated buffer assessment was undertaken to show the buffer requirements should a poor mitigation scenario be adopted by the developer for both the construction and operation phases of the development. Additionally, a mitigated buffer assessment was undertaken to show the buffer requirements should a best-case mitigation scenario be adopted by the developer. Detailed recommendations for the management and maintenance of the buffer areas have been provided in **Section 9**.

As visualised in **Figure 8-5** to **Figure 8-8**, and presented in **Table 8-11,** the buffer for the proposed development is split up into poor mitigation and best-case mitigation scenarios with variable buffer widths for each scenario and for each aquatic ecosystem, depending on their sensitivity and the nature of the buffer zone. While the development **Low** risks to the downstream systems, it is recommended that appropriate mitigation activities are adopted, especially associated with stormwater and sewage management, as the downstream system has been classified as Critically Endangered. **Section 9** provides some mitigation activities that should be adopted.

The results highlight a significant variation in buffer requirements across systems and mitigation scenarios, reflecting both the sensitivity of the aquatic ecosystems and the nature of potential impacts during the construction and operational phases. Notably, the SEEP requires a buffer of up to 63 m under the poor mitigation scenario, compared to 32 m under best-case mitigation. This is primarily due to its sensitivity to sediment and nutrient inputs, particularly during the operational phase, where sustained impacts from stormwater and effluent discharge from the broiler houses pose a high risk to the integrity of the system. The CVB system requires a consistent 16 m buffer under both scenarios, as the system is regarded as being less sensitive to impacts associated with the construction and operational phase. The Kubusi River shows a reduction in buffer width from 44 m (poor mitigation) to 17 m (best-case mitigation) during the operational phase, which assumes that wastewater management and sediment inputs are appropriately managed.

Table 8-11 Recommended buffer distance to be adopted for the wetlands present within the development footprint[16].

Aquatic Ecosystem	Mitigation Scenario	Buffer Distance per Phase	
		Construction	Operational
River	Poor mitigation scenario	15m	44m
	Best-case mitigation scenario	15m	17m
CVB	Poor mitigation scenario	15m	16m
	Best-case mitigation scenario	15m	16m
SEEP 1	Poor mitigation scenario	21m	63m
	Best-case mitigation scenario	15m	32m
SEEP 2	Poor mitigation scenario	15m	15m
	Best-case mitigation scenario	15m	15m

16 Please note that **Table 8-11** is a summary developed for reporting purposes. Full data can be made available upon request.

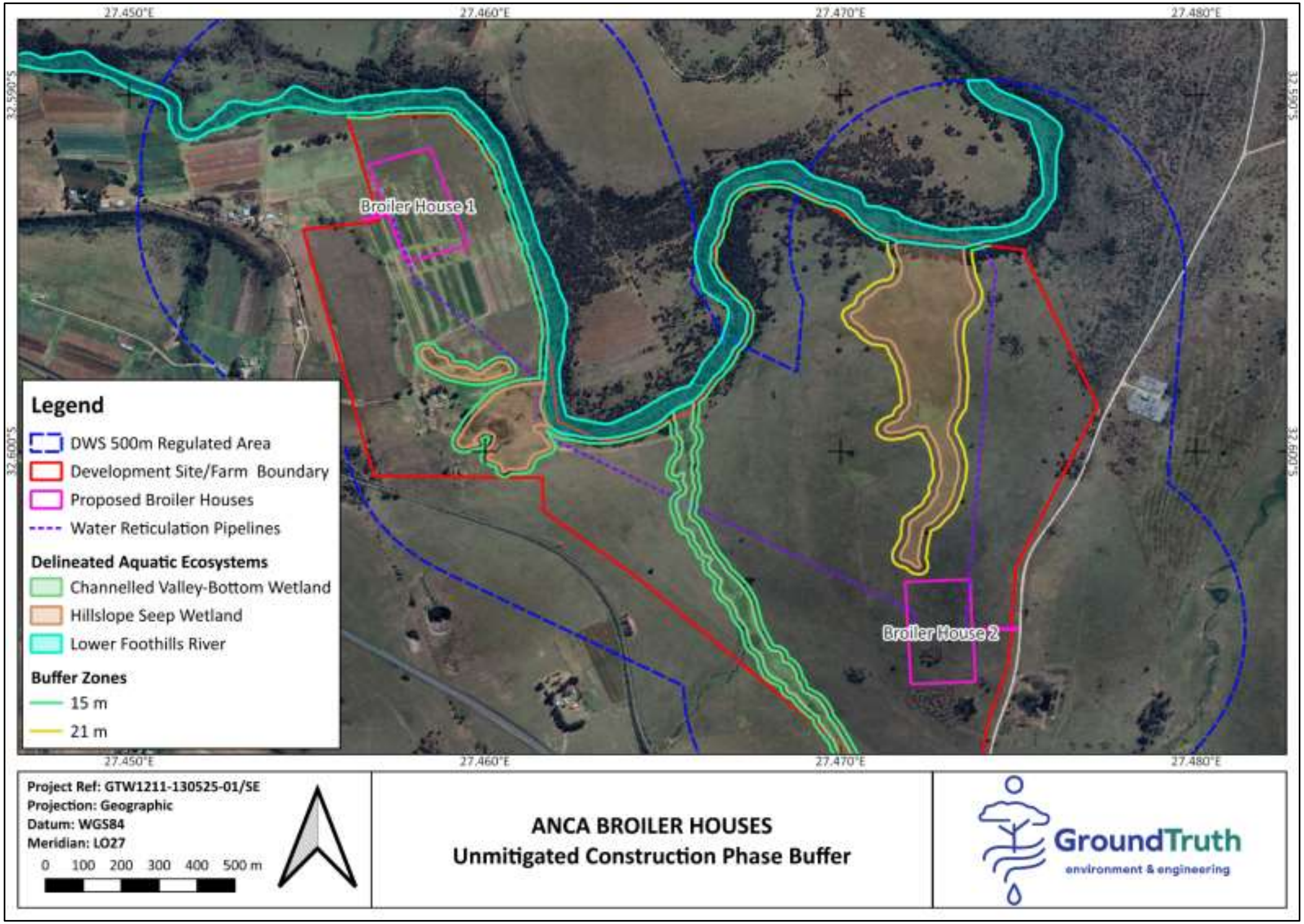

Figure 8-5 Results of the wetland buffer zone assessment for the construction phase (unmitigated) for the freshwater ecosystem habitat.

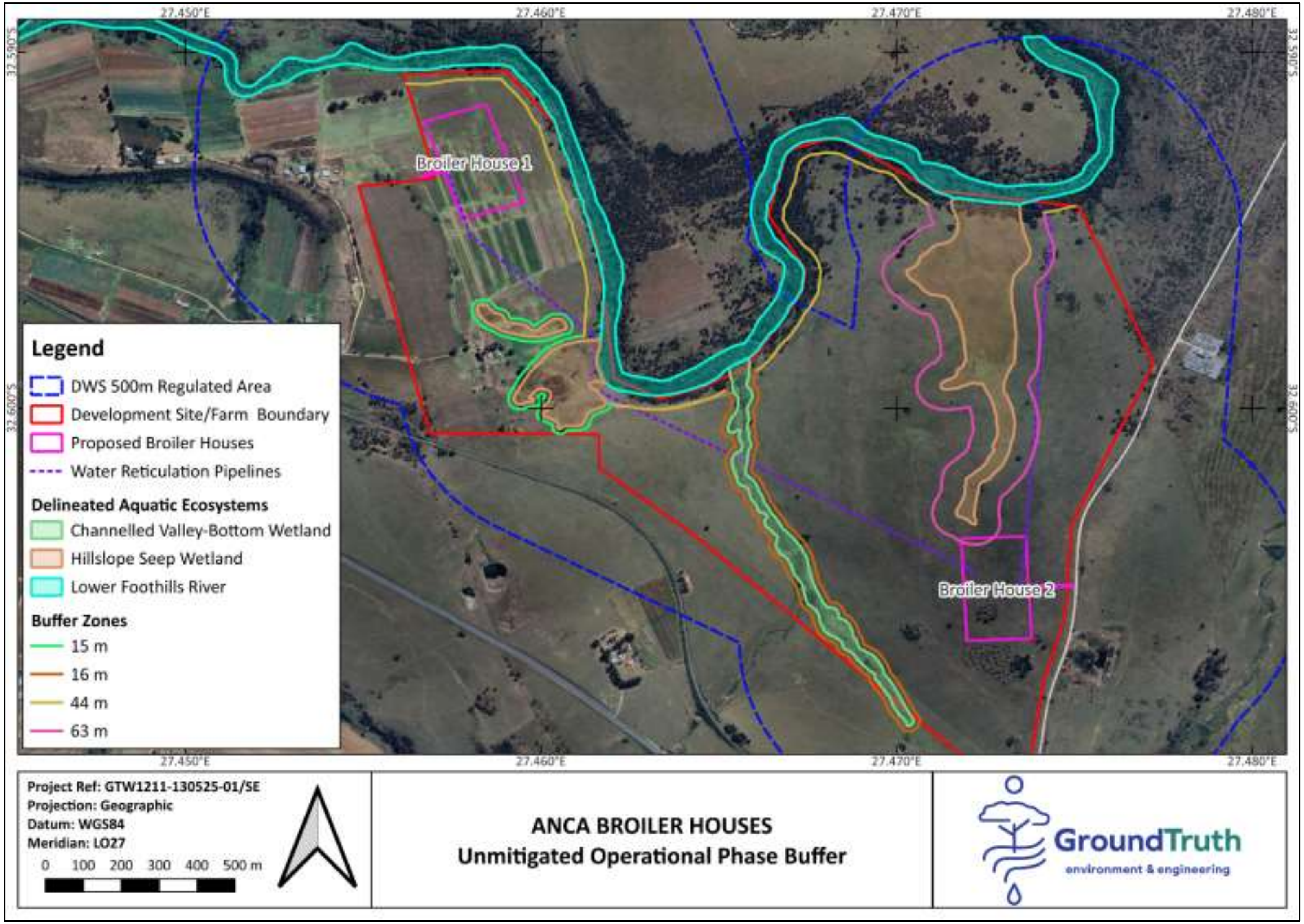

Figure 8-6 Results of the wetland buffer zone assessment for the operational phase (unmitigated) for the freshwater ecosystem habitat.

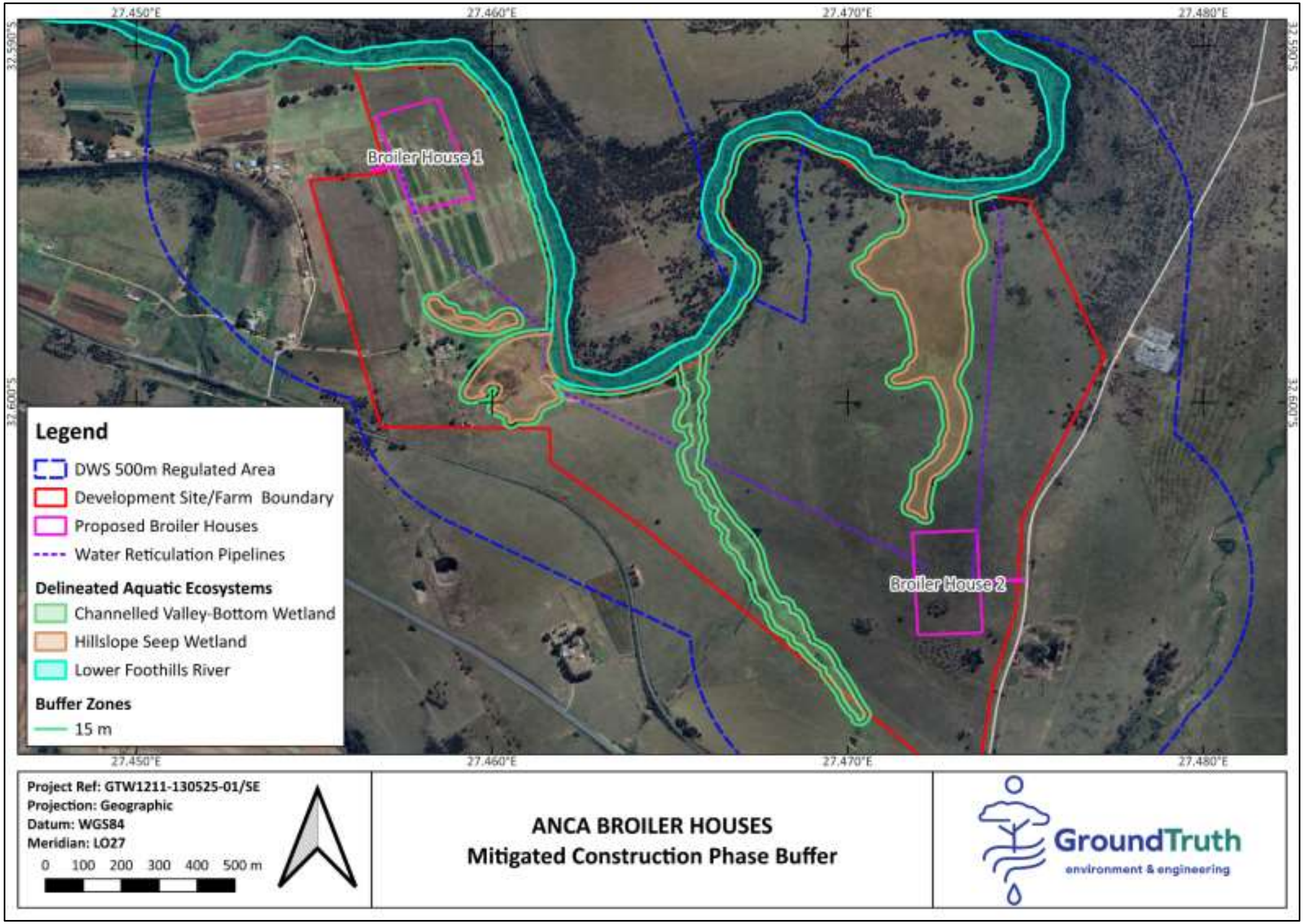

Figure 8-7 Results of the wetland buffer zone assessment for the construction phase (mitigated) for the freshwater ecosystem habitat.

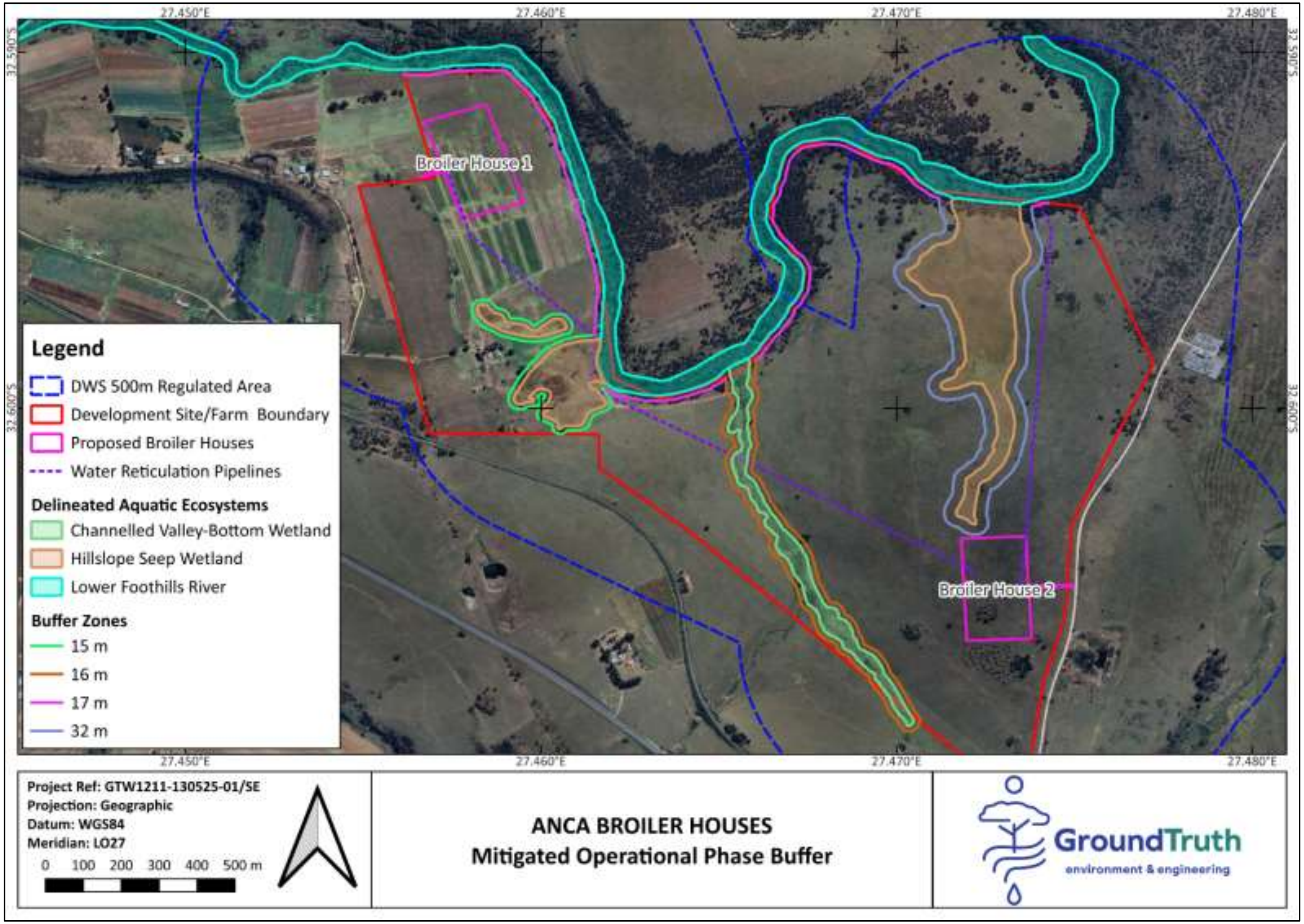

Figure 8-8 Results of the wetland buffer zone assessment for the operational phase (mitigated) for the freshwater ecosystem habitat.

8.9 Watercourse risk assessment

Consideration of the principles and approach described in the DWS Risk Matrix (Gazette No. 49833, Notice 4167 of 2023), highlighted that the proposed chicken houses posed a ***Low*** risk of negative impacts to the downstream hydrologically linked watercourses under mitigated conditions (**Table 8-12** and **Table 8-13**).

The assessment considered the impacts of both the construction and operational phases of the development. During the construction phase, activities such as building, road upgrades, vegetation clearing, and machinery use were identified as potential risks to the downstream freshwater ecosystem. These include water contamination from machinery and siltation from earthworks and vegetation clearing. The SEEP, which is of high ecological importance, is considered the most sensitive to siltation due to its vulnerability to additional sediment inputs from the activities described above. Nevertheless, these risks were rated as ***Low*** for this system. The construction phase is considered short-term and manageable, assuming best-practice sediment and pollution controls are in place as described in **Section 9,** with impacts to the systems being considered minimal.

During the operational phase, risks to the systems are considered ***Low*** under the mitigated scenario. Key potential impacts include hydrological changes due to increased runoff from hardened surfaces, water quality modification from stormwater and septic tank effluent, and sediment mobilisation and erosion, both of which are linked to altered flow dynamics in the upstream catchment. These risks are manageable with appropriate mitigation measures such as effective stormwater management, septic tank maintenance, and the implementation of well-vegetated buffer zones. For instance, the buffer assessment determined that under best-case mitigation, a 32 m buffer for the SEEP system is sufficient to protect the wetland's ecological integrity, while the CVB system requires only a 16 m buffer. However, in the case of the SEEP, all construction and operational activities must occur under mitigated conditions, as the development falls within the 64 m buffer required in an unmitigated scenario.

It is assumed throughout that buffer areas will remain undisturbed, well-vegetated, and appropriately managed in accordance with **Section 9**. This will help to buffer increased surface flows and filter sediments and nutrients generated by the upstream development before entering the freshwater ecosystems. Should mitigation measures fail or buffers be poorly maintained, risk levels to systems are increased.

Table 8-12 Wetland risk assessment activities, impacts and risk ratings for the construction phase[17]

Phase	Activity	Impact	Affected watercourse	Overall intensity	Spatial scale	Duration	Probability / Likelihood	Significance	Risk Rating
Construction	Development within the catchment. Construction of chicken houses, upgrade of the roads, operation of machines, clearing of vegetation within the catchment - assuming appropriate mitigation measures are implemented	1. Water contamination from the operation and washing of machinery	Little Kubusi	0.0	3.0	1.0	20%	2.4	L
			CVB	0.0	3.0	1.0	20%	2.4	L
			SEEP 1	2.0	4.0	1.0	20%	5.6	L
			SEEP 2	2.0	3.0	1.0	40%	7.2	L
		2. Siltation of watercourse due to vegetation clearing and extensive earthworks in the catchments	Little Kubusi	2.0	3.0	2.0	40%	7.2	L
			CVB	2.0	2.0	2.0	40%	7.2	L
			SEEP 1	4.0	2.0	2.0	60%	16.2	L
			SEEP 2	4.0	2.0	2.0	40%	9.6	L
		3. Spread of invasive alien plants as a result of the construction phase disturbances	Little Kubusi	0.0	2.0	2.0	60%	7.2	L
			CVB	2.0	2.0	2.0	60%	10.8	L
			SEEP 1	2.0	2.0	2.0	60%	14.4	L
			SEEP 2	2.0	2.0	2.0	60%	10.8	L
	Excavation and disturbance within an aquatic ecosystem	4. Loss of habitat and disturbance to soils	CVB	2.0	1.0	1.0	100%	12.0	L
			SEEP 2	4.0	1.0	1.0	100%	18.0	L

17 Please note that **Table 8-12** form a summary table developed for reporting purposes. Full data is available upon request.

Table 8-13 Wetland risk assessment activities, impacts and risk ratings for the operational phase[18]

Phase	Activity	Impact	Affected water-course	Overall intensity	Spatial scale	Duration	Probability / Likelihood	Signifi-cance	Risk Rating
Operational	Development within the catchment. Operation of chicken houses, upgrade of the roads, operation of machines, clearing of vegetation within the catchment - assuming appropriate mitigation measures are implemented	5. Increased flood peaks and increased runoff velocity thereby causing increased water inputs (flow modification)	Little Kubusi	2.0	3.0	4.0	40%	10.8	L
			CVB	2.0	3.0	4.0	40%	10.8	L
			SEEP 1	4.0	4.0	4.0	40%	19.2	L
		6. Increased flood peaks and increased runoff velocity (erosional and sediment flux modification)	Little Kubusi	2.0	3.0	4.0	20%	5.4	L
			CVB	2.0	3.0	4.0	20%	5.4	L
			SEEP 1	4.0	4.0	4.0	20%	9.6	L
		7. Polluted stormwater generated from the development site (water quality modification)	Little Kubusi	2.0	3.0	4.0	20%	5.4	L
			CVB	2.0	3.0	4.0	20%	5.4	L
			SEEP 1	4.0	4.0	4.0	20%	9.6	L
		8. Operation of septic tanks in the catchment (water quality modification)	Little Kubusi	0.0	2.0	4.0	20%	3.6	L
			CVB	0.0	2.0	4.0	20%	3.6	L
			SEEP 1	0.0	3.0	4.0	20%	5.6	L
	Operation of water reticulation pipeline in aquatic ecosystems and their catchments	9. Increased water inputs as a result of a leak in the	Little Kubusi	2.0	3.0	2.0	20%	4.2	L
			CVB	2.0	3.0	2.0	20%	4.2	L
			SEEP 1	2.0	3.0	2.0	20%	5.6	L

18 Please note that **Table 8-13** form a summary table developed for reporting purposes. Full data is available upon request.

Phase	Activity	Impact	Affected water-course	Overall intensity	Spatial scale	Duration	Probability / Likelihood	Signifi-cance	Risk Rating
		water pipeline (flow modification)	SEEP 2	2.0	3.0	2.0	20%	5.4	L

8.10 Impact assessment

The seven possible impacts to aquatic ecosystems were assessed first for a poor mitigation scenario and then in a best-case mitigation scenario. Most of the potential impacts scored ***Very Low*** or ***Low*** in the poor mitigation scenario with the exception of the possible spread of IAPs in the construction phase scoring a ***Moderate*** significance rating (**Table 8-14** and **Table 8-15**). All of the potential impacts in the realistic good mitigation scenario fell within the ***Very Low*** impact category.

Table 8-14 Impact assessment results for the potential construction phase related impacts

Construction Phase					
Potential Impact	Poor Mitigation		Realistic Good Mitigation		Mitigation Measure Reference
	Aspect	Score	Aspect	Score	
1. Water contamination from the operation and washing of machinery in the catchments of the aquatic ecosystems.	Intensity	2.0	Intensity	2.0	See 9.1.1 iii), iv), v), vii)
	Extent	2.0	Extent	2.0	
	Duration	1.0	Duration	1.0	
	Reversibility	2.0	Reversibility	2.0	
	Probability	3.0	Probability	1.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	5.3	Significance Rating	1.8	
2. Siltation in the aquatic ecosystems due to vegetation clearing and extensive earthworks that will be undertaken in the catchments of the aquatic ecosystems.	Intensity	3.0	Intensity	2.0	See 9.1.1 i), ii), vi)
	Extent	2.0	Extent	2.0	
	Duration	2.0	Duration	2.0	
	Reversibility	3.0	Reversibility	2.0	
	Probability	3.0	Probability	1.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	7.5	Significance Rating	2.0	
3. Spread of invasive alien plants into the aquatic ecosystems as a result of the disturbance during construction.	Intensity	3.0	Intensity	2.0	See 9.1.1 viii), ix)
	Extent	3.0	Extent	2.0	
	Duration	3.0	Duration	2.0	
	Reversibility	3.0	Reversibility	2.0	
	Probability	5.0	Probability	2.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	2.0	Cumulative Impact	1.0	
	Irreplaceable Loss	2.0	Irreplaceable Loss	1.0	
	Significance Rating	22.5	Significance Rating	3.0	

4. Direct loss of wetland habitat due to excavation and installation of water reticulation pipelines.	Intensity	3.0	Intensity	1.0	See 9.1.1 x), xi), xii)
	Extent	2.0	Extent	1.0	
	Duration	2.0	Duration	1.0	
	Reversibility	2.0	Reversibility	1.0	
	Probability	5.0	Probability	5.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	11.3	Significance Rating	5.0	

Table 8-15 Impact assessment results for the potential operation phase related impacts

Operation Phase					
Potential Impact	Poor Mitigation		Realistic Good Mitigation		Mitigation Measure Reference
	Aspect	Score	Aspect	Score	
5. Increased flood peaks, runoff velocity and water quantity due to the increase in hardened surfaces in the catchments, thereby causing increased water inputs (flow modification).	Intensity	1.0	Intensity	1.0	See 9.1.2 i), ii), vi), viii)
	Extent	3.0	Extent	3.0	
	Duration	4.0	Duration	4.0	
	Reversibility	3.0	Reversibility	3.0	
	Probability	2.0	Probability	1.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	5.5	Significance Rating	2.8	
6. Increased flood peaks, runoff velocity and water quantity due to the increase in hardened surfaces in the catchments, thereby causing increased water inputs (erosional and sediment flux modification).	Intensity	2.0	Intensity	1.0	See 9.1.2 ii), viii)
	Extent	3.0	Extent	1.0	
	Duration	2.0	Duration	1.0	
	Reversibility	3.0	Reversibility	3.0	
	Probability	3.0	Probability	2.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	7.5	Significance Rating	3.0	
7. Polluted stormwater generated from the development site (water quality modification).	Intensity	4.0	Intensity	1.0	See 9.1.2 i), ii), iii), iv),
	Extent	3.0	Extent	1.0	
	Duration	4.0	Duration	1.0	
	Reversibility	4.0	Reversibility	2.0	
	Probability	3.0	Probability	2.0	
	Public response	2.0	Public response	2.0	

	Cumulative Impact	2.0	Cumulative Impact	2.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	15.8	Significance Rating	3.8	
8. Operation of septic tanks in the catchment of the aquatic ecosystems (water quality modification).	Intensity	1.0	Intensity	1.0	See 9.1.2 i), ii), viii)
	Extent	1.0	Extent	1.0	
	Duration	4.0	Duration	4.0	
	Reversibility	3.0	Reversibility	3.0	
	Probability	2.0	Probability	1.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	4.5	Significance Rating	2.3	
9. Increased hydrological inputs into aquatic ecosystems from a leaking water main (flow modification)	Intensity	2.0	Intensity	1.0	See 9.1.2 ix)
	Extent	3.0	Extent	1.0	
	Duration	2.0	Duration	1.0	
	Reversibility	2.0	Reversibility	2.0	
	Probability	2.0	Probability	1.0	
	Public response	1.0	Public response	1.0	
	Cumulative Impact	1.0	Cumulative Impact	1.0	
	Irreplaceable Loss	1.0	Irreplaceable Loss	1.0	
	Significance Rating	4.5	Significance Rating	1.3	

8.10.1 *Cumulative and residual impacts*

In accordance with the EIA requirements, both cumulative and residual impacts were evaluated in the context of this development, as well as other projects planned by the ANCA business group. However, a full cumulative impact assessment was not undertaken in this study due to the need for detailed information on future developments within the aquatic ecosystem broader catchments.

To the knowledge of the specialist, there are no additional developments planned in the catchments of the SEEP and CVB wetlands, and while it is highly likely that additional developments will take place within the catchment of the Kubusi River, the details of these developments is not yet known. However, the Kubusi River is already significantly altered in terms of its instream water quality characteristics, and the development of these broiler houses within in its catchment will contribute to the cumulative water quality impacts on the river. Further developments with the potential to alter water quality will also contribute to the cumulative impacts to the Kubusi River. Therefore, all developments located within the catchment have to adopt stringent water quality management and monitoring protocols to ensure that their impacts do not further contribute to the cumulative impact on the water quality. Furthermore, the proliferation of IAPs across the length of the Kubusi River is another cumulative impact that needs to be considered. Unchecked and unmanaged proliferation of IAPs along the Kubusi River represents a serious possible cumulative impact. As such, strict mitigation measures and IAP clearing and management plans have to be enforced on all additional developments in the Kubusi River catchment and on properties that are adjacent to the river course.

8.10.2 *Assessment of alternative sites and alternative development types*

No alternative development types were considered for this project. However, an alternative location was evaluated for Broiler House 2, as shown in **Figure 8-9**. The broiler operation was relocated to its current site due to the presence of an old quarry beneath the originally proposed location. Although the quarry itself was not considered a direct issue, the volume of fill material required to stabilize the area was expected to be substantial and potentially costly. Additionally, there was a possibility that regulatory authorities might classify the quarry as a watercourse.

As a result, Broiler House 2 was moved to its present location. Since both the original and current sites are situated relatively far from the CVB and SEEP wetlands, the difference in potential impact on aquatic ecosystems is considered negligible. Neither location poses a greater environmental risk than the other.

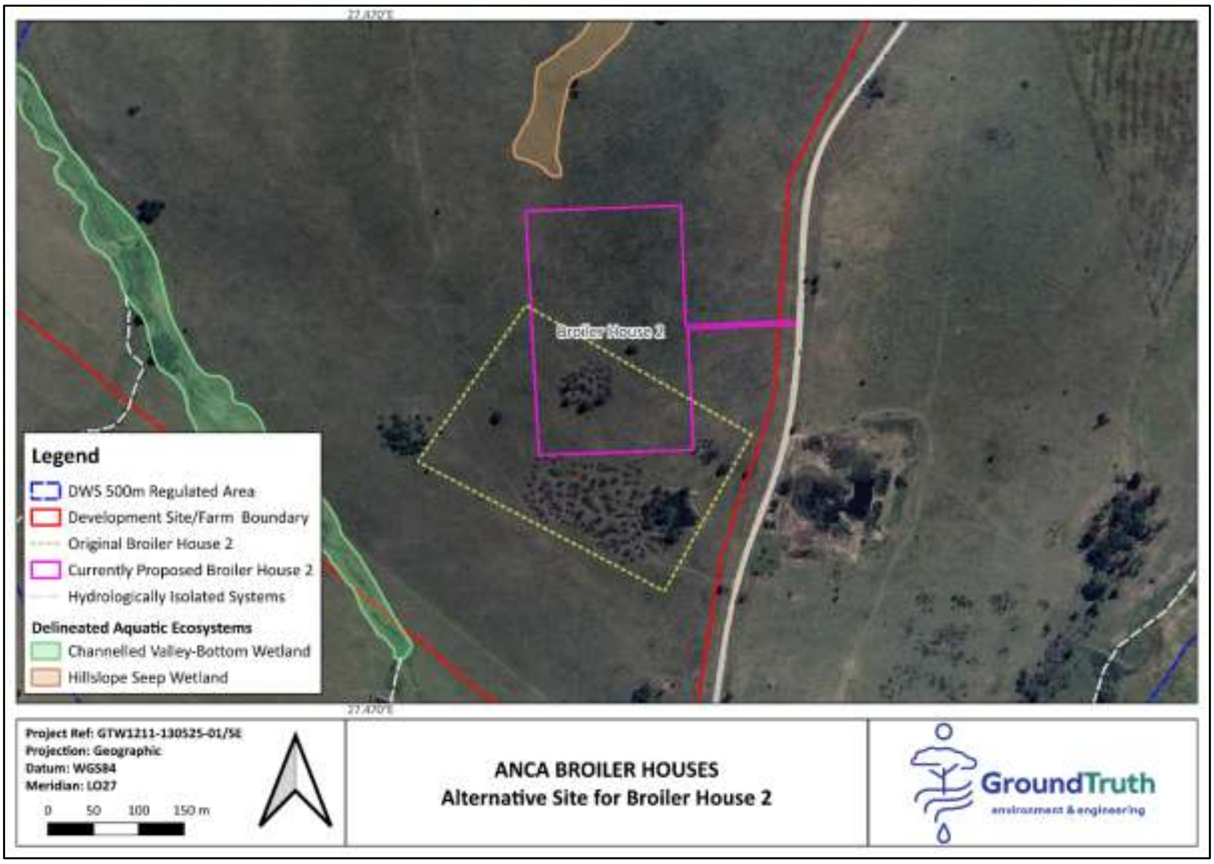

Figure 8-9 **The only alternative location proposed for the broiler houses development**

9. MITIGATION MEASURES AND RECOMMENDATIONS

Considering the loss of freshwater ecosystems within the Eastern Cape, it is recommended that the planning and implementation of any development should adopt a 'nett-gain' approach. This would include the following options for a proposed development:

- Maintaining the current levels of ecosystem integrity and service delivery of the systems within the study area; and/or
- Mitigating impacts of the proposed development on the systems by rehabilitating the habitat within the study area and introducing mitigation measures during the construction and operational phases.

9.1 Mitigation measures

To protect aquatic ecosystems from impacts linked to adjacent land uses, during both the construction and operational phases of an activity, appropriate mitigation measures are generally adopted. In this instance, mitigation activities, including buffer zones, should be incorporated into the development plan. The derived buffer zones presented in **Section 8.8** indicate that without the implementation of mitigation measures, the derived buffer distances would vary between 16 m and 63 m (i.e. the development may not encroach into the unmitigated buffer zone). If the recommended mitigation measures outlined below (**Section 9.1.1**and **9.1.2**) are implemented onsite, the derived mitigated buffer distance would vary between 15 m and 32 m (i.e. the development may encroach into the unmitigated buffer area but not into the mitigated buffer area).

9.1.1 *Mitigation during the construction phase*

The following mitigation activities should be incorporated into the development plan to assist in reducing the impacts of the proposed developments on the onsite wetland and riparian habitat during the construction phase:

i) The construction zone should be demarcated and the activities that should be implemented to minimise the area of soil disturbance and the potential for mobilisation of sediments from bare areas include:
   - Soil stabilisation practices such as sediment blankets and mulching, introduced onsite.
   - Earth dikes and diversions to direct all storm flows from disturbed areas into silt traps.

ii) Vegetation should remain intact where possible during the construction phase to limit high surface flows and mobilisation of sediment.

iii) No mixed concrete should be directly deposited on the ground without a mixing tray and any concrete spilled out of the demarcated area should be removed immediately to avoid impacting on the freshwater ecosystems (Macfarlane et al., 2015).

iv) No concrete mixing machinery can be washed onsite. The concrete wash water contains high levels of chromium, which has the potential to contaminate ground and surface water.

v) All vehicles, plant and equipment shall be maintained on a regular basis, to ensure they are all in good working order; and
   - All of the equipment (including vehicles and plant) may only be operated by competent persons;
   - Designated entry and exit points should be demarcated and used by all construction vehicles to gain access to the site;
   - Vehicles should only utilize demarcated roads and turning areas within the construction site to limit the area of impact;
   - All fuels, oils, and lubricants shall be stored appropriately. All containers shall be inspected on a regular basis for leaks. Should a spill/leak occur, the source will be isolated, and the spill contained. All contaminated soil will be disposed of at the hazardous waste vessel for appropriate disposal at a registered land fill site. Absorbent material shall be placed over the spill site, to ensure the complete removal of the spill.

vi) Ensure minimal or no disturbance outside of the development footprint area during construction, and all material arising from the development must be prohibited from entering the freshwater habitats and associated buffer zones.

vii) No hazardous chemicals used and/or spilled during the construction process must enter the riparian zones, wetlands or groundwater. If such a spill occurs during and/or on completion of the construction, a hazardous spill protocol must be implemented and the affected area cleaned up immediately.

viii) Develop and implement an alien plant control programme to manage problematic plant species and prevent further spread and establishment of problem species into all aquatic ecosystems and natural open spaces.

ix) Areas heavily infested with IAPs will need to be revegetated with indigenous plant species that are suited to the type and composition of the surrounding vegetation (e.g. thicket, forest or grassland).

x) The alignment of the linear infrastructure, together with the adjacent working area, should be clearly demarcated prior to the commencement of the excavations. The width of the working area within freshwater ecosystems should be kept to a minimum (12m)[19] to ensure that impacts on these systems are minimised. All activities must be restricted to within the demarcated working area.

xi) It is assumed that the pipeline will be a buried pipeline and therefore the following measures should be implemented when excavating in the SEEP 2 and CVB wetland systems:
   - The topsoil should be removed and stockpiled separately from the underlying sub-soil on either side of the trench.
   - The vegetation should be carefully removed, and suitably stored for replanting upon the completion of the backfilling process (if possible).

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[19] This width is specified for pipeline infrastructure and may vary depending on the type of linear feature that is being constructed. For example, the construction of the stormwater channel in the upper study site may require a larger working area. These details should be overseen by the relevant EAP.

  - The excavation should be carried out immediately prior to the laying of the pipeline feature foundations in order to minimise the time during which the trench remains open.
  - The excavated material should be protected from erosion if it is anticipated that it will remain exposed for any length of time. Stockpiles of this material should be positioned on either side of the trenches, keeping the topsoil and the subsoil separate. The following mitigation measures should be put in place for the large-scale earthworks associated with the gabion discharge structure:
    - Ensure that the correct sediment control measures are put in place such as earth dikes and diversions to direct all storm flows from disturbed areas into silt traps and soil stabilisation practices, such as sediment blankets and mulching, introduced onsite.
  - It is critical that vegetation is established immediately after all major earthworks. An approved local indigenous grass seed mixture should be applied to the exposed areas.
  - The grass seed should be watered on a regular basis (i.e. every three days unless there is rain) until the vegetation has established and adequate cover is achieved (i.e. >75%).

xii) Vegetation should remain intact where possible during the construction phase to limit high surface flows and mobilisation of sediment.

9.1.2 *Mitigation during the operational phase*

The following recommendations are based on general best practice to assist in reducing the impacts of the proposed development on the freshwater ecosystems during the operational phase:

i) To limit the potential impact of increased water inputs, nutrient inputs and toxic contaminants to the downstream freshwater ecosystems, the following mitigation measures should be implemented:

  - Stormwater from Broiler House 2 should not be directed toward the SEEP 1, but rather toward the CVB wetland. The buffer between the SEEP 1 and the broiler house is limited, and the SEEP 1 is particularly sensitive to hydrological and water quality impacts.
  - Adoption and rehabilitation of the buffer zone, with the removal of invasive alien vegetation, to ensure an undisturbed vegetation community.
  - Management of the buffer should include the prevention of overgrazing, trampling by livestock, invasive alien plant encroachment and undesirable burning regimes (Macfarlane et al., 2015). In addition, routine vegetation monitoring and maintenance should be implemented within buffer zones to ensure adequate ground cover, prevent erosion, and ensure sediment trapping efficiency. Any bare patches should be rehabilitated immediately using indigenous grass species.
  - In addition to the buffer zone, a series of filter strips should be constructed and maintained between the broiler houses and the CVB and Kubusi River. A filter strip is generally defined as a gently sloping area of grass that water flows onto and across in order to trap and remove sediment and silt. The filter strip should

comprise of a mix of grass species that can grow to a height of at least 150 mm to ensure maximum sediment and toxicant trapping. This will help to filter run-off before it enters the wetland and riparian habitat (Valparaiso City, 2004).

- The filter strips should be maintained on ANCA's property to filter off unwanted material in the event that either a stormwater pipe should burst or one of the wash-water channels should overflow.
- In addition to the filter strips, an infiltration trench should be constructed to catch stormwater flows once they have passed through the filter strips, before they leave the ANCA property. Infiltration trenches are designed to offer runoff volume reduction by promoting infiltration and subsurface/lateral flows of water rather than surface flow. Infiltration trenches also offer further sediment and toxicant removal capacity. A decant point should be constructed away from the freshwater ecosystems and into a vegetated area to offer similar functionality to the vegetated strips.
- A clearly defined contingency plan should be compiled and adhered to in the case of failures or spills from the waste treatment systems or other point sources of pollution.

ii) Any sewage pump stations and/or wastewater treatment works must have appropriate mitigation measures in place in case of power failures and/or operational failures. As a minimum, this should include backup generators, sumps and/or bunds and an emergency protocol to manage failures and spills/leaks with immediate effect.

iii) In the case of the SEEP 1 system, sufficient bunding and filters should be constructed on the downslope side of Broiler House 2 to prevent any pollutants from entering the wetland system.

iv) The evaporation pond used for wash-water storage should be appropriately lined with a geosynthetic liner to prevent infiltration into groundwater and should be designed to accommodate potential high rainfall events that produce excess storm flows. The pond should be fenced to prevent access by livestock or wildlife, and any overflows must be directed away from the freshwater ecosystems. It must also be designed to accommodate extreme rainfall events, especially in light of increasing climatic variability and associated storm intensities.

v) Incorporate the aforementioned recommendations into the Environmental Management Programme (EMP) and include monitoring of riparian habitats, natural corridors and other open spaces to be implemented during both construction and operation phases.

vi) The existing and proposed access road upgrades that runs through the proposed development site must be appropriately drained to prevent the concentration and direct discharge of surface water into the wetland and river systems. A series of mitre drains and surface-cross drains should be installed along the road gradient to divert stormwater into adjacent vegetated areas or infiltration trenches, thereby reducing erosion and sediment transport. Drains must be regularly inspected and maintained to prevent blockage and ensure functionality.

vii) A monitoring programme should be developed and implemented to assess the effectiveness of the mitigation measures over time. This should include seasonal inspections of buffer zones, filter strips, stormwater infrastructure, and the evaporation ponds. Particular attention should be given to the accumulation of sediment, vegetation cover in buffers, and the quality of water discharged from the ponds to ensure ongoing protection of the SEEP, CVB, and Kubusi River systems.

viii) An appropriate maintenance regime should be drawn up and adopted for all stormwater and wash-water related infrastructure to ensure its continued functionality. Maintenance is not limited to, but should include:

- Dredging and cleaning of all pipes and dams associated with stormwater management to prevent build-up of sludge and sedimentation.
- Clearing of inlets, outlets and emergency spillways associated with stormwater dams.
- Regular cutting of any vegetation associated with wash-water management to maximise nutrient removal efficiency.
- Regular water samples should be taken from a point below the two wash-water evaporation ponds to ensure the desired water quality is being maintained.
- Ensure all septic tanks are operating effectively with routine annual checks.

ix) A leak detection system should be incorporated into the design of the water reticulation pipeline such that any leaks are detected and dealt with expediently.

x) While the current mitigation measures are considered sufficient for the proposed development footprint, any future expansion of infrastructure or increase in broiler house numbers should trigger a reassessment of cumulative impacts, particularly on hydrology and water quality in the downstream freshwater systems.

9.2 Conditions for inclusion in the environmental authorisation

The following items are a series of conditions for inclusion in the Environmental Authorisation for the proposed development:

- A competent environmental control officer (ECO) must oversee the construction and immediate post-construction phases of this development, with aquatic ecosystems as a priority to limit the listed impacts. The ECO must be supplied with a copy of this report and other specialist study reports conducted for this project to familiarise themselves with the mitigation measures and recommendations prior to the commencement of construction.
- The construction activities must be restricted to the approved actual footprint. Ensure minimal or no disturbance outside of the development footprint area during construction, and all material arising from the development must be prohibited from entering the aquatic habitats and associated buffer zones.
- Develop and implement an IAP control program to manage problematic plant species and prevent further spread and establishment of problem species into all aquatic ecosystems and natural open spaces. The development of an IAP management plan must occur prior to the construction and should be implemented simultaneously with the construction.
- In the event where erosion and sedimentation or pollution of the water resource occurs, and where environmental damage is caused, the holder of this environmental authorisation must take responsibility to recover and rehabilitate the damaged ecosystems expediently.

10. CONCLUSIONS

Multiple aquatic ecosystems (both riverine and wetland) were identified within the study area (i.e. the 500m regulated area) and multiple watercourses were similarly identified to be located within the proposed development footprint. An assessment of the aquatic ecosystems' ecological condition indicated a range of PES scores between **C** and **D** for both the current and post development scenarios. There is not substantial or overall change in the riverine or wetland PES categories from the current to post-development scenario given the limited extent of the proposed development. This is in alignment with the RECs which have been set for each of the wetland units which indicate that they should be maintained in their current PES category.

An assessment of the overall risks posed to each aquatic ecosystem indicated that the overall risk to the aquatic ecosystems (provided the mitigation measures are implemented) are **Low**. The impact assessment revealed that without mitigation measures, there is a potential for a **Moderate** impact to the surrounding environment, however, with appropriate mitigation measures in place, this potential impact can be reduced to a **Low** or **Very low** impact.

Considering the information presented in the report, it is the opinion of the specialists from the GroundTruth team that the proposed development could proceed due to the generally low significance of impacts identified, provided that the recommended mitigation measures are properly implemented to limit any potential impacts on sensitive features, particularly those associated with the aquatic environment.

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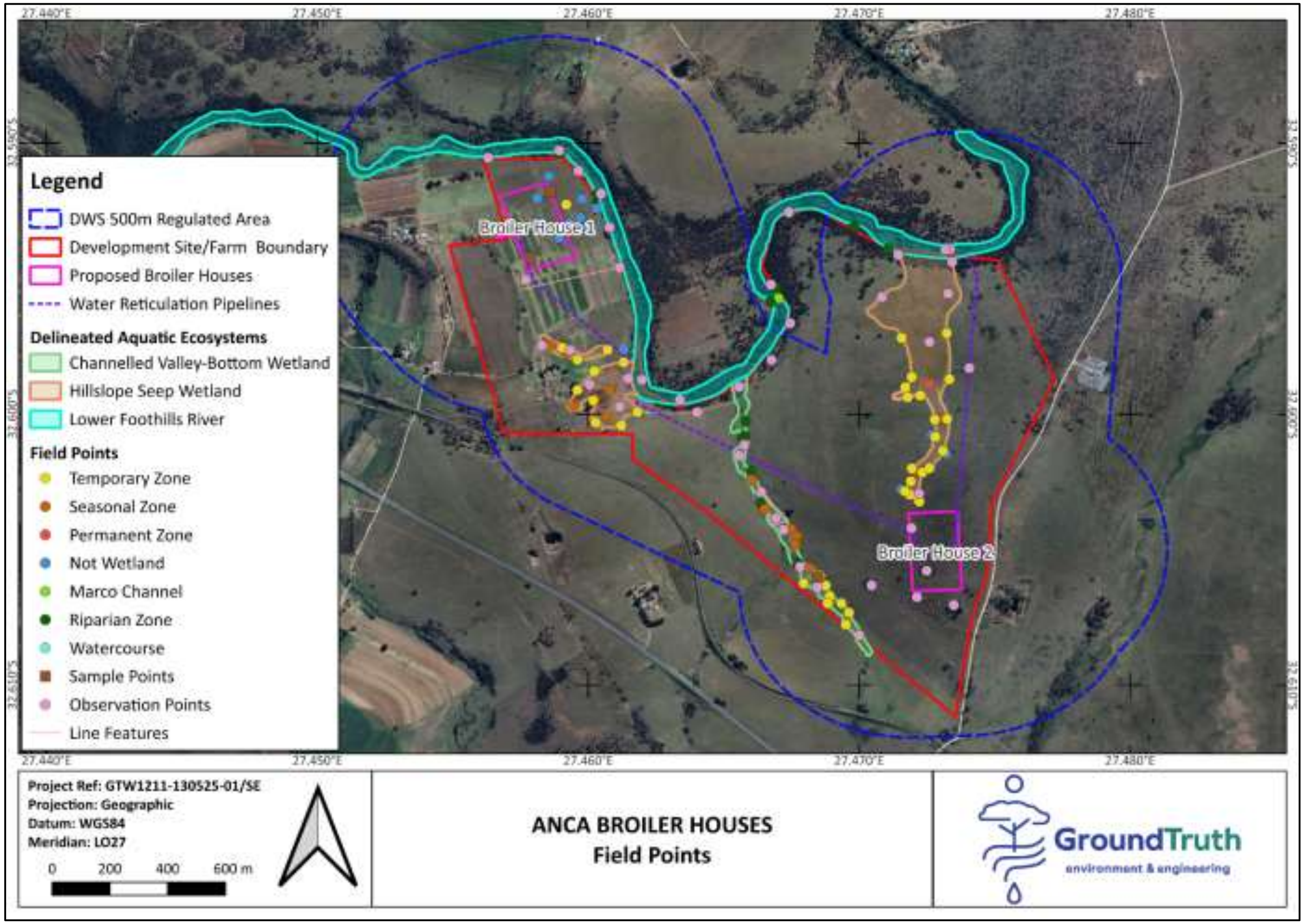
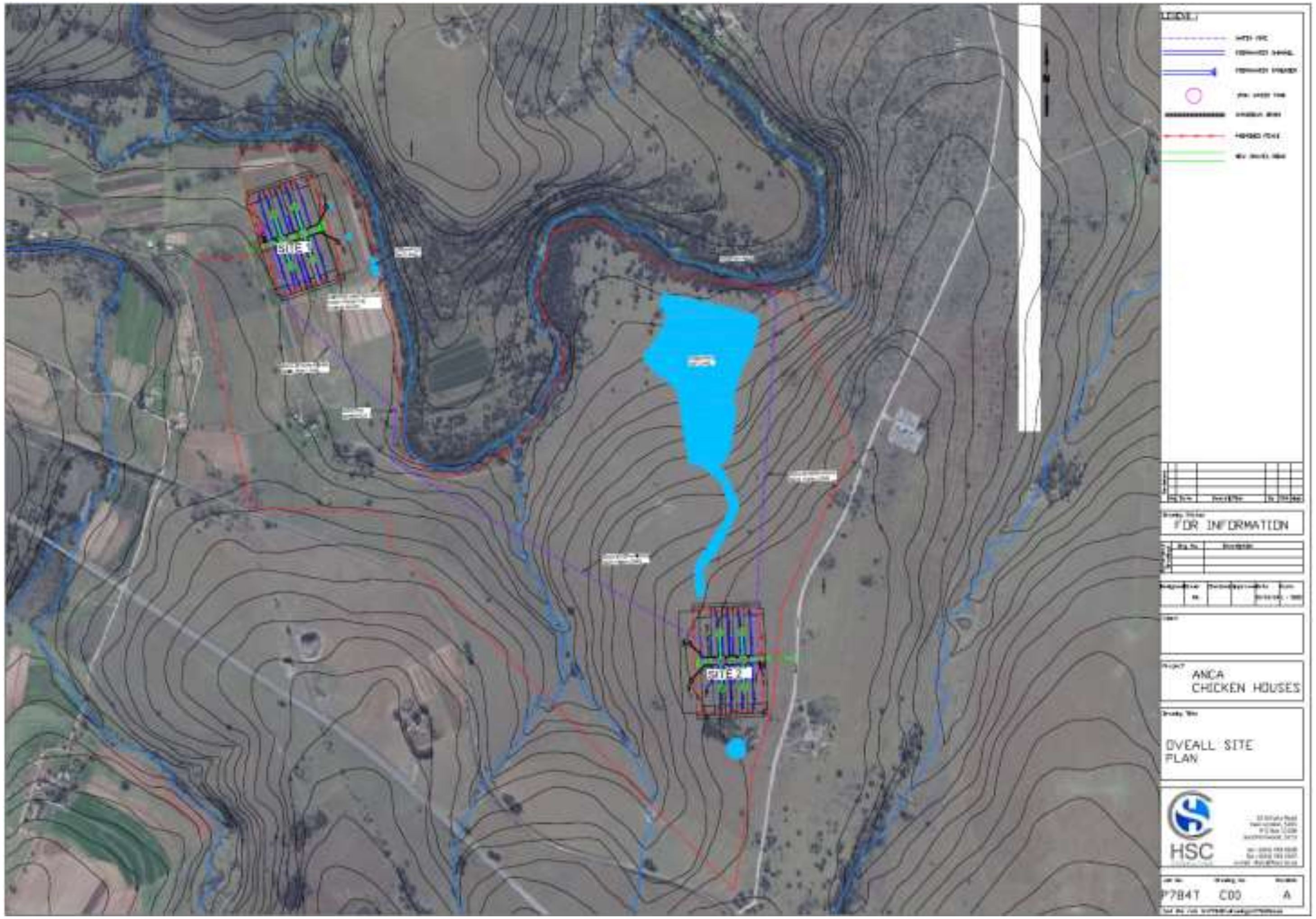
12. APPENDICES

Appendix 1
Field data collection.



Appendix 2

Proposed development layout as provided by the client on the 17th July 2025.



Appendix 3

A generic risk assessment matrix used to score risks associated with Section 21c and i.

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)
						Abiotic Habitat (Drivers)			Biota (Responses)							
			Name/s	PES	Ecological Importance	Hydrology	Water Quality	Geomorph	Vegetation	Fauna						
CONSTRUCTION	<1>	<1a>									0			0	none	#VALUE!
		<1b>									0			0	none	#VALUE!
		<1c>									0			0	none	#VALUE!
	<2>	<2a>									0			0	none	#VALUE!
		<2b>									0			0	none	#VALUE!
		<2c>									0			0	none	#VALUE!
	<3>	<3a>									0			0	none	#VALUE!
		<3b>									0			0	none	#VALUE!
		<3c>									0			0	none	#VALUE!
OPERATIONAL	<1>	<1a>									0			0	none	#VALUE!
		<1b>									0			0	none	#VALUE!
		<1c>									0			0	none	#VALUE!
	<2>	<2a>									0			0	none	#VALUE!
		<2b>									0			0	none	#VALUE!
		<2c>									0			0	none	#VALUE!
	<3>	<3a>									0			0	none	#VALUE!
		<3b>									0			0	none	#VALUE!
		<3c>									0			0	none	#VALUE!

Appendix 4

A generic impact assessment spreadsheet used to score potential impacts to inform the environmental impact assessment process.

Construction Phase															
Impact and Status			Consequence					Risk Scoring		Cumulative Impact Scoring					
No.	Impact description	Status	Intensity	Extent	Duration	Reversibility	Consequence	Probability	Environmental Significance Rating	Public response	Cumulative Impact	Irreplaceable loss of resources	Priority	Prioritisation Factor	Cumulative Impact Significance
Realistic 'Poor' Mitigation Scenario															
C1	1. Water contamination from the operation and washing of machinery in the catchments of the aquatic ecosystems.						0		0				0		#VALUE!
C2	2. Siltation in the aquatic ecosystems due to vegetation clearing and extensive earthworks that will be undertaken in the catchments of the aquatic ecosystems.						0		0				0		#VALUE!
C3	3. Spread of invasive alien plants into the aquatic ecosystems as a result of the disturbance during construction.						0		0				0		#VALUE!
C4	4. Direct loss of wetland habitat due to excavation and installation of water reticulation pipelines.						0		0				0		#VALUE!
Realistic 'Good' Mitigation Scenario															
C1	1. Water contamination from the operation and washing of machinery in the catchments of the aquatic ecosystems.						0		0				0		#VALUE!
C2	2. Siltation in the aquatic ecosystems due to vegetation clearing and extensive earthworks that will be undertaken in the catchments of the aquatic ecosystems.						0		0				0		#VALUE!
C3	3. Spread of invasive alien plants into the aquatic ecosystems as a result of the disturbance during construction.						0		0				0		#VALUE!
C4	4. Direct loss of wetland habitat due to excavation and installation of water reticulation pipelines.						0		0				0		#VALUE!

Operation Phase															
Impact and Status			Consequence					Risk Scoring		Cumulative Impact Scoring					
No.	Impact description	Status	Intensity	Extent	Duration	Reversibility	Consequence	Probability	Environmental Significance Rating	Public response	Cumulative Impact	Irreplaceable loss of resources	Priority	Prioritisation Factor	Cumulative Impact Significance
Realistic 'Poor' Mitigation Scenario															
O1	Soil erosion and siltation of watercourse						0		0				0		#VALUE!
O2	Pollution of water resource from stormwater runoff						0		0				0		#VALUE!
O3	Hydrological impacts to downstream systems						0		0				0		#VALUE!
O4	Pollution of water resource from septic tank discharge						0		0				0		#VALUE!
O6	Increased hydrological inputs						0		0				0		#VALUE!
Realistic 'Good' Mitigation Scenario															
O1	Soil erosion and siltation of watercourse						0	2	0				0		#VALUE!
O2	Pollution of water resource from stormwater runoff						0	2	0				0		#VALUE!
O3	Hydrological impacts to downstream systems						0	1	0				0		#VALUE!
O4	Pollution of water resource from septic tank discharge						0	1	0				0		#VALUE!
O6	Increased hydrological inputs						0	1	0				0		#VALUE!
							0		0				0		#VALUE!

Appendix 5

CV of the specialist.

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Curriculum Vitae – Steven Ellery

Personal Details:

Name:	Steven Ellery
Profession:	Wetland Specialist
Date of Birth:	01 October 1993
Marital Status:	Single
Nationality:	South African

Key Qualifications:
Involvement in a variety of projects over eight years ranging from:

- Wetland rehabilitation implementation support as an ecologist;
- Compliance related projects requiring sound knowledge and understanding of The National Water Act and The National Environmental Management Act;
- Wetland and riparian rehabilitation planning;
- Unmanned Aerial Vehicle (UAV) surveys and photography;
- IFC/IUCN compliant environmental and social impact assessment reporting;
- Nature based solution and ecological infrastructure conceptualisation and design
- Organisation and teaching of wetland and aquatic related courses;
- Citizen science water resource monitoring training;
- Monitoring and evaluating wetland rehabilitation interventions;
- Compilation of monitoring reports;
- Created wetland design and implementation for wastewater treatment purposes;
- Infield delineation of wetland and riparian habitats;
- Desktop mapping and identification of freshwater ecosystems;
- Assessing impacts on wetland ecosystems and calculating functional equivalents for offset/mitigation requirements;
- Remote sensing and imagery generation tools (Maps Made Easy, DroneDeploy, DJIFly, AgiSoft)
- Geographic Information Systems (QGIS, GRASS, MobileMapper, R); and
- Working in Microsoft Project (Word, Excel, Powerpoint, Outlook etc.)

Education and Training:

- 2015 B.Sc. Triple Major (Anthropology, Botany and Environmental Science) – Rhodes University
- 2016 B.Sc. Double Honours (Botany and Environmental Science) – Rhodes University

- 2017 Tools for Wetland Assessment Course – Hosted by Fred Ellery at Rhodes University
- 2018 M.Sc. in Geography specialising in geomorphology and geochemistry – Rhodes University
- 2019 Soils Classification and Land Potential Course at Cedara College of Agriculture
- 2022 Remote Pilots License (RPL) Training – Cortac
- 2024 Remote Pilots License (RPL) Training - HeliCam

Professional Memberships:

- Member – Society of Wetland Scientists
- Member – South African Wetland Society (Board Member 2022-2025)
- Professional Natural Scientist (Pr.Sci.Nat) in Ecological Science – The South African Council for Natural Scientific Professions (Reg. No. 132408)

Experience Record:

2018 to present: GroundTruth – Water, Wetlands and Environmental Engineering Consultants.

Wetland specialist with input into various projects including wetland delineation and assessment, vegetation monitoring, wetland rehabilitation planning and wetland rehabilitation monitoring and evaluation.

2012 to 2016: Rhodes University

Research assistant on multiple research projects where roles included infield data collection, data processing, data analysis and report writing.

Countries Worked in:

South Africa, Mozambique, Lesotho, Nigeria

Examples of Recent and Current Projects:

- Wetland ecologist on the rehabilitation implementation support team at Exxaro Belfast, responsible for bi-monthly progress reports, onsite ecological support and ensuring the wetland rehabilitation was carried out according to the rehabilitation plan
- Project lead and primary wetlander on the Mondi Wetlands project, carrying out long term wetland monitoring and making management recommendations for improved wetland management across Mondi landholdings
- Wetland ecologist on the Total Energies scoping study in Palma, Mozambique, responsible for the compilation of a long-term wetland monitoring and management plan
- Wetland ecologist on the rehabilitation implementation support team at Exxaro Grootegeluk, responsible for bi-monthly progress reports, onsite ecological support, UAV monitoring and ensuring the wetland creation was carried out according to the creation plan
- Wetland ecologist and GIS specialist on the United Nations Office for Project Services (UNOPS) flood alleviation and climate adaptation project in the Zambezi, Limpopo and Bons Sinias estuaries.
- Primary wetlander on the Working for Wetlands Strategic Plan for the province of KwaZulu-Natal
- Project manager, facilitator and presenter on the SAQA accredited Tools for Wetland Assessment Short Course hosted by GroundTruth, Rhodes University, Water Research Commission and Verdant Environmental
- Primary wetlander in KZN for the South African National Biodiversity Institute's Ecological Infrastructure for Water Security field validation project, responsible for the

writing, refinement and testing of a new rapid wetland assessment technique and for field validating modelled wetland condition data

- Project manager and primary wetlander on the uMngeni-uThukela Water Baynespruit and iXopo wetland rehabilitation planning projects, responsible for the creation and compilation of wetland rehabilitation plans and long term monitoring and maintenance plans
- Project manager and primary wetland ecologist responsible for the remapping and infield verification of all freshwater ecosystems across Mondi's 255 000ha landholdings
- Project manager, facilitator and presenter on the SACANASP accredited Introduction to Wetland Assessment Short Course hosted by GroundTruth
- Project lead on the Fulbright Specialist Exchange with North Dakota State University and UKZN with a focus on creating a model to predict the pollutant assimilation capacity of natural in-situ wetlands
- Facilitator and presenter at the AfriAlliance Ubuntu Action Group: Upscaling of Citizen Science Tools for Network and Capacity Building in SADC at the AFRESH II workshop
- Wetland ecologist responsible for compiling the wetland reports and the novel 'integration' methodology for the Upper Orange Reserve Study for the Department of Water and Sanitation
- Wetland ecologist partially responsible for compiling the wetland reports and the novel 'integration' methodology for the Fish/Keiskamma-Tsitsikamma Reserve Study for the Department of Water and Sanitation
- Delineation, assessment and rehabilitation planning for Exxaro Grootegeluk wetland offset study
- Wetland ecologist responsible for managing the Free State Working for Wetlands rehabilitation planning projects for the 2020-2022 rehabilitation cycle.
- Wetland ecologist responsible for compiling the iSimangaliso Working for Wetlands rehabilitation plan for the 2014-2019 rehabilitation cycle.
- Delineation, assessment, created wetland design and rehabilitation planning for Mountain Valley created wetland project

Volunteer Work:

- South African Wetland Society trustee (2022-current) – Head of the Communications and Information portfolio, responsible for the initiation and running of the new SAWS Webinar series that started in 2023, maintenance of the SAWS website and the initiation and running of the SAWS blog page.
- Friends of Beacon Hill trustee (2021-current) – responsible for bi-annual UAV monitoring of the grassland and leading alien invasive clearing parties.
- Co-founder of the Hilton Rail Trail organisation and parent NPC (2022-current) – Board member on the Earth and Art NPC, project lead and head strategist on the Hilton Rail Trail project, responsible for leading a team of 11 to implement alien plant clearing, indigenous tree planting and trail creation/maintenance along the Rail Trail.
- Co-supervising a Masters student at UKZN working on completing a feasibility study for the use of UAV technology for wetland monitoring and management
- Co-supervising a Honours student at UKZN working on the pollutant assimilation capacity of rehabilitated wetlands in KwaZulu-Natal
- Mentor to three young wetland professionals (currently) – with a history of mentorship over the last two years

Publications and Presentations:

- Ellery S, Ellery WN, Tsikos H, Dunlevey J. 2024. Depression wetland formation by redoc-driven iron and silica cycling. *Wetlands Ecology and Management* 32, 191-206. https://doi.org/10.1007/s11273-023-09968-7
- Ellery S. 2017 The geochemical origin and evolution of depression wetlands on the African Erosion Surface. Presentation at the National Wetland Indaba in Port Edward, KwaZulu-Natal, South Africa.
- Ellery S. 2018 The geochemical origin and evolution of depression wetlands on the African Erosion Surface. Presentation at the Society of Wetland Scientists Annual Meeting in Denver, Colorado, United States of America.
- Ellery S, Harvey T, Cowden C, Pike T, Dale T. 2022. Wetland rehabilitation as a collaborative, adaptive and iterative process. Presentation at the National Wetlands Indaba in Golden Gate, Free State, South Africa.
- Ellery S, Harvey T, Cowden C, Pike T, Dale T. 2023. Wetland rehabilitation as a collaborative, adaptive and iterative process. Presentation at the Society of Wetland Scientists Annual Meeting in Spokane, Washington, United States of America.
- Eggers F, Ellery S, Cowden C, Pike T. 2023. Re-creating non-perennial pans in semi-arid conditions using substrate from intact pans. Presentation at the Society of Wetland Scientists Annual Meeting in Spokane, Washington, United States of America.