SCIENTIFIC AQUATIC SERVICES

Freshwater Ecosystem Assessment

AS PART OF THE ENVIRONMENTAL AND WATER USE AUTHORISATION PROCESSES FOR THE PROPOSED VORNA VALLEY SPARK SCHOOL, GAUTENG PROVINCE.

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Vorna Valley Spark School, in the Carlswald suburb of Midrand, Gauteng Province. The proposed development is located on the TLC Stables property. The proposed development area will henceforth be referred to as the "study area". To assess the possible impacts associated with the proposed project, a 500 m radius around the study area (hereafter referred to as the "investigation area") was used as the area beyond the study area boundaries within which regulated zones of freshwater ecosystems could occur, in accordance with Government Notice 4167 (GN 4167) of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA).

Freshwater ecosystem assessment:
The freshwater ecosystem assessment was undertaken in June 2025 during which a freshwater ecosystem complex was identified within the central portion of the study area. This freshwater ecosystem consisted of several Hydrogeomorphic (HGM) units, namely, a Channelled Valley Bottom (CVB) wetland, a Hillslope Seep (HSS) wetland and a Non-Perennial Drainage Line (NDL) system. The freshwater ecosystem HGM units have a moderate to low Ecological Importance and Sensitivity (EIS), and a Present Ecological State (PES) which ranged between largely modified and seriously modified. In terms of ecoservice provisioning, the freshwater ecosystem HGM units were considered to be of moderate to low importance, as a result of their degraded state. Ecosystem services such as sediment trapping, and to a lesser extent, assimilation of nutrients and toxicants, are provided by the freshwater ecosystems on a local scale.

Water quality assessment:
Basic water quality parameters were recorded at two sites situated on the freshwater ecosystem complex (upstream and downstream of the study area). The pH can be regarded as within acceptable ranges at the time of the assessment for both sites (DWS, 2021). Measured Electrical Conductivity (EC) was elevated at both sites and therefore did not comply with the RWQOs considered (DWS, 2021). The Dissolved Oxygen (DO) levels were within the stipulated recommended ranges (DWS, 2021) at both sites. The diatom analysis revealed that both upstream and downstream sites have a moderate to high diatom species diversity with a relatively even distribution of taxa. Based on the Specific Pollution Sensitivity Index (SPI) score, the upstream site is considered to be in moderate ecological quality (Category C/D); however, the downstream site was indicated to be in a poor ecological condition (Category D). The dominant diatom species, functional groups, ecological guilds, size classes, and index scores suggest a mesotrophic to eutrophic condition for the upstream site and a eutrophic condition for the downstream site. The presence of pollution-tolerant but not metal-sensitive species suggest that the site is mainly impacted by nutrient enrichment rather than metals. Impacts at the site are likely due to urban runoff and diffuse anthropogenic inputs from the surrounding catchment.

DWS Risk Assessment:
Following the freshwater ecosystem assessment, the Department of Water and Sanitation (DWS) Risk Assessment Matrix (2023) (RAM) was applied to determine the significance of impacts of the proposed development on the identified freshwater ecosystem habitats (all confirmed to conform to the definition of a watercourse as per the NWA). The majority of the footprint areas have been optimised to avoid the delineated extent of the watercourses and associated 15m buffer areas. The proposed infrastructure is also mostly located outside the 1 in 100 year floodlines of the watercourse habitat. Some activities are proposed within the delineated extents of the watercourses. These include the upgrade of the crossing over a section of the Non-Perennial Drainage Line, and a marginal portion of an access road that encroaches on a small section of the HSS wetland. While there is a 100% probability that these watercourses would be impacted should the proposed activities commence, these impacts are likely to be very localised if the mitigation measures outlined in Section 8 of this report are strictly implemented to minimise edge effects. Despite the low risk significance outcome, it is highly recommended that the layout of the proposed roadway be further revised to avoid the HSS wetland and its associated ecological buffer area if possible.

Specialist opinion:
If all mitigation measures as stipulated in Section 8 of this report are implemented to prevent any edge effects and cumulative impacts from occurring on the sensitive freshwater ecosystems, it is the opinion of the freshwater specialist that the proposed development project may be authorised by the respective authorities.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Vorna Valley Spark School, in the Carlswald suburb of Midrand, Gauteng Province. The proposed development is located on the TLC Stables property. The proposed development area will henceforth be referred to as the "study area". To assess the possible impacts associated with the proposed project, a 500 m radius around the study area (hereafter referred to as the "investigation area") was used as the area beyond the study area boundaries within which regulated zones of freshwater ecosystems could occur, in accordance with Government Notice 4167 (GN 4167) of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA).

The purpose of this report is to define the ecology of the freshwater ecosystem habitat associated with the study area and associated investigation area (defined as a 500 m radius around the study area, in line with Government Notice (GN) 4167 of 2023 as it relates to the National Water Act (NWA), 1998 (Act No. 36 of 1998) as amended, in terms of freshwater characteristics, including mapping of the freshwater ecosystem habitat, defining areas of increased Ecological Importance and Sensitivity (EIS) and defining the Present Ecological State (PES) of the freshwater ecosystem Hydrogeomorphic (HGM) units associated with the study area. The report aims to define the socio-cultural and ecological service provision of the freshwater ecosystems and additionally outlines the Recommended Ecological Category (REC), Recommended Management Objective (RMO) and Best Attainable State (BAS) for the freshwater ecosystems. The assessment took the following approach:

- A desktop study was conducted, in which possible freshwater ecosystems were identified for on-site investigation, and relevant national and provincial databases were consulted;
- The field assessment was undertaken on the 19th of June 2025 during which various freshwater ecosystem HGM units were identified in the study area. The results of the detailed assessment of these freshwater ecosystems located in the study area are presented in Section 4 of this report, and are summarised in Table A below;
- An assessment was conducted considering basic water quality parameters (pH, electrical conductivity (EC), dissolved oxygen concentration (DO) and temperature) and sampling for diatom communities to serve as a pre-development baseline assessment of water quality.

Table A: Summary of results of the freshwater assessment as discussed in Section 4.

Freshwater Ecosystem	PES	Ecoservice Provisioning	EIS	REC / RMO / BAS*
Channelled Valley Bottom (CVB) Wetland	Category D (Largely Modified)	Moderately Low-Very Low	Moderate	REC Category: D; RMO: D (Maintain); BAS: D
Hillslope Seep (HSS) Wetland	Category D (Largely Modified)	Moderate-Very Low	Low	REC Category: D; RMO: D (Maintain); BAS: D
Non-Perennial Drainage Line (NDL)	Riparian IHI: Category D/E (Largely to Seriously Modified) VEGRAI: Category E (Seriously Modified)	Moderately Low-Very Low	Moderate	REC Category: D; RMO: D (Improve); BAS: D

*Recommended Management Objective **(RMO)**, Recommended Ecological Category **(REC),** Best Attainable State **(BAS)**

Water Quality Assessment Results:

Basic water quality parameters were recorded at two sites situated on the freshwater ecosystem complex (upstream and downstream of the study area). The pH can be regarded as within acceptable ranges at the time of the assessment for both sites (DWS, 2021). Measured Electrical Conductivity (EC) was elevated at both sites and therefore did not comply with the RWQOs considered (DWS, 2021). The Dissolved Oxygen (DO) levels were within the stipulated recommended ranges (DWS, 2021) at both sites. The diatom analysis revealed that both upstream and downstream sites have a moderate to high diatom species diversity with a relatively even distribution of taxa. Based on the Specific Pollution Sensitivity Index (SPI) score, the upstream site is considered to be in moderate ecological quality (Category C/D); however, the downstream site was indicated to be in a poor ecological condition (Category D). The dominant diatom species, functional groups, ecological guilds, size classes, and

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DWS Risk Assessment:
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Conclusion:
If all mitigation measures as stipulated in Section 8 of this report are implemented to prevent any edge effects and cumulative impacts from occurring on the sensitive freshwater ecosystems, it is the opinion of the freshwater specialist that the proposed development project may be authorised by the respective authorities.

DOCUMENT GUIDE

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

No.	Requirements	Section in report
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist.	Appendix J
2.2	Description of the preferred development site, including the following aspects-	-
2.2.1	a. Aquatic ecosystem type b. Presence of aquatic species and composition of aquatic species communities, their habitat, distribution and movement patterns.	Section 4.3 & 5
2.2.2	Threat status, according to the national web based environmental screening tool of the species and ecosystems, including listed ecosystems as well as locally important habitat types identified.	Section 3.1
2.2.3	National and Provincial priority status of the aquatic ecosystem (i.e. is this a wetland or river Freshwater Ecosystem Priority Area (FEPA), a FEPA sub- catchment, a Strategic Water Source Area (SWSA), a priority estuary, whether or not they are free-flowing rivers, wetland clusters, etc., a CBA or an ESA; including for all a description of the criteria for their given status.	Section 3.1
2.2.4	A description of the Ecological Importance and Sensitivity of the aquatic ecosystem including: a. The description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); b. The historic ecological condition (reference) as well as Present Ecological State (PES) of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel, flow regime (surface and groundwater).	Section 4.3 & 5
2.3	Identify any alternative development footprints within the preferred development site. which would be of a “low” sensitivity as identified by the national web based environmental screening tool and verified through the Initial Site Sensitivity Verification.	Section 6
2.4	Assessment of impacts - a detailed assessment of the potential impact(s) of the proposed development on the following very high sensitivity areas/ features:	Section 8
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Section 4 & 8
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	Section 4 & 8
2.4.3	How will the development impact on fixed and dynamic ecological processes that operate within or across the site, including: a. Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); b. Change in the sediment regime (e.g. sand movement, meandering river mouth/estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub-catchment; c. The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.). d. Assessment of the risks associated with water use/s and related activities.	Section 4 & 8
2.4.4	How will the development impact on the functionality of the aquatic feature including: a. Base flows (e.g. too little/too much water in terms of characteristics and requirements of system); b. Quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river);	Section 4 & 8

	c. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland); d. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); and e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal).	
2.4.5	How will the development impact on the functionality of the aquatic feature including: a. water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river); b. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland); c. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); d. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and e. The loss or degradation of all or part of any unique or important features (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soil, etc.) associated with or within the aquatic ecosystem.	Section 4 & 8
2.4.6	How will the development impact on key ecosystem regulating and supporting services especially Flood attenuation; Streamflow regulation; Sediment trapping; Phosphate assimilation; Nitrate assimilation; Toxicant assimilation; Erosion control; and Carbon storage.	Section 4 & 8
2.4.7	How will the development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 4 & 8
2.4.9	A motivation must be provided if there were development footprints identified as per paragraph 2.3 above that were identified as having a “low” biodiversity sensitivity and were not considered appropriate.	Section 6, Appendix H
3.	**The report must contain as a minimum the following information:**	
3.1	Contact details and curriculum vitae of the specialist including SACNASP registration number and field of expertise and their curriculum vitae.	Appendix J
3.2	A signed statement of independence by the specialist.	Appendix J
3.3	The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment.	Section 1 & 2
3.4	The methodology used to undertake the impact assessment and site inspection, including equipment and modelling used, where relevant.	Appendix C - E
3.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.4
3.6	Areas not suitable for development, to be avoided during construction and operation (where relevant).	Section 7, 8
3.7	Additional environmental impacts expected from the proposed development based on those already evident on the site and a discussion on the cumulative impacts.	Section 9
3.8	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted protocol.	Section 7
3.9	Impact management actions and impact management outcomes proposed by the specialist for inclusion in the EMPr.	Section 8
3.10	A motivation where the development footprint identified as per 2.3 were not considered stating reasons why these were not being considered.	Section 8
3.11	A reasoned opinion, based on the finding of the specialist assessment, regarding the acceptability or not, of the development and if the development should receive approval, and any conditions to which the statement is subjected.	Section 10

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GLOSSARY OF TERMS – FRESHWATER COMPONENT

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome - usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animals and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the outer boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Fluvial:	Resulting from water movement.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soil).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Land Type:	Distinct areas defined as part of the Land Type Survey of South Africa based on a unique combination of soil pattern, macroclimate and terrain form.
Perennial:	Flows all year round.
Redoximorphism:	Features within soil that are a result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation of the upper 50 cm of the soil from three to ten months of the year.
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50 cm of the surface for less than three months of the year
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soil, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

GLOSSARY OF TERMS – AQUATIC COMPONENT

Abbreviations and Acronyms	Full Form	Definition (Where Applicable)
DO	**Dissolved Oxygen**	Dissolved Oxygen is the amount of oxygen that is present in the water. It is measured in milligrams per litre (mg/L).
% DO sat	**Dissolved Oxygen Saturation**	In aquatic environments, oxygen saturation is a ratio of the concentration of dissolved oxygen in the water to the maximum amount of oxygen that will dissolve in the water at that temperature and pressure under stable equilibrium.
EC	**Electrical Conductivity**	Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current. This ability is a result of the presence in water of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge.
EIS	**Ecological Importance and Sensitivity**	Ecological importance refers to the diversity, rarity or uniqueness of the habitats and biota. Ecological sensitivity refers to the ability of the ecosystem to tolerate disturbances and to recover from certain impacts.
EWR	**Ecological Water Requirements**	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
mS/m	**Milisiemens per meter**	
PES	**Present Ecological State**	The current state or condition of a water resource in terms of its biophysical components (drivers) such as hydrology, geomorphology and water quality and biological responses viz. fish, invertebrates, riparian vegetation). The degree to which ecological conditions of an area have been modified from natural (reference) conditions.
RQIS	**Resource Quality Information Services**	RQIS provides national water resource managers with aquatic resource data, technical information, guidelines and procedures that support the strategic and operational requirements for assessment and protection of water resource quality.
SA RHP	**South African River Health Programme**	The RHP serves as a source of information regarding the overall ecological status of river ecosystems in South Africa. For this reason, the RHP primarily makes use of in-stream and riparian biological communities (e.g. fish, invertebrates, vegetation) to characterise the response of the aquatic environment to multiple disturbances.
SQR	**Sub-quaternary Reach**	A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments).
WMS	**Water Management System**	WMS is a suite of computer programmes developed for the Department of Water and Sanitation to provide information for water resource monitoring and management in South Africa.

***General Note:** The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, was used.

ACRONYMS

%	Percentage
°C	Degrees Celsius
AIP	Alien Invasive Plant
BAS	Best Attainable State
CBA	Critical Biodiversity Area
CVB	Channelled Valley Bottom
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
EO	Environmental Officer
EPL	Ecosystem Protection Level
ES	Ecological Sensitivity
ESA	Ecological Support Area
ETS	Ecosystem Threat Status
FEPA	Freshwater Ecosystem Priority Areas
GA	General Authorisation
GDARD	Gauteng Department of Agriculture and Rural Development
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
ha	hectare
HGM	Hydrogeomorphic
HSS	Hillslope Seep
IHI	Index of Habitat Integrity
km	Kilometres
m	Metre
m.a.m.s.l	Metres above mean sea level
mm	Millimetre
NBA	National Biodiversity Assessment
NDL	Non-Perennial Drainage Line
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
ONA	Other Natural Area
PES	Present Ecological State
RAM	Risk Assessment Matrix
REC	Recommended Ecological Category
RMO	Resource Management Objective
RQIS	Research Quality Information Services
RWQO	Resource Water Quality Objectives
SACNASP	South African Council for Natural Scientific Professions
SAIIAE	South African Inventory of Inland Aquatic Ecosystems
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services (Pty) Ltd
SQR	Sub quaternary catchment reach
subWMA	Sub-Water Management Area
SWMP	Stormwater Management Plan
SWSA	Strategic Water Source Area
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WUA	Water Use Authorisation
ZoR	Zone of Regulation

1 INTRODUCTION

1.1 *Background*

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Vorna Valley Spark School, in the Carlswald suburb of Midrand, Gauteng Province. The proposed development (henceforth referred to as the "study area") is located on the TLC Stables property. The proposed development is within an urban area where much of the land has been developed into residential properties. The M39 metropolitan route is approximately 377 m south of the study area, and the R55 provincial route is approximately 1 km west of the study area. To assess the possible impacts associated with the proposed project, a 500 m radius around the study area (hereafter referred to as the "investigation area") was used as the area beyond the study area boundaries within which regulated zones of freshwater ecosystems could occur, in accordance with Government Notice 4167 (GN 4167) of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended (NWA).

The proposed development consists of the following components:

- Buildings;
- Sports fields/Multisport areas;
- Swimming pool;
- Water tanks; and
- Roads and parking areas.

The sewer infrastructure for the proposed development will tie into the existing sewer line located on the property.

The locality, extent and components of the proposed development are illustrated in Figures 1-3 below.

This report, after consideration of the description of the ecological integrity of the freshwater and aquatic environment associated with the study area, must guide the Environmental Assessment Practitioner (EAP) and the relevant authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed activities in relation to the freshwater and aquatic ecosystems and guide the development of the final layout of the project.

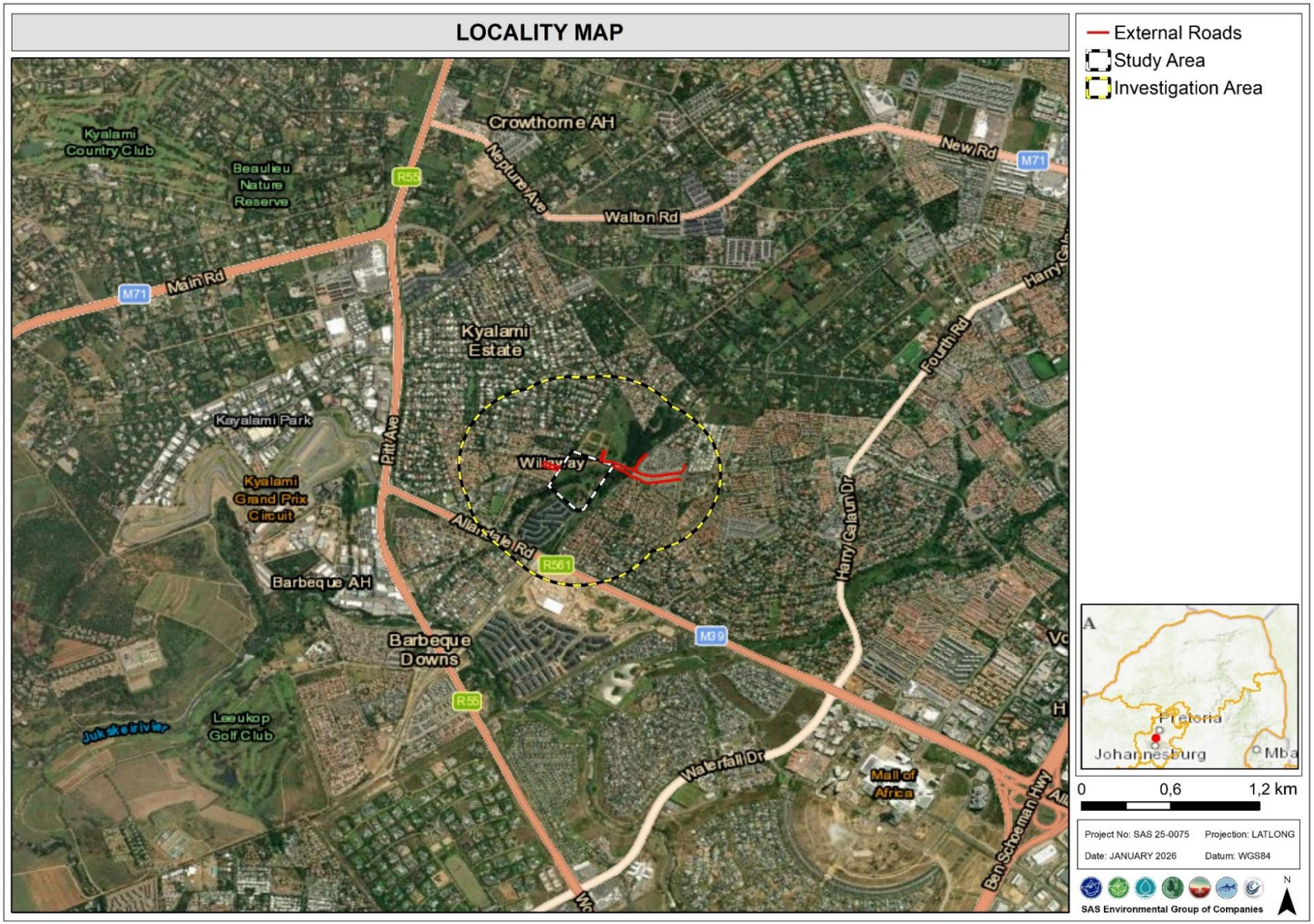


Figure 1: Digital satellite image depicting the location of the study area and the associated investigation area in relation to the surrounding area.

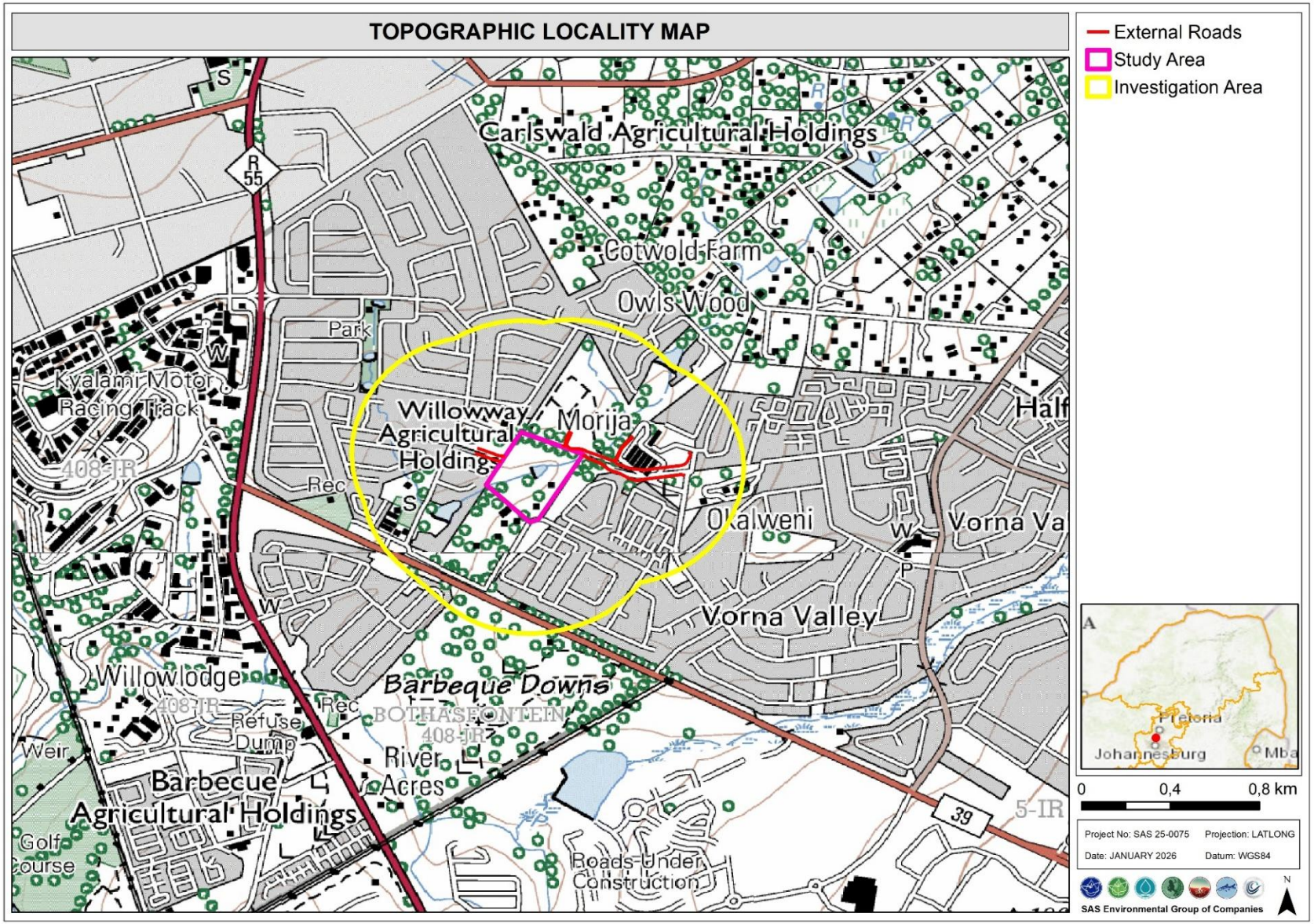


Figure 2: The study area and investigation area depicted on a topo-cadastal map in relation to the surrounding area.

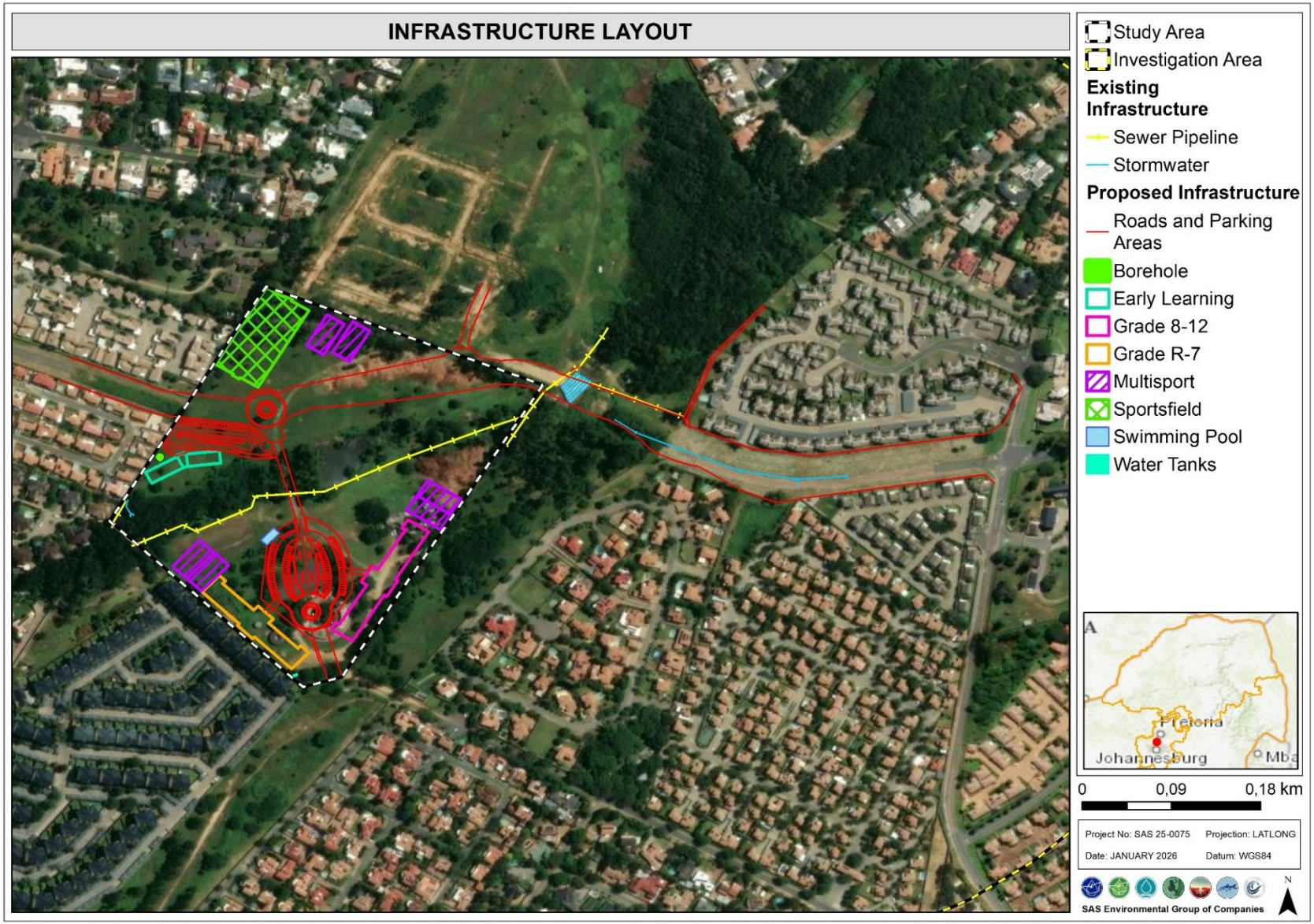


Figure 3: The proposed layout of the Vorna Valley school development.

1.2 *Scope of Work*

Specific outcomes in terms of this report are outlined below:

- A **background study** of relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas (NFEPA) 2011 database, the Department of Water and Sanitation Research Quality Information Services (DWS RQIS PES/EIS) (2014) database, National Biodiversity Assessment (NBA) 2018, and the Gauteng Conservation Plan (C-Plan, 2023), was undertaken to aid in defining the Present Ecological State (PES) and Ecosystem Importance and Sensitivity (EIS) of the relevant freshwater ecosystems;
- Freshwater ecosystems within the study area **were field-verified** at strategic points according to the "Department of Water Affairs and Forestry (DWAF)[1] (2008)[2]: A practical field procedure for identification of wetlands and riparian areas". Aspects such as soil morphological characteristics and wetness along with vegetation types were used to verify the freshwater ecosystems;
- Freshwater ecosystem extents associated with the **investigation area outside the study area were delineated using desktop methods** in accordance with GN 4167 of 2023 as it relates to activities as stipulated in the National Water Act, 1998 (Act No. 36 of 1998) as amended;
- **The freshwater ecosystems were mapped** according to hydrogeomorphic (HGM) units in relation to the landscape associated with the study and investigation areas;
- The **PES** of the freshwater ecosystems was assessed according to the Resource Directed Measures guideline as advocated by Macfarlane *et al.* (2008);
- The general habitat integrity of the drainage line system was assessed based on the application of the **Index of Habitat Integrity (IHI)**, based on the protocol of Kleynhans et al. (2008);
- Assessment of the riparian vegetation was performed using the **Riparian Vegetation Response Assessment Index (VEGRAI**), designed in such a way that qualitative ratings translate into quantitative and defensible results (Kleynhans et al., 2007b);
- The **EIS** of the freshwater ecosystems was determined according to the method described by Rountree and Kotze (2013);

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

- The **Ecoservices** of the freshwater ecosystems were assessed according to "A technique for rapidly assessing ecosystem services supplied by wetlands" (Kotze *et al.,* 2020);
- Allocation of a suitable **Recommended Management Objective (RMO), Recommended Ecological Category (REC) and Best Attainable State (BAS)** of the freshwater ecosystems was assigned based on the results obtained from the PES and EIS assessments;
- The freshwater ecosystem **legislated zones of regulation and ecological buffer areas** were depicted, where applicable;
- On-site testing of biota **specific water quality parameters** including pH, electrical conductivity (EC), dissolved oxygen concentration (DO) and temperature was undertaken. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF, 1996 volume 7) as well as the Resource Water Quality Objectives (RWQO) of South Africa. In addition, sampling for diatom communities was undertaken at the points where water quality parameters were recorded as an additional indicator of water quality;
- The Department of Water and Sanitation (DWS) **Risk Assessment Matrix (RAM)** (2023) was applied to identify potential impacts that may affect the freshwater ecosystems as a result of the proposed development, and to aim to quantify the significance thereof; and
- **Management and mitigation measures** are presented that must be implemented during the various development phases to assist in minimising the impact of the proposed development on the receiving freshwater environment.

1.3 *Assumptions and Limitations*

The following assumptions and limitations are applicable to this report:

- The site assessment was conducted in June (mid-winter, dry season), and therefore during the dormant phase of most plants in the area. This placed a constraint on the assessment of the vegetation component of the system, particularly in terms of species composition and the ecological state thereof, and aspects such as the level of Alien Invasive Plant (AIP) proliferation. Furthermore, there were some constraints with regard to the use of vegetation for the delineation process of the wetlands in some areas, and greater reliance was placed on soil characteristics as an indicator of seasonally or temporarily saturated soil;
- The freshwater ecosystems associated with the study area were ground-truthed, however freshwater ecosystems within 500 m of the study area (within the investigation area) were delineated in fulfilment of GN 4167 of the NWA using various

desktop methods including use of topographic maps, historical and current digital satellite imagery and aerial photographs. Desk based delineations were ground-truthed where feasible. The delineations of freshwater ecosystems outside the study area may not be utilised for any purpose, other than a baseline assessment. Any areas that may have additionally been mapped (within the investigation area) will require field-based delineation and ground-truthing as directed by applicable legislation and best practice methods;

- It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics associated with the proposed projects at the scale required to inform the EA and WUA processes. However, this information is considered to be useful as background information to the study;
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required, the freshwater ecosystems will need to be surveyed and pegged according to surveying principles and with surveying equipment;
- Wetland, riparian, and terrestrial zones create transitional areas where an ecotone is formed as floral species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater ecosystem boundaries may occur. However, if the DWAF (2008) method is followed, all assessors should get largely similar results;
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. It is, however, expected that the relevant freshwater ecosystems have been assessed as accurately as possible and considered, based on the site observations undertaken in terms of freshwater ecosystem ecology;
- The composition of aquatic biota in proximity to the proposed project prior to major disturbance, is largely unknown. The study area and surrounding areas are dominated by transformed urban landscapes. For this reason, reference conditions are hypothetical and are based on professional judgement and/or inferred from limited data available (such as the DWS RQIS PES/EIS database);
- To ensure that our turnaround time meets expectations, diatom analysis and identification is done on “live” diatom samples. There are no limitations through the use of “live” samples with accurate analysis and identification of samples, and as such, results presented in this report are considered accurate. There is no substantial impact on the validity of the final conclusions drawn in this report.

2 ASSESSMENT APPROACH

2.1 *Freshwater Ecosystem definition*

The National Water Act, 1998 (Act No. 36 of 1998), as amended is aimed at the protection of the country's water resources, defined in the Act as "a watercourse, surface water, estuary or aquifer". According to the National Water Act, 1998 (Act No. 36 of 1998) a **watercourse** means:

(a) a river or spring;

(b) a natural channel in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the *Gazette,* declare a watercourse.

It should be noted that in this report "freshwater ecosystem" is used and carries the same meaning as "watercourse" as defined by the NWA.

The Act further provides definitions of wetland and riparian habitats as follows:

Wetland habitat is "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

Riparian habitat includes "the physical structure and associated vegetation of areas associated with a freshwater ecosystem which are commonly characterised by alluvial soil, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas".

2.2 *Freshwater Ecosystem Field verification*

A field assessment was undertaken for the freshwater assessment on the 19th of June 2025 (mid-winter, dry season), during which the presence of any freshwater ecosystem characteristics as defined by the DWAF (2008) and the NWA (1998) were noted (please refer to Section 4 of this report).

As far as possible, the freshwater ecosystem delineation took place according to the methods presented in the “Updated manual for the identification and delineation of wetland and riparian resources” (DWAF, 2008). The foundation of the method is based on the fact that freshwater ecosystems have several distinguishing factors including the following:

- Landscape position;
- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils; and
- Vegetation adapted to saturated soils.

In addition to the delineation process, a detailed assessment of the delineated freshwater ecosystems was undertaken. Factors affecting the integrity of the freshwater ecosystems were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the freshwater ecosystems. A detailed explanation of the methods of assessment undertaken is provided in **Appendix C** of this report.

2.3 *Sensitivity Mapping*

All freshwater ecosystems associated with the proposed development were delineated with the use of a Global Positioning System (GPS). Geographic Information System (GIS) software was used to project these features onto aerial imagery and topographic maps. The sensitivity maps presented in Sections 4 and 7 should guide the design, layout and management of the proposed development.

2.4 *Risk Assessment and Recommendations*

Following the completion of the site assessment, the DWS Risk Assessment was conducted (please refer to **Appendix E** for the methods of approach) and recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures, which apply to the proposed construction and operational activities. Mitigation measures have been developed to address issues in all phases throughout the life of the proposed development including planning, construction, and operation.

3 RESULTS OF THE DESKTOP ANALYSIS

3.1 *Analyses of Relevant Databases*

The following section contains data accessed as part of the desktop assessment and are presented as a “dashboard” report below (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible to allow for integration of results by the reader to take place. Where required, further discussion and interpretation is provided, and information that was considered of importance was emboldened. It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics of the study area at the scale required to inform the EA and WUA processes. Nevertheless, this information is considered useful as background information to the study, is important in legislative contextualisation of risk and impact, and thus was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance.

It must be noted that site assessment of key areas may potentially contradict the information contained in the relevant databases. In such cases, the site verified information must carry more weight in the decision-making process. The information contained in the dashboard report below is intended to provide background to the landscape of the study area. Actual site conditions at the time of the assessment may differ to the background information provided by various datasets. Please refer to **Section 4** for details pertaining to the site investigation.

Table 1: Desktop data indicating the characteristics of the freshwater ecosystems associated with the study area and investigation area [(Quarter Degree Squares (Quarter Degree Squares 2528CC & 2628AA).

Aquatic ecoregion and sub-regions in which the study area is located	
Ecoregion	Highveld
Catchment	Limpopo
Quaternary Catchment	A21C
WMA	Crocodile (West) and Marico
subWMA	Upper Crocodile
Characteristics of the Highveld Ecoregion Level II (Kleynhans *et al.*, 2007)	
Level II Code	11.01
Dominant primary terrain morphology	Plains
Dominant primary vegetation types	Rocky Highveld Grassland, Mixed Bushveld
Altitude (m a.m.s.l)	1300 to 1900
MAP (mm)	500 to 700
The coefficient of Variation	20 to 34
Rainfall concentration index	55 to 64
Rainfall seasonality	Early to mid-summer
Mean annual temp. (°C)	14 to 18
Winter temperature (July)	0 to 20
Summer temperature (Feb)	12 to 30
Median simulated runoff (mm)	20 to 60
Ecological Status of the proximal sub-quaternary reach (DWS, 2014)	
Sub-quaternary reach	A21C – 01232 (Jukskei River)
Point Distance from the study area	± 2.1 km south of the study area
Assessed by an expert?	Yes
PES Category Median	Seriously Modified (Class E)
Mean EI Class	Low
Mean ES Class	Moderate
Stream Order	2
Default Ecological Class	Moderate (C)
DWS Gauteng Rivers Database (2021)	
The database indicates three non-perennial tributaries of the Jukskei River traversing the investigation area, one of which traverses the study area. Two tributaries are within a developed landscape; this this is where the river passes through a landscape that is generally transformed. The other tributary west of the study area is in a historical landscape which are rivers that would have occurred if they had not been developed over.	
National web-based Environmental Screening Tool (2020, Accessed 2025) (Figure 6)	

Detail in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) Database	
FEPACODE	The entire study area and associated investigation area are located within an **Upstream Management Areas Catchment (Code 4).** Upstream Management Areas are sub-quaternary catchments in which human activities need to be managed to prevent degradation of downstream river FEPAs and Fish Support Areas.
NFEPA Wetlands (Figure 4)	According to the NFEPA Database, a channelled valley bottom (CVB) wetland is indicated within the study area and another west and north east of the study area within the investigation area. All wetlands are indicated as Heavily to Critically Modified (Class Z).
Wetland Vegetation (Wetveg) Type	The entire study area and investigation area are situated within the Mesic Highveld Grassland Group 3 WetVeg Group, indicated as Least Threatened (LT) by Mbona *et al.* (2015).
NFEPA Rivers	As per the NFEPA database, no rivers flow within the study area or the associated investigation area.
National Biodiversity Assessment (2018): South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (including the draft National Wetland Map 6 (2024)) – Condition is based on Map 5 (2018) (Figure 5).	
According to the NBA 2018: SAIIAE Rivers Database, no rivers flow within the study area or the investigation area. The Draft National Wetland Map 6 database indicates a CVB wetland to traverse the study area and investigation area. Two seep wetlands adjacent to the CVB wetland, east and north of the study area are also indicated by the database. An unchannelled valley bottom (UCVB) wetland is indicated to flow west of the study area within the investigation area. The CVB that traverses the study area, the UCVB west of the study area, and the eastern seep that also traverses the study area are indicated by the database as Largely to Critically Modified (Present Ecological State [PES]: D/E/F). The northern seep is indicated as Moderately Modified (PES C). All the wetlands are indicated as Critically Endangered in terms of its Ecological Threat Status (ETS). The CVB and UCVB wetlands are Not Protected while the seep wetlands are Poorly Protected in terms of their Ecological Protection Level (EPL). According to the Artificial Wetlands Database, two dams are indicated to overlay the CVB wetland traversing the investigation area. One of the dams is within the study area.	
Strategic Water Source Areas (SWSA) (2017 & 2021)	
Surface water SWSAs are defined as areas of land that supply a disproportionate (i.e., relatively large) quantity of mean annual surface water runoff in relation to their size. The SWSA for groundwater reflect areas that have high groundwater recharge and where the groundwater forms a nationally important resource. The database developed jointly by the Mpumalanga Tourism and Parks Agency (MTPA) and the Council for Scientific and Industrial Research (CSIR) (Lötter, M.C. and Le Maitre, D., 2021) was consulted for surface water, while the Water Research Commission (WRC) developed database (Le Maitre, D.C. *et al*., 2017) was consulted for the groundwater SWSAs.	
The study area and its associated investigation area are not indicated to be within a surface water or groundwater Strategic Water Source Area.	

The screening tool is intended for the pre-screening of sensitivities in the landscape to be assessed within the EIA process. This assists with implementing the migration hierarchy by allowing developers to adjust their proposed development footprint to avoid sensitive areas.	
The section of the study area and investigation area associated with rivers and wetlands (per NBA National Wetland Map 6; and the CPLAN Buffers) are indicated by the Screening Tool to be in an area considered to be of **Very High aquatic biodiversity sensitivity** while the remaining extents of the study area and investigation area are indicated to be of **low aquatic biodiversity sensitivity**. The triggering features for the very high sensitivity within the study area and investigation area are due to the presence of **wetlands** (seep and Valley-bottom wetlands).	
Detail of the Assessment area in terms of Land Type Data (Job et al., 2019) (Figure 7)	
The study area is within the **Bb2 landtype** while the investigation area is located within the **Bb1 and Bb2 land types**. In Bb Land Types dystrophic yellow-brown and grey soils are widespread. Ba and Bb Land Types are generally located in the eastern and central interior basins. A very large part of the South African interior is occupied by a catena in its perfect form represented by Hutton, Avalon, Bainsvlei, and Longlands soil forms. Glencoe, Wasbank, Westleigh and occasionally Tambankulu and Mispah (Hillside and Klipfontein series; or Dresden 1991 classification) plinthic soils are also present. Plinthic soils occupy at least 10% of the landscape. Where sedimentary rocks dominate the underlying geology, Pinedene and Kroonstad occupy lower slope positions, while Katspruit soil forms and streambeds are present in stable bottomland terrain positions. Duplex soils of the Valsrivier and Sterkspruit forms and alluvium (Dundee and Oakleaf forms) are dominant in many less stable bottomland sites. In addition, where basic igneous rocks are widespread, black clay soils of the Rensburg, Willowbrook and Bonheim soils also occupy bottomland positions. Mispah, Glenrosa and rock land are also common features of the landscape. Margalitic soils refers to black clays of the Rensburg, Arcadia, Willowbrook, Bonheim, Tambankulu, Mayo and Milkwood soil forms.	
Detail of the study area in terms of the Gauteng Conservation Plan (C-Plan, 2023) (Figure 8)	
Critical Biodiversity Area (CBA)	The database indicates the study area and portions of the investigation area in the north and south as Irreplaceable CBA 1 site. The rest of the study area and investigation area are not classed. They were determined as irreplaceable status areas through the MARXAN Mean Summed Solution and MARXAN Summed Best Solution analysis, Gauteng ecological corridor network 2023, ridges, and Aquatic Ecosystem Life Zones Biodiversity and Land Cover Criteria. CBAs are areas included in the C-Plan Map because of their biodiversity importance and contribution to achieving conservation targets. They should be maintained in a natural state, with no further loss of habitat and no deterioration in ecological condition. **CBA1: Irreplaceable Sites**: Mandatory sites required to meet conservation targets where there are no other options to meet these targets (i.e., the remaining extent of the biodiversity feature is at or less than the conservation target). Typically, CBA1 sites include Critically Endangered and Endangered Ecosystems and known populations of threatened species.
Detail of the study area in terms of the Gauteng Conservation Plan Buffers (Figure 9)	
Wetland and River Buffers	The database indicates three non-perennial river buffer tributaries of the Jukskei River traversing the study area and the investigation area, one of which traverses the study area. The wetland buffer database indicates wetland features traversing the study area and investigation area along the non-perennial rivers. The database also indicates three waterbodies (artificial features) overlain wetland feature traversing the study area.
Gauteng Environmental Management Framework (GEMF, 2021)	
The study area and half of the investigation area are within **Zone 1: Urban Zone** except the freshwater ecosystems which are indicated within **Zone 2: High Control Zone (Inside Urban Boundary).** **Zone 1 (Urban Zone):** The intention of this zone is to streamline urban development activities in it and to promote development infill, densification, and concentration of urban development in order to establish a more effective and efficient city region that will minimise urban sprawl into rural areas. **Zone 2 (High Control Zone Inside Urban Boundary Zone 1):** This zone is sensitive to development activities. Only conservation should be allowed in this zone. Related tourism and recreation activities must be accommodated in areas surrounding this zone.	

CBA = Critical Biodiversity Area; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; GEMF = Gauteng Environmental Management Framework; m.a.m.s.l = Metres Above Mean Sea Level; MAP = Mean Annual Precipitation; mm = millimetres; MTPA = Mpumalanga Tourism and Parks Agency; NBA = National Biodiversity Assessment; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State; SAIIAE = South African Inventory of Inland Aquatic Ecosystems; SWSA = Strategic Water Source Area; WMA = Water Management Area; WRC = Water Resource Commission.

Figure 4: Wetlands associated with the study area and associated investigation area according to the National Freshwater Ecosystems Priority Areas (2011).

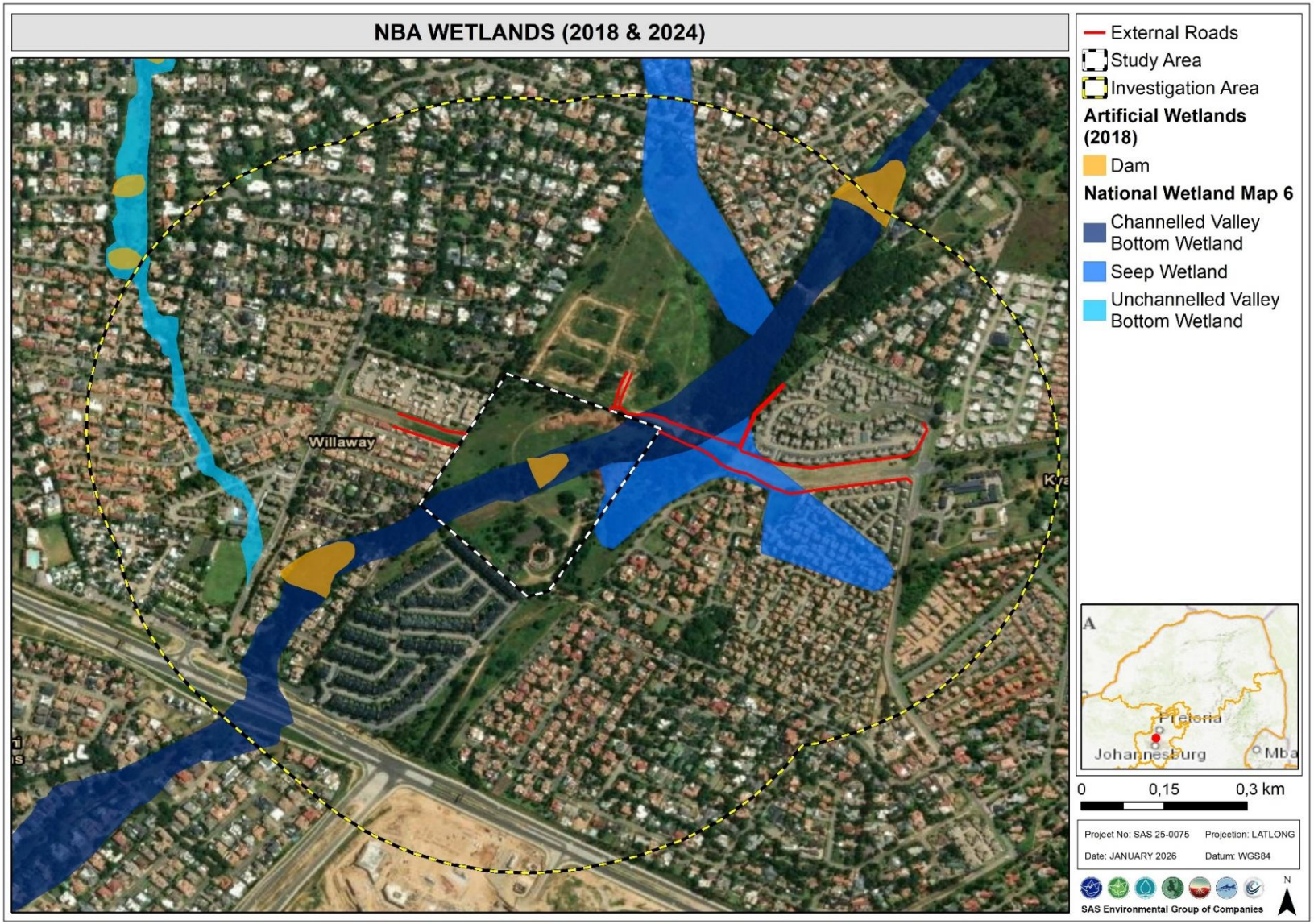


Figure 5: Wetlands and rivers associated with the study area and associated investigation area according to the National Biodiversity Assessment databases (2018 and 2024).

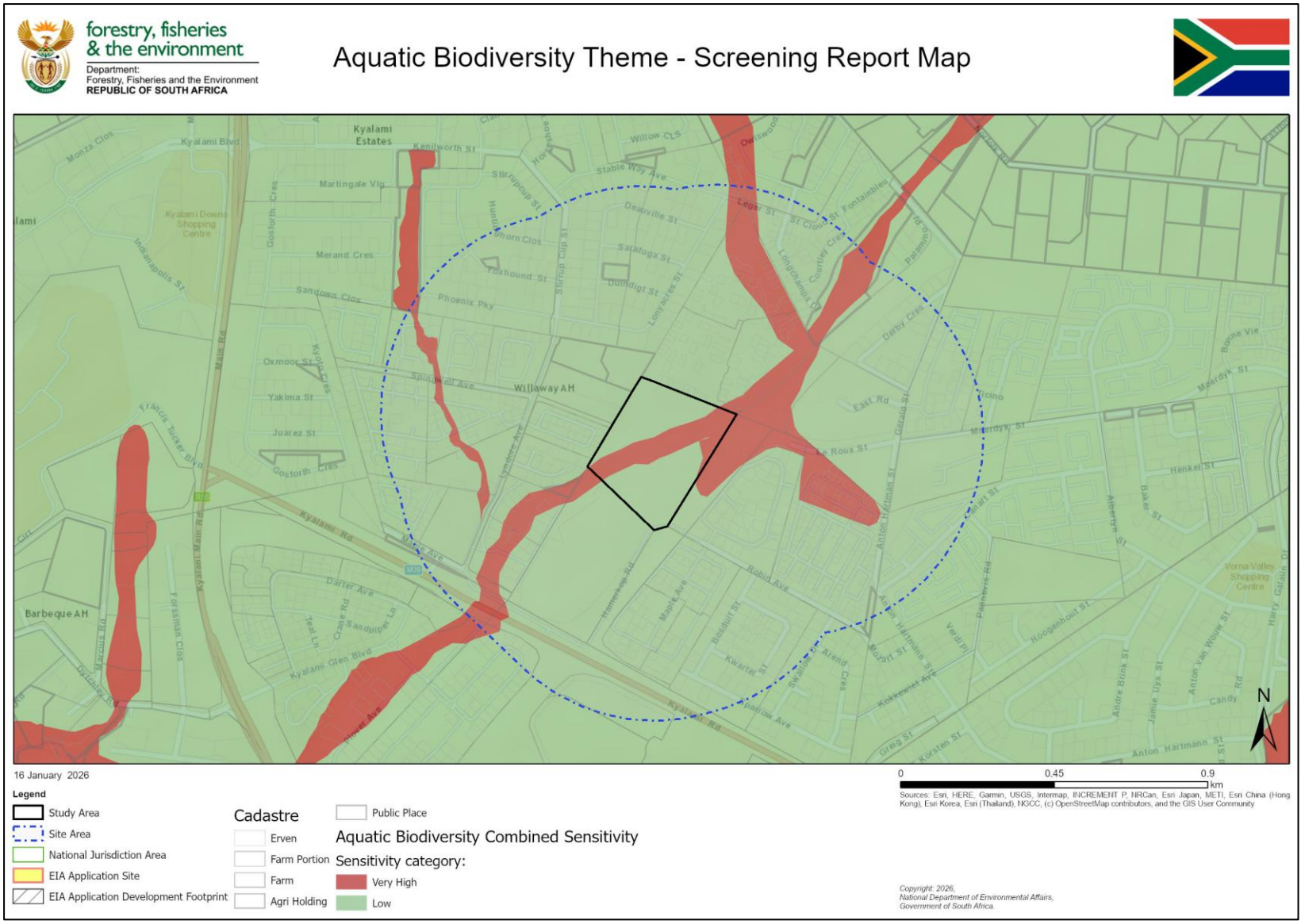


Figure 6: Aquatic Biodiversity Sensitivity of the study areas (black outline) and investigation area (blue dashed line) (Screening Tool: Accessed 2025).

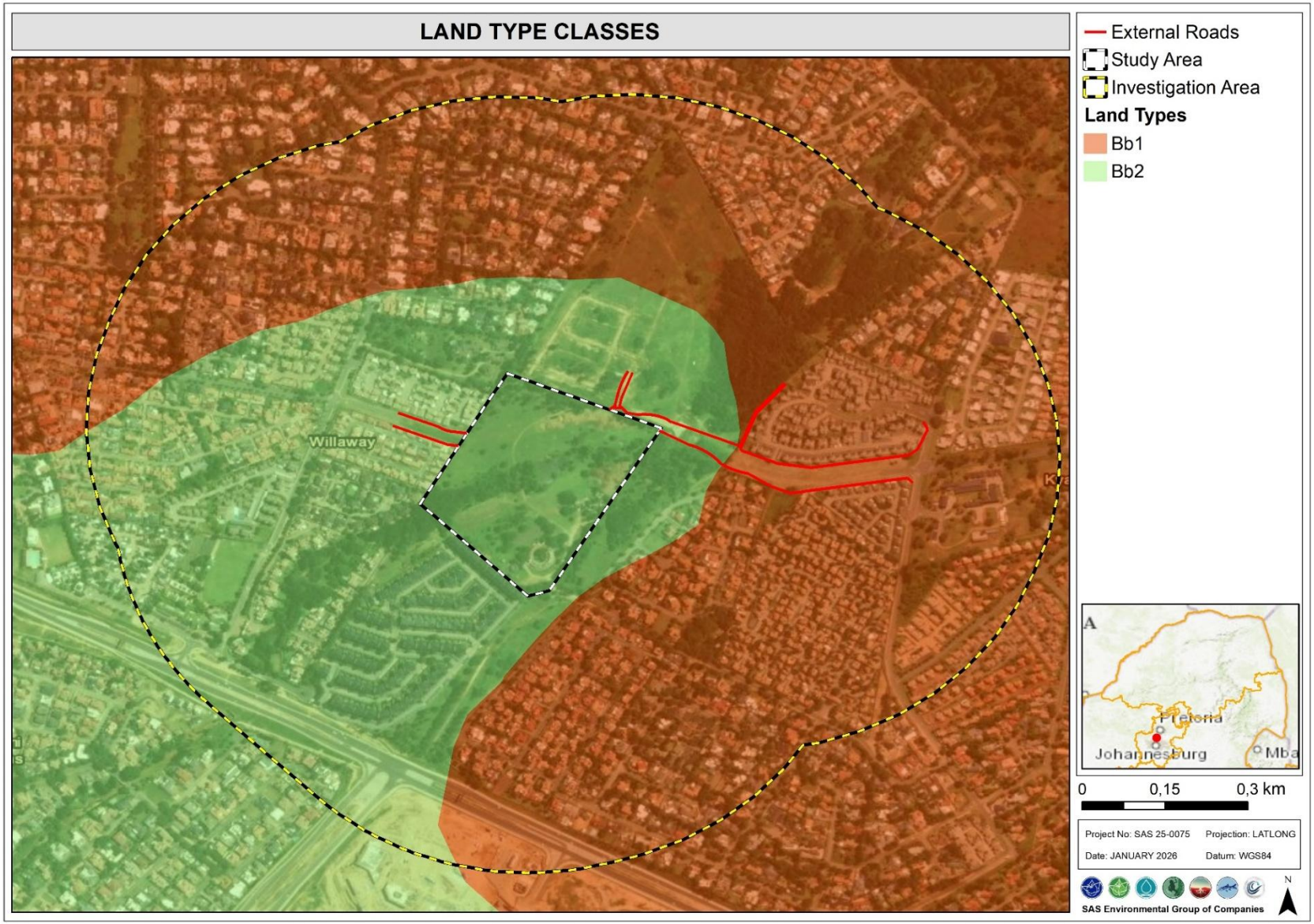


Figure 7: Land type classes associated with the study area and associated investigation area according to the Land type database.

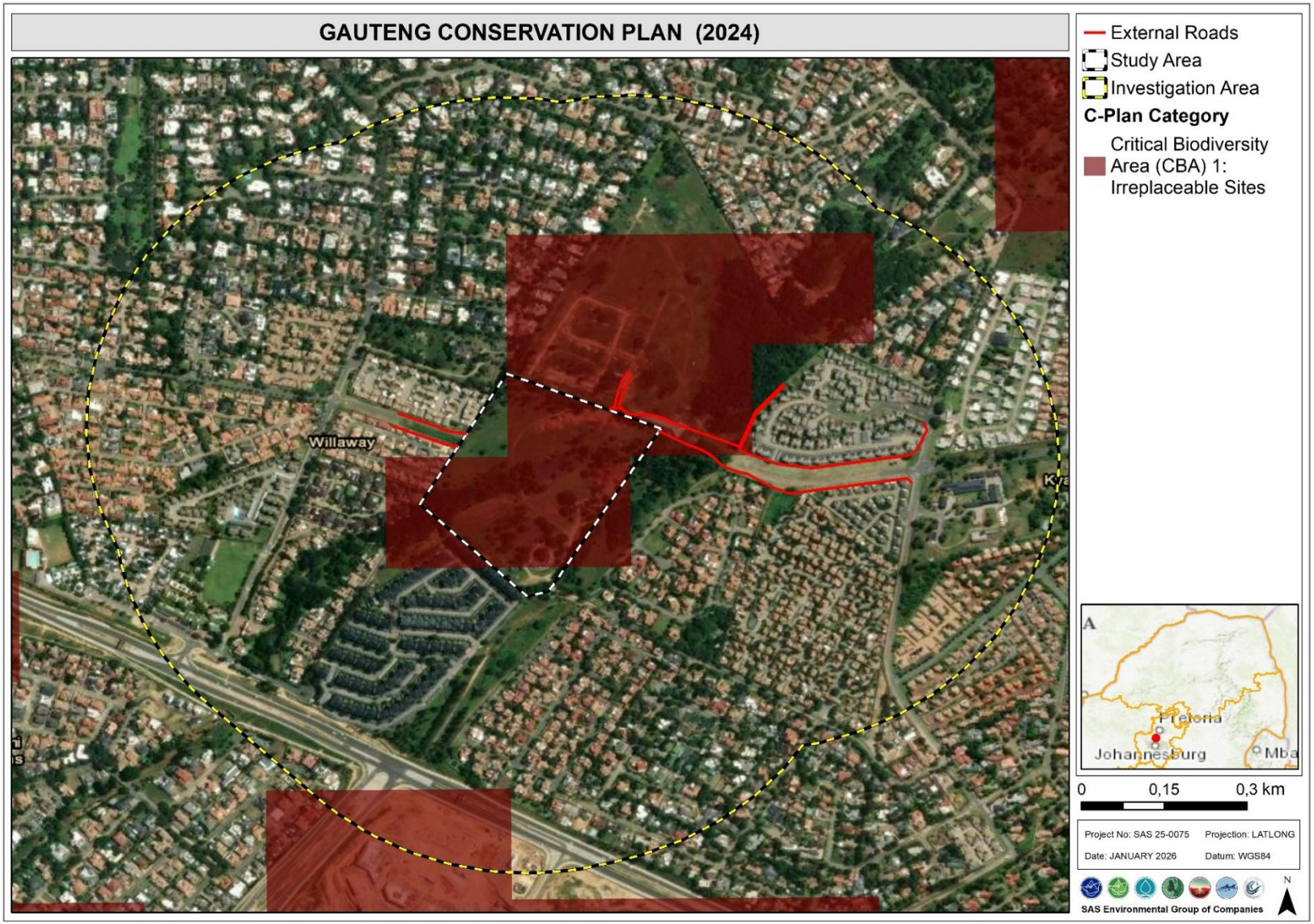


Figure 8: Important biodiversity areas associated with the study area and associated investigation area in terms of the Gauteng Conservation Plan (C-Plan, 2023).

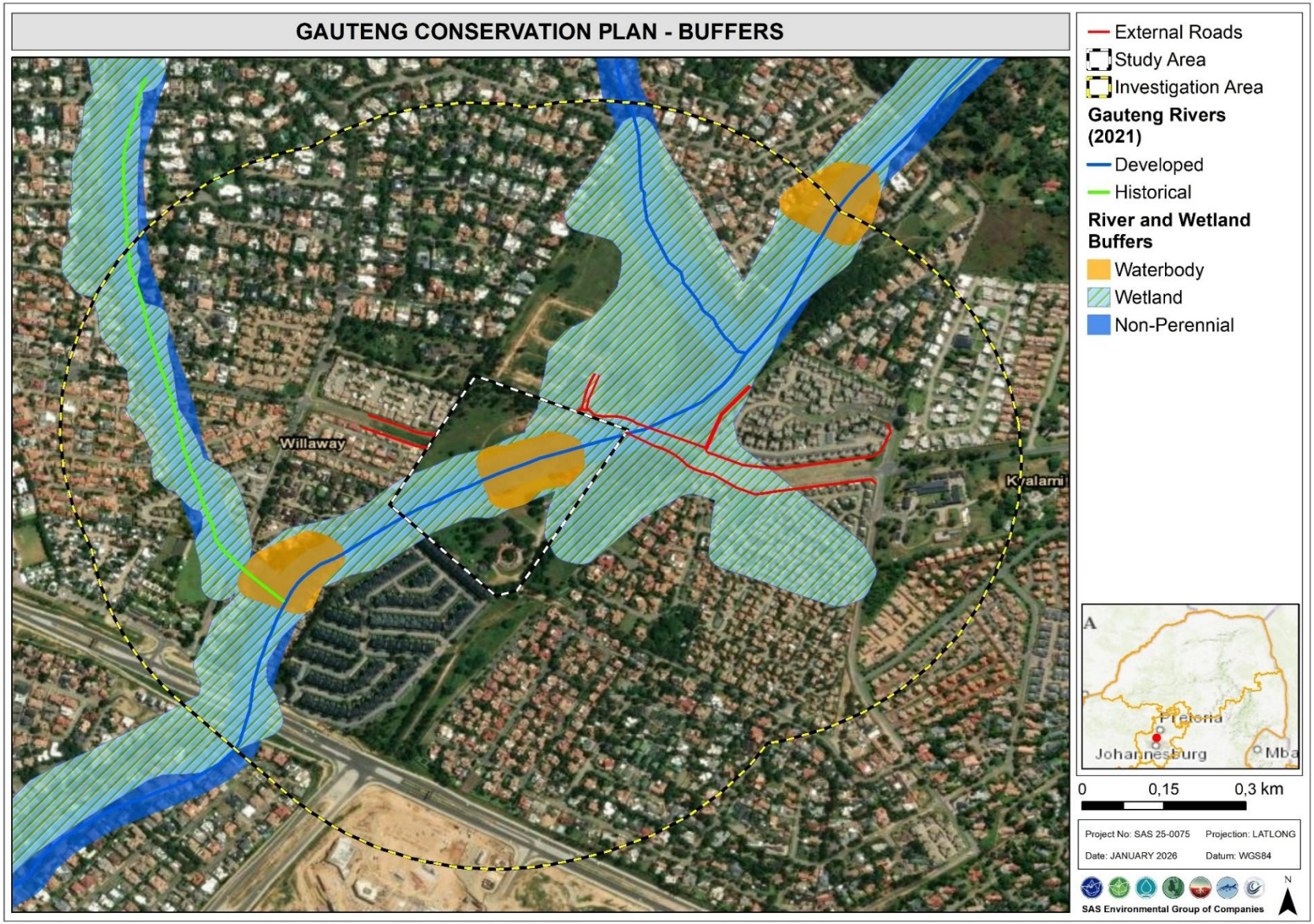


Figure 9: Detail of the study area in terms of the Gauteng Conservation Plan Buffers.

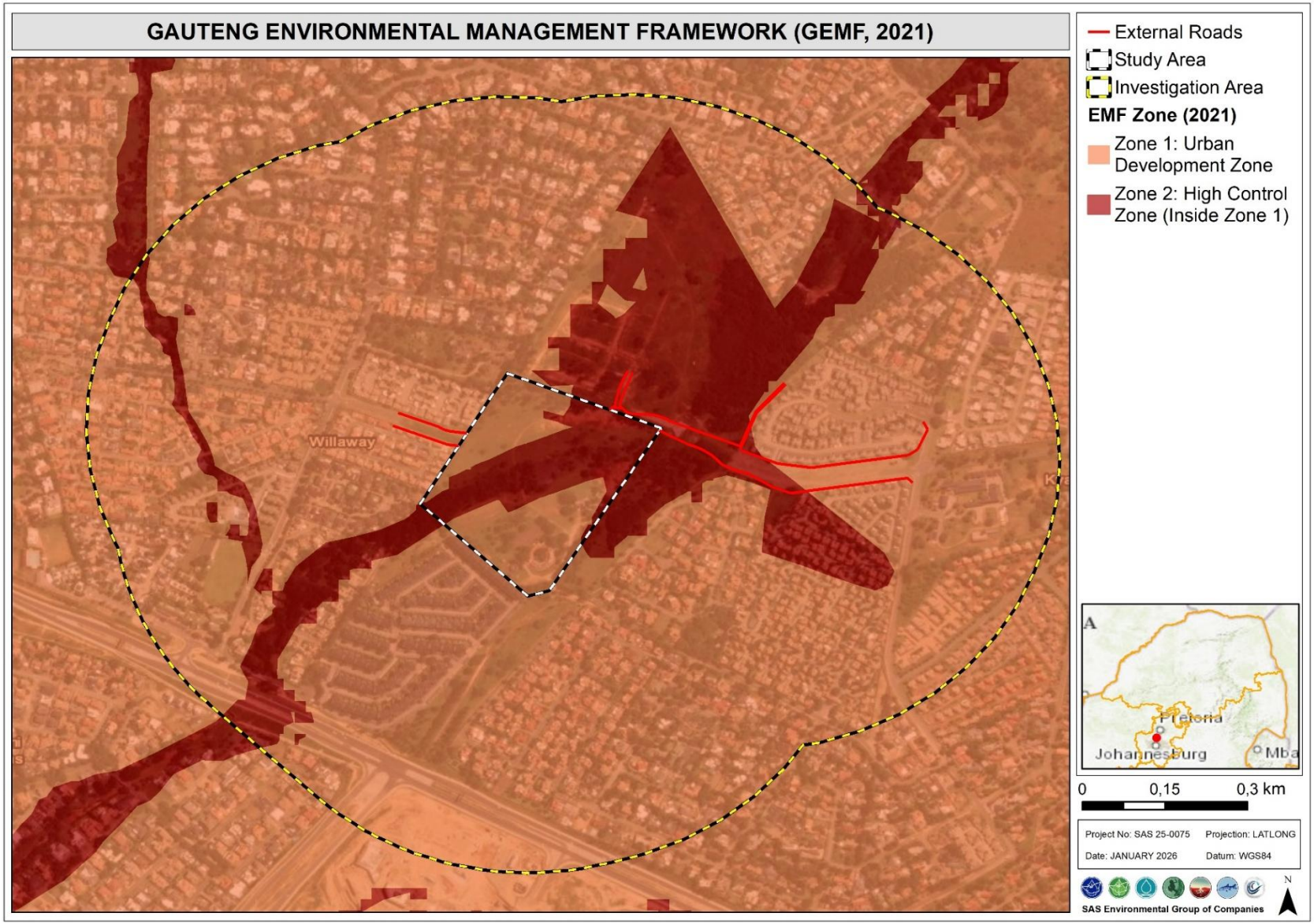


Figure 10: Detail of the study area in terms of the Gauteng Environmental Management Framework (GEMF, 2021).

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

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

The study area falls within the Highveld Ecoregion and is within the A21C – 01232 (Jukskei River) quaternary catchment. According to the PES/EIS database, as developed by the DWS RQIS department, the Sub-Quaternary Catchment Reach (SQR) for the A21C – 01232 (Figure 12) is applicable; although the SQR monitoring point is located approximately 2.1 km south of the study area, the freshwater ecosystems within the study area drain to the Jukskei River, thus, the potential for indirect, cumulative impacts on the river as a result of the proposed development are marginally increased. Key information on background conditions associated with the study area as contained in this database and pertaining to the PES and EIS for the reach is indicated in the tables below.

The following aquatic macro-invertebrate taxa have previously been reported from A21C – 01232 (Jukskei River):

Aeshnidae	Dytiscidae	Notonectidae
Ancylidae	Gerridae	Oligochaeta
Baetidae 1 Sp	Gomphidae	Physidae
Belostomatidae	Gyrinidae	Potamonautidae
Caenidae	Hirudinea	Simuliidae
Ceratopogonidae	Hydropsychidae 1 Sp	Tabanidae T
Chironomidae	Ipulidae	Turbellaria
Coenagrionidae	Libellulidae	Veliidae/Mesoveliidae
Corixidae		

The following aquatic fish species have previously been reported from SQR A21C – 01232 (Jukskei River):

Clarias gariepinus	*Tilapia sparrmanii*	*Pseudocrenilabrus philander*

Table 2: Summary of the ecological status of the sub-quaternary (SQ) catchment reach associated with the freshwater ecosystems in the proximity of the study area based on the DWS RQS PES/EIS database.

Ecological status	A21C – 01232 (Jukskei River)
Synopsis	
PES Category Median	Seriously Modified (E)
Mean EI[3] class	Low
Mean ES[4] class	Moderate
Length (km)	10.17
Stream order	2
Default EC[5]	Moderate (Class C)
PES[6] Details	
Instream habitat continuity MOD[7]	Serious
RIP/wetland zone continuity MOD	Large
Potential instream habitat MOD	Serious
Riparian/wetland zone MOD	Serious
Potential flow MOD activities	Serious
Potential physico-chemical MOD	Critical
EI Details	
Fish spp/SQ	3.00
Fish average confidence	1.00
Fish representivity per secondary class	Very Low
Fish rarity per secondary class	Very Low
Invertebrate taxa/SQ	25.00
Invertebrate average confidence	2.76
Invertebrate representivity per secondary class	Low
Invertebrate rarity per secondary class	Very Low
EI importance: riparian-wetland-instream vertebrates (excluding fish)	Low
Habitat diversity class	Moderate
Habitat size (length) class	Very Low
Instream migration link class	Low
Riparian-wetland zone migration link	Moderate
Riparian-wetland zone habitat integrity class	Low
Instream habitat integrity class	Low
Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m	Moderate
Riparian-wetland natural vegetation rating based on expert rating	High
ES Details	
Fish physical-chemical sensitivity description	Low
Fish no-flow sensitivity	Low
Invertebrates physical-chemical sensitivity description	Moderate
Invertebrates velocity sensitivity	Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	Low
Stream size sensitivity to modified flow/water level changes description	Low
Riparian-wetland vegetation intolerance to water level changes description	High

[5] EC = Ecological Category; default based on median PES and highest of EI or ES means
[6] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors
[3] ES = Ecological Sensitivity[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.
[7] MOD = Modification

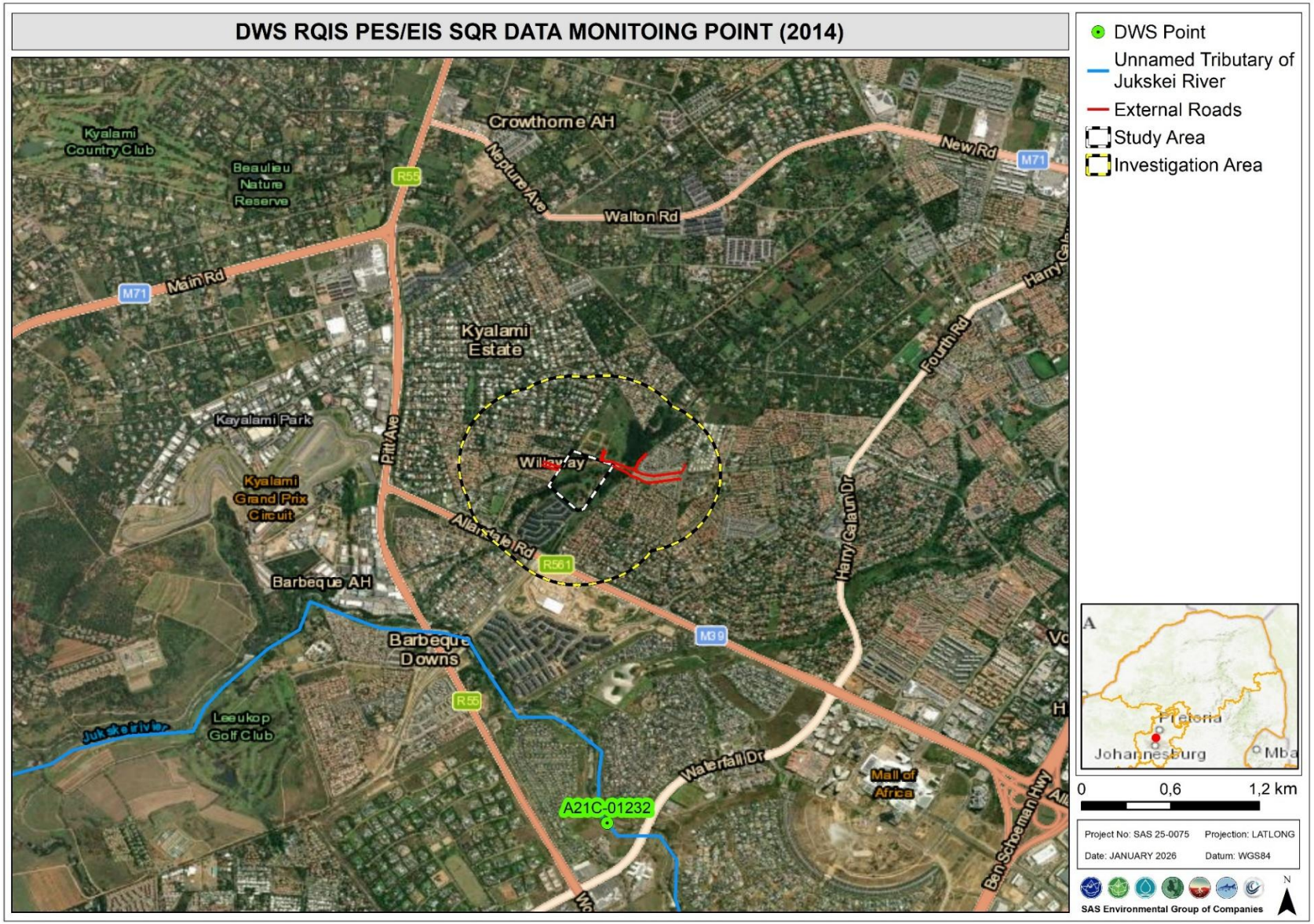


Figure 11: The DWS RQIS PES/EIS monitoring points associated with the study area and investigation area.

4 RESULTS: FRESHWATER ECOSYSTEM ASSESSMENT

4.1 *Freshwater Ecosystem Characterisation*

The site assessment confirmed the presence of a number of freshwater HGM units located within the study area and the associated investigation area, which included:

- One Channelled Valley Bottom (CVB) wetland;
- One Hillslope Seep (HSS) wetland; and
- One Non-Perennial Drainage Line (NDL), i.e. a tributary of the Jukskei River.

The identified freshwater ecosystems (depicted in Figures 12 and 13 overleaf) were classified according to the Classification System (Ollis *et al.*, 2013) as Inland Systems. The freshwater ecosystems fall within the Mesic Highveld Grassland Group 3 WetVeg Group, classified by Mbona *et al.* (2015) as "Least Threatened". At Levels 3 (Landscape Unit) and 4 (HGM Type) of the Classification System, the systems were classified as per the summary in Table 3, below.

Table 3: Characterisation at Levels 3 and 4 of the Classification System (Ollis *et al*., 2013) of the freshwater ecosystems associated with the study and associated investigation area.

Freshwater Ecosystems	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) Type
Channelled Valley Bottom (CVB) wetland	Valley floor – the base of a valley, situated between two distinct valley side slopes, where alluvial or fluvial processes typically dominate.	**Channelled valley bottom:** A valley bottom wetland with a river channel running through it.
Hillslope Seep (HSS) wetland	Slope – an inclined stretch of ground typically located on the side of a mountain, hill or valley, not forming part of a valley floor. Includes scarp slopes, midslopes and footslopes.	**Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley, but they do not, typically, extend into a valley floor. (Includes seep wetlands with channelled outflow).
Tributary of the Jukskei River (Non-Perennial Drainage Line)	**Valley floor:** The base of a valley, situated between two distinct valley side-slopes.	A description for this classification is not contained in Ollis *et al*. 2013, thus the following definition is utilised: **River** - Linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit. A non-perennial drainage line may be either semi-permanent, ephemeral or episodic (Rossouw *et al.* 2005)[8]; the NDL associated with the study area can be characterised as a semi-permanent system as follows: • **Semi-permanent systems** flow intermittently, for at least nine months of the year. Flow is absent for between 1%-25% of the year.

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

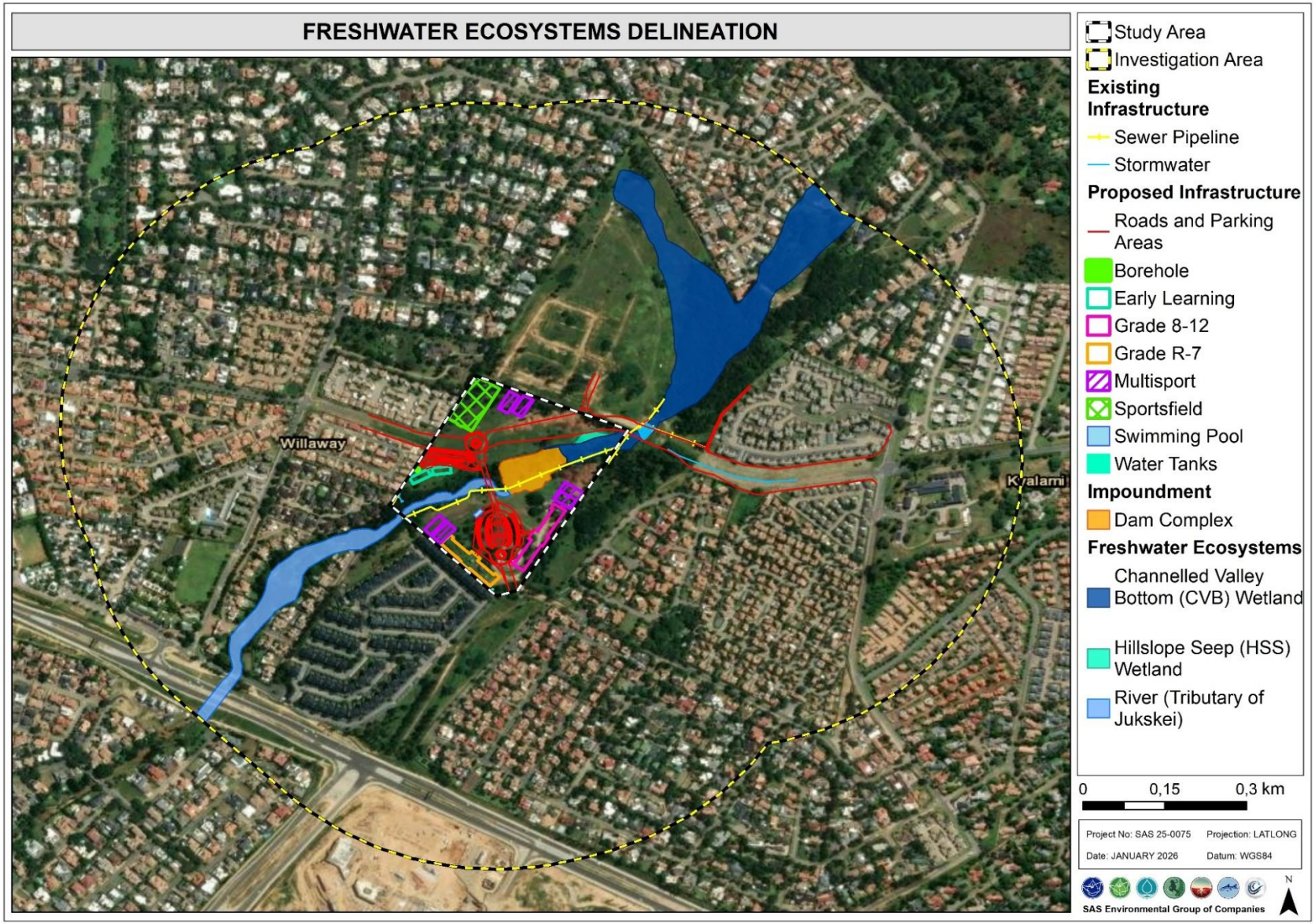


Figure 12: Overview of the field verified freshwater ecosystems in the investigation area.

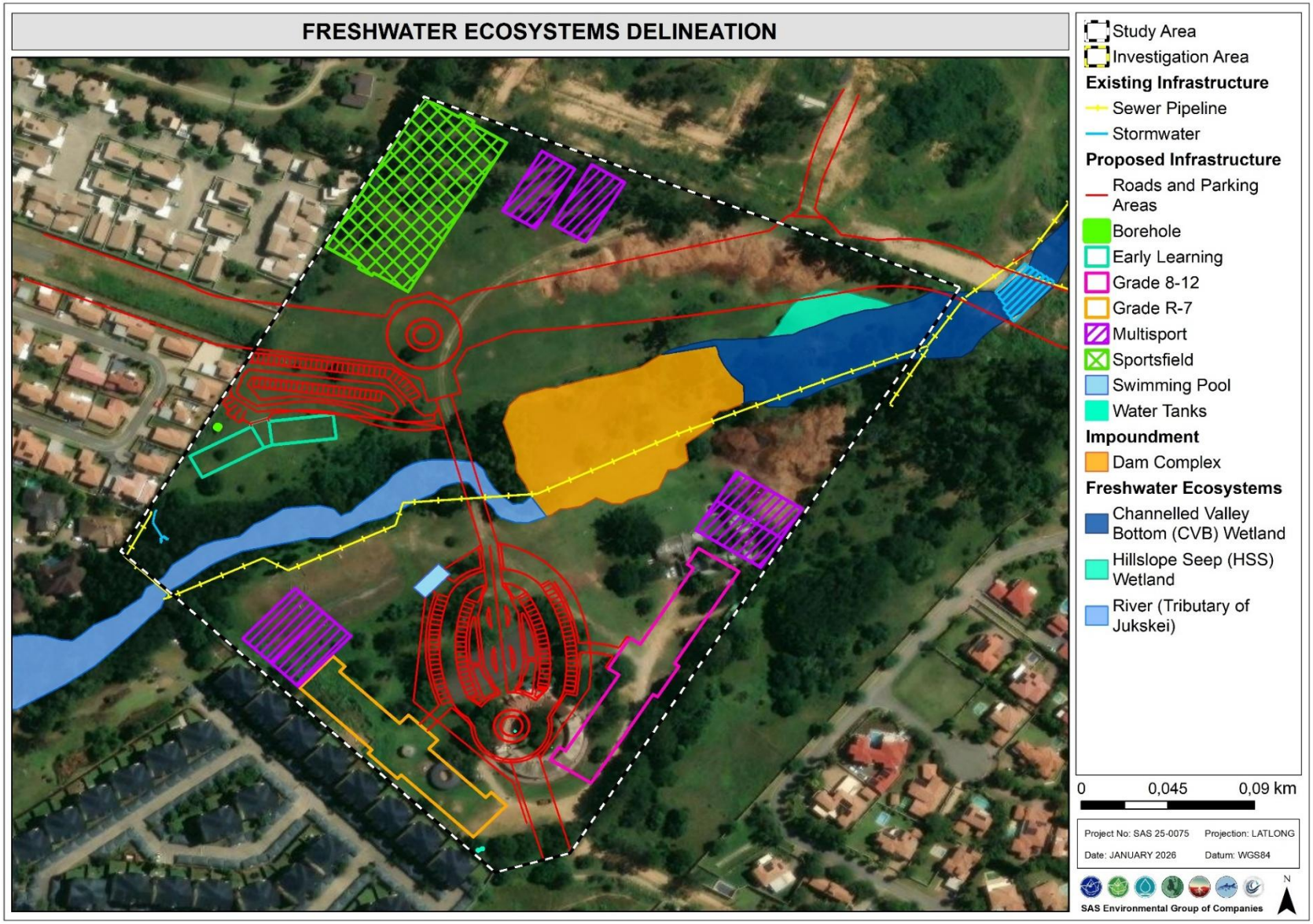


Figure 13: The field verified freshwater ecosystems associated with the study area in relation to the proposed project layout.

4.2 *Freshwater Ecosystem Delineation*

As noted in Section 1.4, the freshwater ecosystem assessment was limited to the study area as provided by the proponent. A delineation methodology which was based on vegetation, terrain and hydrological indicators was applied and is described as follows:

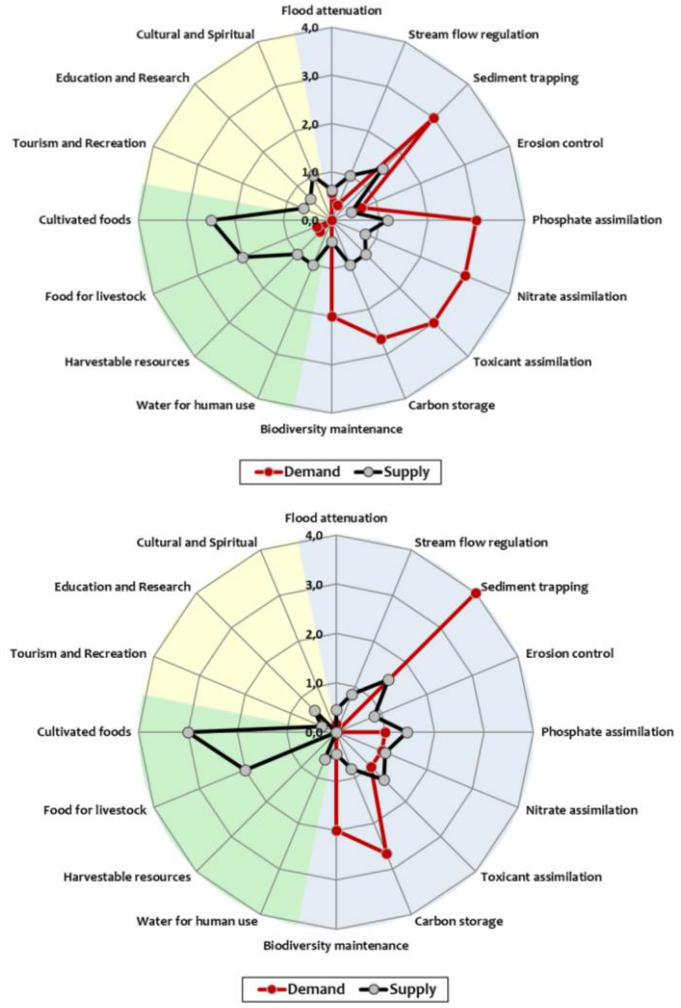
- Terrain setting indicators were used as the primary indicator. Terrain was utilised to provide an indication of low-lying areas where water is likely to collect and/or move through the landscape;
- Soil wetness indicators, duration and frequency of saturation in the soil profile is a diagnostic indicator since it influences the colour change in the soil. Low chroma (grey and muted colours) as well as mottles are more prominent in soil which have higher saturation frequency. Soils displaying signs of hydromorphism also indicate an increased hydroperiod and thus the potential presence of hydromorphic characteristics;
- The presence of alluvial deposits, which is characteristic of riparian areas;
- Vegetation was utilised as the secondary (confirmatory) indicator to identify and define freshwater ecosystems, where feasible. Vegetation species composition and structure was also considered when determining the wetland boundaries; and
- The presence of moisture and evidence of water movement in the landscape was utilised as a further confirmatory indicator, although this was utilised with caution due to numerous impacts and changes within the landscape related to agricultural activities.

4.3 *Freshwater Ecosystems: Site Verification Results*

Following the site assessment, the assessments outlined in Section 1.3 were applied. The results of the freshwater assessments are discussed in the dashboard style reports which follow (Tables 4 and 5), and the details thereof are presented in **Appendix F**.

Table 4: Summary of the assessment of the Channelled Valley Bottom (CVB) and Hillslope Seep (HSS) wetlands located inside the study area.

Ecological & socio-cultural service provision graphs. Top: CVB wetland; Bottom**:** HSS wetland.



Photograph notes: Top Left and Right: Representative photographs of the CVB wetland located inside the study area. Bottom Left and Right: Representative photographs of the HSS wetland located inside the study area.

Ecoservice provision	**CVB:** Sediment Trapping – Moderately Low; all other services - Low-Very Low **HSS:** Sediment Trapping - Moderate; all other services - Moderately Low-Very Low The wetlands inside the study area are overall considered to be of low value in terms of ecosystem service provisioning as their ability to do so has been compromised by their degraded state. The wetlands are, however, considered marginally important for trapping sediment on a local scale. The wetlands also provide an additional foraging site for the horses on the property. Wetland systems in general are considered beneficial for crop production, although the wetlands inside the study area are not utilised for crop cultivation at the present time. The demand for nutrient assimilation is high, given the expected large inputs from the adjacent urban landscape. However, the wetlands, particularly the CVB system, are severely incised, and as such have a reduced effectiveness to assimilate nutrients and toxicants due to the reduced contact of the water with vegetation.	**EIS discussion**	**EIS Category:** CVB – Moderate; HSS - Low The EIS of the CVB wetland has been assessed as "Moderate", while the HSS wetland has been assigned a "Low" EIS. The EIS scores are largely dependent on the sizes of the wetlands, with the CVB wetland being larger, and therefore having an increased capacity to provide ecosystem services. The CVB wetland also contains a greater diversity of habitat types (compared to the HSS wetland) which increases the potential to support a variety of fauna. Another important consideration is that the wetlands are both located within a CBA. In terms of ecological sensitivity, the CVB wetland is considered sensitive to changes in floods and changes to low flows during the dry season, as this would affect one of the natural recharge mechanisms of the wetland (i.e. overbank flooding). The HSS wetland is not considered sensitive to these aspects.
PES discussion	**Category D (Largely Modified)** The wetlands within the study area were assessed to be largely modified. The most prominent modifying factor of the CVB wetland is urban expansion, in particular, the increased flood peaks as a result of increased hardened surfaces, and the concentration of stormwater runoff in the wetland catchment. The associated pollution and soil disturbance have modified the hydrology, geomorphology and water quality in the system. Inside the study area, the CVB and HSS wetlands are impacted by grazing and trampling by the horses on the property. A composting facility is located directly upslope of the CVB wetland, which is expected to have an effect on water quality since there is no barrier that prevents runoff from the composting facility from entering the wetland. The HSS is encroached by discarded soil on its northern boundary.	**REC, RMO & BAS Category**	**REC Category: D; RMO: D (Maintain); BAS: D** The technical recommendation is for the wetlands to be maintained at a PES category of D. Maintaining the current PES classes of the wetlands entails that the development should carefully consider the impact on the wetlands to ensure that the ecological state of the wetland units does not become degraded due to the proposed development. Accordingly, the recommendations made in Section 8 are important to ensure that realisation of the REC.
Freshwater ecosystem drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):			
The CVB wetland associated with the study area occupies a lower foothill position where water flow is either concentrated into defined channels, or occurs as diffuse flows across the valley floor. The HSS wetland is located on a northern side slope of the CVB wetland, and is hydrologically connected to the latter. The main expected recharge mechanisms for these wetlands is a combination of overbank flooding (flooding from the channel that spreads across the wetland), shallow interflow, and hillslope runoff (during rainfall, surface runoff from valley sides contributes water, and sometimes sediment or nutrients, to the wetland). The hydrology of the CVB wetland is modified with consideration to the timing and pattern of flow in the landscape, due to the reduced surface roughness in the catchment (urban development) and likely augmentation by stormwater runoff from the surrounding areas. As a result, the wetland channel is severely incised along the majority of the assessed reach. Grazing and general activity of the horses on the property have also reduced the vegetation cover of the wetland, and likely also contributing to channel incision. The retention of water within a small instream farm dam on the property is also expected to have an effect on the natural flow regimes and sediment balance of the CVB wetland. The HSS wetland is affected by grazing and trampling, and by the discard of soil in the immediate wetland catchment. Water quality parameters were recorded at two sites situated on the freshwater ecosystem complex (upstream and downstream of the proposed development). The upstream sample was taken within the CVB wetland, while the downstream sample was taken within the non-perennial drainage line (discussed in Table 5 below). Basic water quality parameters (pH Electrical Conductivity and Dissolved Oxygen) were generally within the stipulated recommended ranges (DWS, 2021) at both sites. Diatom analysis suggest that the upstream site is in moderate		

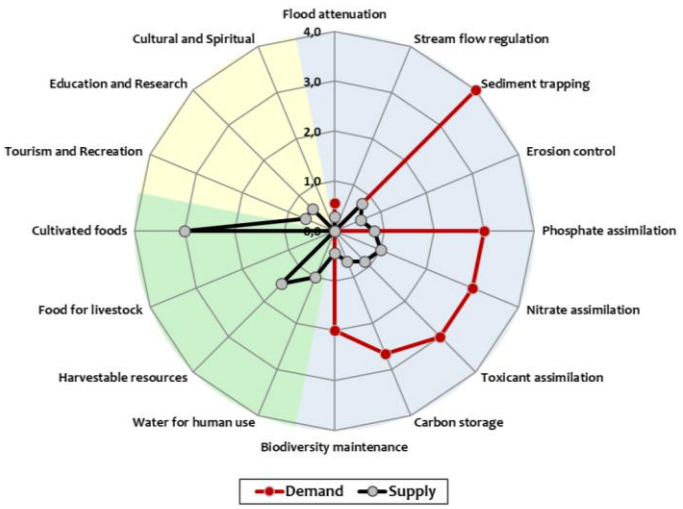
<table>
<tr><td colspan="2">ecological state (Category C/D); however the downstream site was indicated to be in a poor ecological condition (Category D). The water quality results suggest a mesotrophic to eutrophic condition. Impacts at the site are likely due to agricultural runoff and diffuse anthropogenic inputs from the surrounding catchment. Please refer to Section 5 of this report for further detail regarding water quality findings.

The CVB and HSS wetlands have vegetation components consisting of medium to short vegetation growth (grasses, sedges and reeds) which is kept short by a combination of mowing and grazing. Indigenous woody species are generally absent, and large sections of the CVB wetland are encroached by alien woody species (e.g. Eucalyptus and Populus). Part of the CVB wetland vegetation is also flooded by a farm dam. Due to the degraded state of the wetlands and their location in an urban landscape, the wetlands are not particularly diverse in fauna, although the faunal study conducted at the same time as the freshwater study confirmed the presence of Common Duiker (Sylvicapra grimmia) in the wetland habitat. This illustrates the importance of the wetlands in providing corridor areas for wildlife movement in the urban landscape. A range of common garden avifauna are also expected to utilise the wetlands as a water source and as breeding habitat.</td></tr>
<tr><td>Extent of modification anticipated</td><td>The majority of the footprint areas have been optimised to avoid the delineated extent of the wetlands and associated 15 m buffer areas. The proposed infrastructure is also mostly located outside the 1 in 100 year floodlines of the freshwater habitat. A marginal portion of an access road encroaches on a section of the HSS wetland some degree of local scale modification to the wetland is expected as a result. It is highly recommended that the layout of the proposed roadway be further revised to avoid the HSS wetland and its associated ecological buffer area if possible.

The extent of modification to the CVB wetland is expected to be minimal if the mitigation measures outlined in Section 8 of this report are implemented.</td></tr>
<tr><td colspan="2">Risk Assessment Outcome and Business Case:</td></tr>
<tr><td>Low</td><td>The footprint areas mostly avoid the delineated extent of the freshwater ecosystems (i.e. watercourses) and associated 15 m ecological buffers. In those areas where infrastructure encroaches on wetland habitat, the extent of encroachment is minimal. The localised nature of these impacts, combined with the relatively low EIS of the watercourses, results in a ‘Low’ risk significance of all activities associated with the proposed project. Despite the low risk significance outcome, it is highly recommended that the layout of the proposed roadway be further revised to avoid the HSS wetland and its associated ecological buffer area if possible.

Besides further optimisation of the footprint area layout, the following key mitigation measures are proposed for reducing impacts to the watercourses on site:
➢ Construction works must preferably be undertaken during the driest period of the year when there is reduced risk of significant stormwater runoff from the construction site to the receiving environment.
➢ It must be ensured that all stormwater discharge is done in an attenuated manner. The stormwater infrastructure and outlets must therefore be appropriately designed to achieve this.
➢ The entire construction area (development site) must be fenced prior to the commencement of construction and vegetation clearing to ensure that no vehicle or other construction personnel access occurs off the approved site.
➢ Erosion control must be strictly implemented in all areas where soil is exposed. Sediment traps (i.e. drifts fences/silt curtains or sandbags) should be used to prevent runoff from exposed soil into the adjacent freshwater environment.
➢ A waste management plan must be strictly implemented.
➢ An AIP control plan must be strictly implemented.
➢ With construction and operation of the proposed road crossing over the watercourse (i.e. CVB wetland), it must be ensured that flow is maintained within the stream channel so that no loss of hydraulic connectivity occurs in the watercourse.</td></tr>
</table>

Table 5: Summary of the assessment of the Non-Perennial Drainage Line (NDL) located inside the study area.

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

Photograph notes: Representative photographs of the Non-Perennial Drainage Line located inside the study area. Left: A section of the drainage line at an existing road crossing. Right: The outer edge of the drainage line (yellow dashed line). The woody component of the system consisted largely of alien trees.</td></tr>
<tr><td>Ecoservice provision</td><td>Cultivated Foods – Moderately Low; all other services - Low-Very Low
As for the wetland systems, the drainage line inside the study area is overall considered to be of relatively low value in terms of ecosystem service provisioning given its degraded state. The water supplied by the river has the potential to support crops, however, the watercourse is not utilised for crop production on the property. The drainage line is considered of less importance in terms of sediment trapping and assimilation of nutrients and toxicants, as the water flow in the system is largely concentrated in a single channel, which does not allow for impurities to come into contact with vegetation to any significant degree. The expected demand for nutrient assimilation is much higher than the drainage line can provide, given the expected large inputs from the adjacent urban landscape.</td><td>EIS discussion</td><td>EIS Category: Moderate
The EIS of the drainage line has been assessed to be “Medium”. While the system is in a degraded state, it does provide some ecosystem services on a local scale and represents a corridor area for the movement of wildlife. Another important consideration is that the drainage line is located within a CBA.
In terms of ecological sensitivity, the drainage line is not considered sensitive to changes in floods and changes to low flows during the dry season.</td></tr>
<tr><td>PES discussion</td><td>Riparian IHI: Category D/E (Largely to Seriously Modified)
VEGRAI: Category E (Seriously Modified)
It is hypothesised that the NDL in its natural state, would have resembled a wetland system more closely than a river, and that the shift to a fluvial system has likely come about through the heavy encroachment by alien trees in the watercourse,</td><td>REC, RMO & BAS Category</td><td>REC Category: D; RMO: D (Improve); BAS: D
PES Categories E and F are considered ecologically unacceptable (Malan and Day, 2012) and therefore, should a freshwater ecosystem fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category. Therefore, the technical</td></tr>
</table>

	which have resulted in the loss of marginal and temporary zone herbaceous vegetation and the resulting incision of the channel bed. Also, the presence of the instream impoundment is expected to result in loss of recharge and associated desiccation of the downstream system. The drainage line was thus assessed to be in a seriously modified ecological condition. The entire watercourse is heavily encroached by alien woody vegetation and as such, the natural vegetation component has been lost. As for the wetland systems further upstream, the drainage line is negatively impacted by urban expansion, in particular, increased flood peaks as a result of increased hardened surfaces, and the concentration of stormwater runoff in the system catchment. The associated pollution and soil disturbance have modified the hydrology, geomorphology and water quality in the system.		recommendation is for the Ecostatus of the drainage line to be improved. However, given the landscape setting of the watercourse outside a protected area and the high impacts associated with its catchment which are beyond the influence of the proponent, it is considered impractical to realistically improve the PES status of the watercourse. However, at the very least, the ecological condition of the watercourse must be maintained and ensure that further direct impacts are avoided. This entails that the proposed development should carefully consider the impact on the watercourse to ensure that the ecological state of the watercourse does not become degraded due to the proposed development. Accordingly, the recommendations made in Section 8 are important to ensure that realisation of the REC.

Freshwater ecosystem drivers and receptors discussion (hydraulic regime, geomorphological processes, water quality and habitat and biota):

The NDL is situated in the lower portion of the study area below the dam wall where the CVB wetland ends. It is expected that the drainage line represents a semi-permanent system, which flows intermittently, for at least nine months of the year and with very low flow or stagnant conditions in the dry season. Flow frequency and volumes are expected to be altered by stormwater runoff from the urban areas in the system's catchment. The hydrology of the watercourse is also expected to be significantly affected by the farm dam at the upper end of the system, which is expected to reduce flow during the dry season and also affect the sediment balance of the system. The settling of sediment in the dam may have the effect of starving the downstream watercourse of sediment, and may contribute, to a degree, to the streambed incision the system has undergone.

Water quality was recorded at two sites (upstream and downstream of the proposed development) situated on the freshwater ecosystem complex. Water quality considerations are briefly summarised in Table 4 above and discussed in detail in Section 5.

The stream banks of the drainage line retain very little indigenous vegetation. The vegetation is dominated by *Eucalyptus* and *Populus*, which have resulted in the development of a woody 'riparian' zone along the marginal areas of the drainage line. The alien woody vegetation has outcompeted the herbaceous component of the drainage line, which would have provided support to the soil along the channel banks. Therefore, the AIP encroachment is anticipated to have contributed significantly to the bank incision noted within the system. As noted above, it is expected that the current state of the system as a fluvial system is not the natural 'reference' state of the watercourse but that it may have had more characteristics of a CVB wetland before the modifications that have taken place. Despite the modified nature of the watercourse, it provides a corridor area for wildlife movement in the landscape. A range of common garden avifauna are also expected to utilised the system as a water source and as breeding habitat.

Extent of modification anticipated	The footprint areas mostly avoid the delineated extent of the Non-Perennial Drainage Line. An exception to this is the road crossing to be upgraded over the channel. It is however expected to have only localised impacts on the watercourse, and therefore the extent of modification to the system is expected to be minimal (subject to the implementation of the mitigation measures outlined in Section 8 of this report.

Risk Assessment Outcome and Business Case:

Low	The proposed activities were assessed to be of a 'Low' risk significance to the NDL, provided that the mitigation measures outlined in Section 8 of this report are strictly implemented. Key mitigation measures relevant to the proposed activities are listed in Table 4 above.

5 RESULTS: WATER QUALITY ASSESSMENT

Water quality parameters (pH, Electrical Conductivity (EC), and temperature) were measured at two sites inside the study area, which included a sampling point on the CVB wetland, upstream of the proposed development, and a sampling point in the NDL (tributary of the Jukskei River) downstream of the proposed development. Sampling of the diatom communities was undertaken at the same sites where water quality parameters were recorded. Diatoms are unicellular algae at the base of the aquatic food web and thus provide meaningful and valuable information for means of biomonitoring as they are highly representative of water quality. As diatoms are primary producers localised within an area, and due to their short life span (2 – 3 weeks), they are important indicators of short-term impacts; they are thus the first indicators of change within their environment. Diatoms have a rapid response to environmental change and their ecology is well understood, allowing the interpretation of specific physico-chemical conditions within the aquatic environment. Specific environmental changes (nutrient loading, salinisation, pH change and organic enrichment) can be determined based on the presence and absence of key indicator diatom taxa. Table 6 and Figure 14 contains geographic information regarding the water quality assessment points.

Table 6: Co-ordinates of the assessment sites.

Site	GPS co-ordinates	
	Latitude	Longitude
S1 (Upstream site)	25°59'46.24"S	28° 5'23.69"E
S2 (Downstream site)	25°59'49.90"S	28° 5'11.23"E

The results of the aquatic assessment are discussed in the dashboard style report that follows. The monitoring sites applicable to the proposed development are located in the Limpopo Catchment and the A21C (Jukskei River) quaternary catchment. With regard to acceptable ranges of water quality parameters, the acceptable ranges for the Jukskei River (EWR2 (Table 7) were considered, as this represents the closest site to the sampling points with available data. The CVB system sampled confluences with the Jukskei River approximately 1.2 km downstream of the proposed development.

Table 7: A summary of the relevant classes and resource quality objectives.

Description	Parameter	Classification / Value
River name: Jukskei River A21C EWR: Croc_EWR2	**Present Ecological State (PES)**	E
	Ecological Importance and Sensitivity	Moderate
	Target Ecological Category (TEC)	D
	Temperature	Limited data available
	pH	8.0 - 8.8
	Electrical Conductivity (EC) (mS/m)	≤ 85
	Dissolved Oxygen (DO) (mg/L)	≥ 6.1

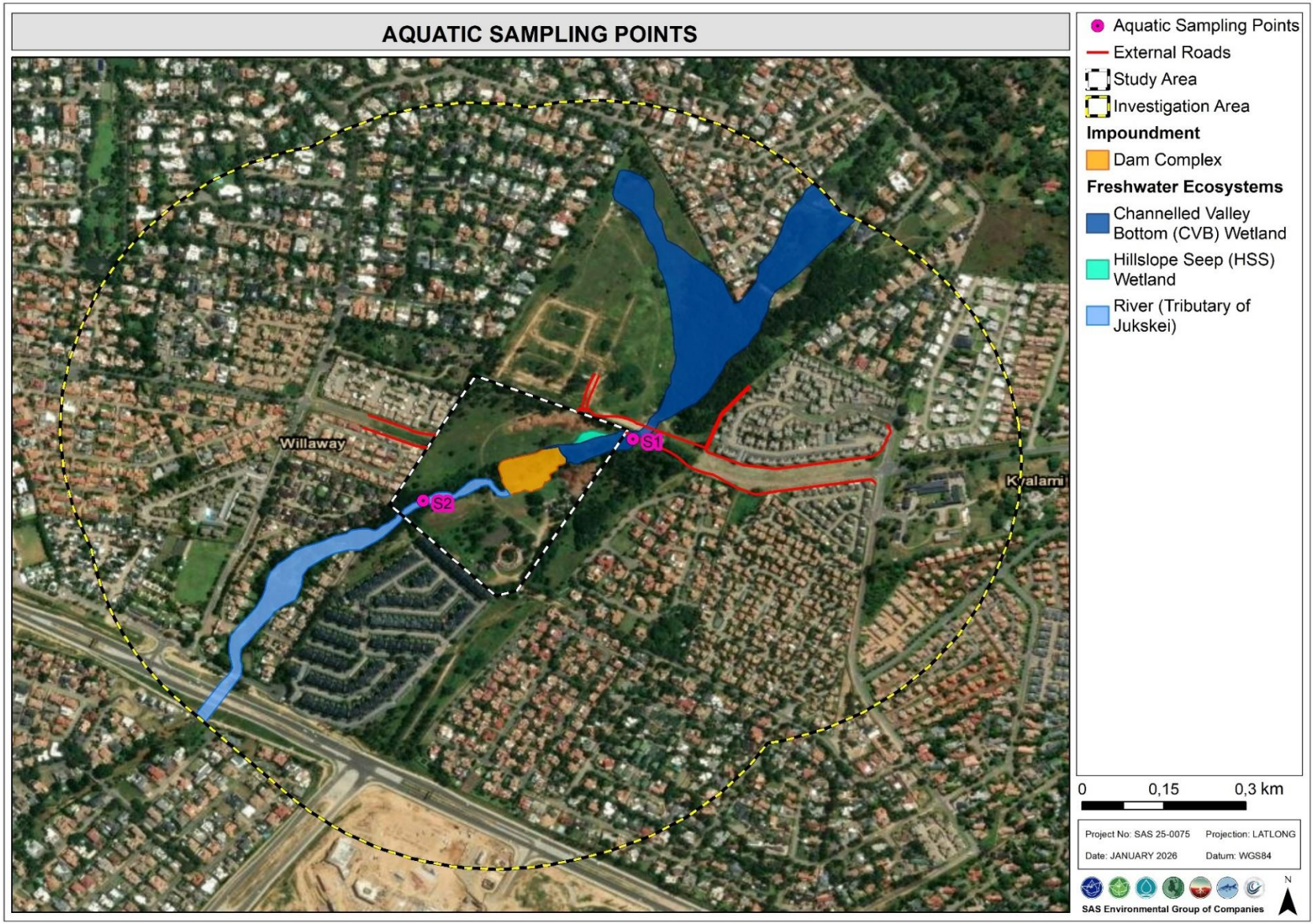
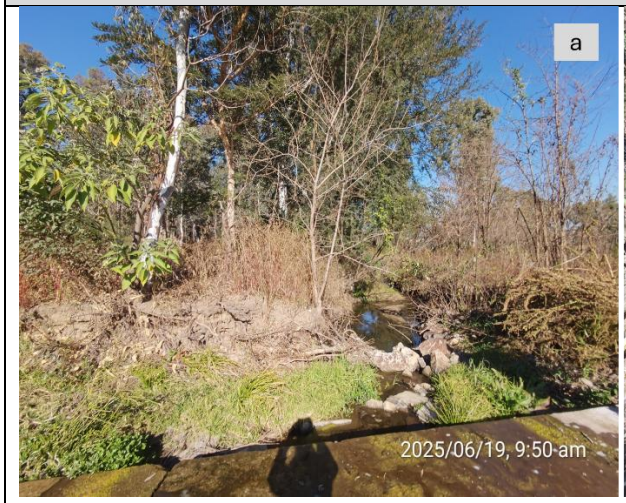


Figure 14: Locality of the water quality assessment points inside the study area.

Table 8: Results of the water quality assessment at the relevant sites.

<table>
<tr><td colspan="2"></td><td colspan="3">Physico-chemical water quality</td></tr>
<tr><td colspan="2" rowspan="5"> 

Photographic notes: General view of (a) S1, the upstream site on the CVB wetland system inside the study area; (b) S2, the downstream site on the NDL inside the study area. The sites were sampled in June 2025.</td><td>Water Quality Parameter</td><td>S1</td><td>S2</td></tr>
<tr><td>pH</td><td>8.60</td><td>8.73</td></tr>
<tr><td>EC (mS/m)</td><td>95.9</td><td>92.6</td></tr>
<tr><td>DO (mg/L)</td><td>9.62</td><td>8.24</td></tr>
<tr><td colspan="3">Comments
➢ The pH can be regarded as within acceptable ranges at the time of the assessment for both sites (DWS, 2021). Potential impacts regarding pH on the freshwater community is deemed limited;
➢ Measured Electrical Conductivity (EC) was elevated at both sites and therefore did not comply with the RWQOs considered (DWS, 2021). Osmotic stress to the freshwater/aquatic community is deemed likely if it is assumed that the readings are accurate;
➢ The Dissolved Oxygen (DO) levels were within the stipulated recommended ranges (DWS, 2021) at both sites.</td></tr>
<tr><td>Algal proliferation</td><td colspan="4">Limited filament algae growth was observed at all sites. However, very little to no suspended algae was observed at any of the sampling sites.</td></tr>
<tr><td>Flow condition</td><td colspan="4">Low flow conditions prevailed, although the sampled stream had gentle flow at the time of the assessment.</td></tr>
<tr><td>Stream characteristics</td><td colspan="4">Indigenous woody species are found in very low abundance at the sites. The streambanks were densely encroached by alien woody vegetation. The central stream has no instream vegetation. The stream bank slope is steep and heavily incised within the vicinity of S1, and but becomes more gentle towards S2.</td></tr>
<tr><td>Water clarity and odour</td><td colspan="4">The water was slightly discoloured and turbid. Odors suggesting organic pollution was not detected, however, pollution by solid material from further upstream is evident.</td></tr>
<tr><td>Significance</td><td colspan="4">Site S1 is located directly upstream of the proposed development and S2 is located directly downstream of the proposed development.</td></tr>
</table>

Table 9: Ecological and Biological traits summary of diatom analysis.

Parameter	S1 (Upstream)	S2 (Downstream)
Dominant Taxa	*Gomphonema* sp., *Nitzschia linearis*, *Fragilaria biceps*, and *Nitzschia palea.*	*Fragilaria biceps*, *Nitzschia* sp., *Navicula* sp., and *Aulacoseira granulata.*
Functional Groups	Mix of benthic and motile/planktonic species.	Similar mix to site S1, with higher number of planktonic and motile species.
Ecological Guilds	Low-profile, Motile and Planktonic guilds dominate the site.	Motile, Low-profile and Planktonic guilds dominate the site.
Size Classes	Mix of medium-sized benthic and small-medium motile/planktonic species.	Mix of small-medium motile and medium-large planktonic species
SPI	10.6 (Moderate)	8.5 (Poor)
%PTV	30.8%	18.5%
Diversity	2.9 (Moderate–High)	2.9 (Moderate–High)
Evenness	0.87	0.97

Site S1 has a moderate to high species diversity with a relatively even distribution of taxa. Based on the SPI score, the site is considered to be in moderate ecological quality (Category C/D). The dominant diatom species, functional groups, ecological guilds, size classes, and index scores, the site has moderate to high nutrient enrichment (mesotrophic to eutrophic), little to no metal contamination, and some evidence of organic contamination based on the %PTV score. The diatom community mainly consist of a mixture of motile, low-profile, and planktonic species, with mostly small to medium-sized taxa, indicating low to moderate physical disturbance at the site. The presence of pollution-tolerant but not metal-sensitive species suggest that the site is mainly impacted by nutrient enrichment rather than metals. Impacts at the site are likely due to agricultural runoff and diffuse anthropogenic inputs from the surrounding catchment. **Site S2** has a moderate to high species diversity with an even species diversity. The SPI score indicates that the site is in a poor ecological quality category (Category D). From the dominant diatom species, functional groups, ecological guilds, size classes, and index scores, the site is considered to be in an impacted condition with nutrient enrichment (eutrophic). The community is dominated by motile and planktonic species, with mostly small to medium-sized taxa and some larger, slow-growing species. This indicates an increase in nutrient levels and possibly flow alterations or reduced habitat at the site. While the %PTV is relatively low and suggest little to no organic contamination, the overall community indicates to moderate stressors at the site.

Spatially, the diatom results indicate a deterioration in ecological category between sites S1 (Moderate: Category C/D) and S2 (Poor: Category D). Even though the species diversity remains relatively similar between the sites, the diatom community shifts by an increase in motile and planktonic species at the downstream site. Thus, indicating changes in the habitat conditions and potential nutrient enrichment or organic inputs. The downstream site (S2) has a higher species evenness, indicating no dominance by one specific species but rather a more

stressed and altered community. The spatial trend between the two sites indicates increasing environmental stressors, likely due to cumulative impacts such as nutrient loading and anthropogenic disturbances. This is further supported by lower pollution-sensitive taxa and functional diversity at the downstream site. Overall, the diatom community results indicate a deteriorating aquatic ecosystem.

6 FRESHWATER SENSITIVITY VERIFICATION

The protocol for the assessment of freshwater and aquatic biodiversity prepared in support of the Department of Forestry, Fisheries and Environment (DFFE) (previously the Department of Environmental Affairs (DEA)) National Web-based Environmental Screening Tool (2020), provides the criteria for the assessment and reporting of impacts on aquatic/freshwater biodiversity for activities requiring EA. For the aquatic biodiversity (freshwater) theme, the requirements are for sites which support various levels of biodiversity. The relevant aquatic biodiversity (freshwater) theme in the National Web-based Environmental Screening Tool (2020) has been provided by the South African National Biodiversity Institute (SANBI). Based on the sensitivity rating, a suitably qualified specialist must prepare the relevant report or opinion memorandum which is to be submitted as part of the EA application.

As part of the process of background information gathering, the screening tool was applied to the proposed development. According to the guidelines, an applicant intending to undertake an activity on a site identified as being of “very high sensitivity” for an aquatic biodiversity theme must submit an Aquatic Biodiversity Impact Assessment, or if the area is identified as being of “low sensitivity” then an Aquatic Biodiversity Compliance Statement must be compiled and submitted to the competent authority.

According to the screening tool, the majority of study area is located within an area of low aquatic/freshwater biodiversity sensitivity, however, the freshwater features indicated as seep and channelled valley bottom wetlands (per the draft National Wetland Map 6; 2024) are located within areas of very high aquatic/ freshwater biodiversity sensitivity (Figure 15). The designation of very high sensitivity to freshwater features by the DFFE Screening Tool is confirmed through the findings of the freshwater assessment, in the context of the inherently sensitive freshwater ecosystems. The designation of low freshwater sensitivity for the remainder of the study area where no freshwater ecosystems have been identified or delineated is confirmed.

Under the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity, (GN320 of March 2020), for areas of very high aquatic biodiversity sensitivity an Aquatic Biodiversity Assessment must be produced. Please refer to the site sensitivity verification report contained in **Appendix H**.

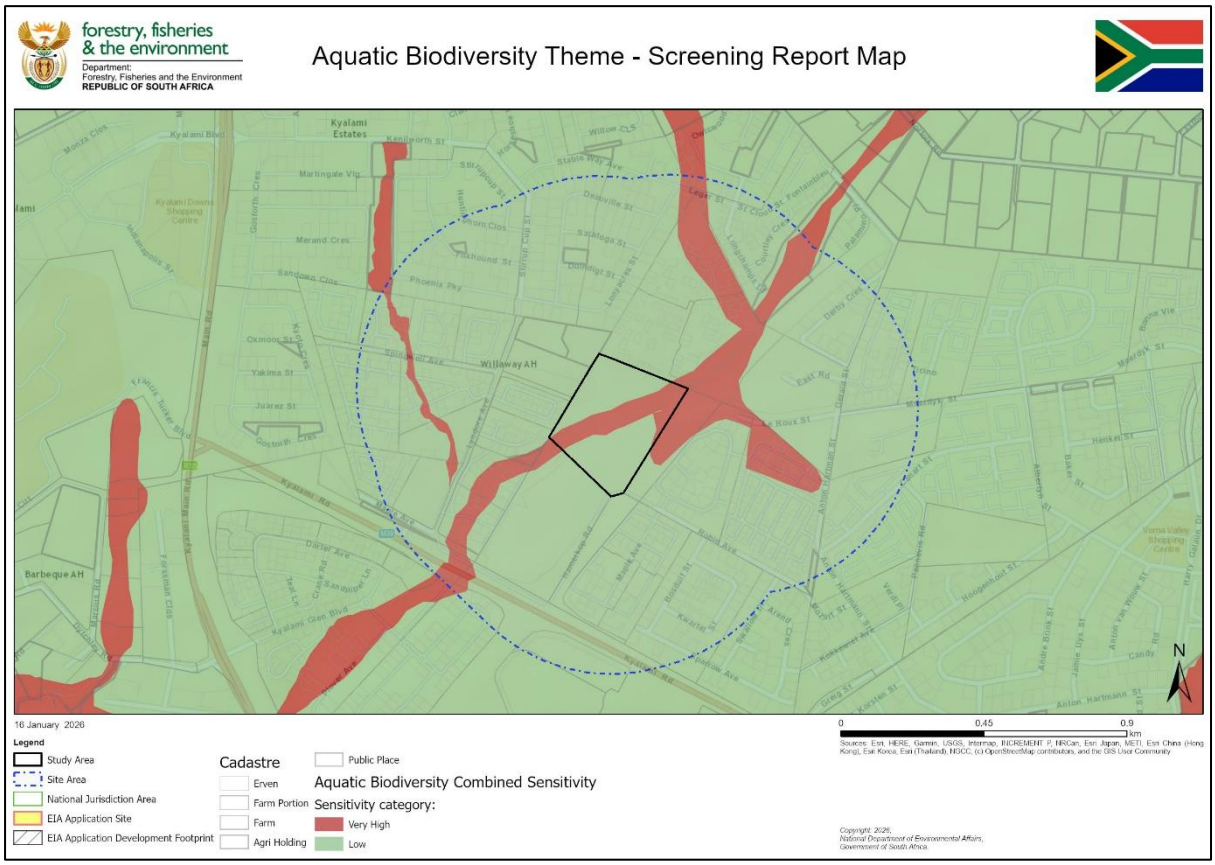


Figure 15: Map of aquatic biodiversity related sensitivity theme for the study area (black outline) and investigation area (blue dashed outline) according to the National Web-Based Environmental Screening Tool (2020, Accessed 2025).

7 LEGISLATIVE REQUIREMENTS AND SENSITIVITY MAPPING

The following legislative requirements were considered during the assessment. A detailed description of these legislative requirements is presented in **Appendix B** of this report:

- The Constitution of the Republic of South Africa, 1996[9];
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA) as amended;
- Government Notice 4167 (GN 4167) as published in the Government Gazette 49833 of 08 December 2023 as it relates to the National Water Act, 1998 as amended (Act No. 36 of 1998); and
- The Gauteng Conservation Plan (C-Plan, 2023).

7.1 *Legislative Zones of Regulation*

Certain articles of legislation related to the above Acts and legislation impose potential zones of regulation on freshwater ecosystems in both the national and provincial context. The Zones of Regulation (ZoR) are not necessarily development exclusion zones, but rather areas in which EIA and WUA legislative tools have been introduced for the protection and sustainable use of freshwater resources by requiring that certain types of activities within a freshwater ecosystem, or within a certain distance of a freshwater ecosystem require authorisation. The definition and motivation for a regulated zone of activity for the protection of freshwater ecosystems can be summarised as follows (Table 10).

Table 10: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Water Use Authorisation Application in terms of the National Water Act, 1998 (Act No. 36 of 1998) as amended). **Department of Water and Sanitation (DWS)**	**Government Notice 4167 as published in the Government Gazette 49833 of 2023 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) as amended.** Government Notice 4167 as published in the Government Gazette 49833 of 08 January 2024 as it relates to the National Water Act, 1998 (Act No.36 of 1998) as amended. In accordance with GN 4167, a regulated area of a watercourse in terms of water uses as listed in Section 21(c) and 21(i) is defined as: • **the outer edge of the 1 in 100-year flood line or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake, or dam;** • in the absence of a determined 1 in 100-year flood line or riparian area the area within 100 m distance from the edge of a watercourse where the edge of the watercourse (excluding flood plains) is the first identifiable annual bank fill flood bench; or

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

Regulatory authorisation required	Zone of applicability
	• **In respect of a wetland, a 500 m radius around the delineated boundary (extent) of any wetland, including pans.**
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) EIA Regulations (2014), as amended (2017). ***(The activities which might trigger the required authorisations must be determined by the EAP in consultation with the relevant authorities).***	**Activity 12 of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended in 2017)** The development of— (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs—; a) within a watercourse; b) in front of a development setback; or c) if no development setback exists, **within 32 metres of a watercourse, measured from the edge of a watercourse.** excluding— (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (ee) where such development occurs within existing roads, road reserves or railway line reserves; or (ff) the development of temporary infrastructure or structures where such infrastructure or structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared. **Activity 12 of Listing Notice 3** The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. **Activity 14** of Listing Notice 3 of the National Environmental Management Act, 1998 (Act No.107 of 1998) EIA regulations, 2014 (as amended) states that: *The development of:* *(xii) Infrastructure or structures with a physical footprint of 10 square meters or more.* *Where such development occurs—* *a) Within a watercourse;* *b) In front of a **development setback**; or* *c) **If no development setback has been adopted, within 32 meters of a watercourse**, measured from the edge of a watercourse.* c. Gauteng *iv. Sites identified as Critical Biodiversity Areas (CBAs) or Ecological Support Areas (ESAs) in the Gauteng Conservation Plan or in bioregional plans.*
GDARD Requirements for Biodiversity Assessments, Version 3 (2014).	The GDARD Requirements for Biodiversity Assessments, Version 3 (2014) specifies buffer widths for sensitive features. For rivers (non-perennial / perennial) riparian zones and wetlands, buffer zones must be designated as sensitive according to the following mapping rules. • The riparian zone/wetland must be delineated according to "DWAF, 2003: A Practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". • A 100m buffer zone from the edge of the riparian zone for rivers/streams outside urban areas must apply. • **A 30 m buffer for wetlands occurring inside urban areas must apply.** The Guidelines highlight that these buffer zones are essential to ensure healthy functioning and maintenance of aquatic ecosystems and function as wildlife corridors and refugia.

Based on the above, the relevant Zones of Regulation (ZoR) are interpreted to be the following:

- NEMA 32 m ZoR (NEMA EIA Regulations), applicable to all identified freshwater ecosystem HGM units;
- GN 4167 500 m ZoR (NWA Regulations), applicable to the wetlands; and
- The 1 in 100 year floodline, applicable to the Non-Perennial Drainage Line.

In addition, the following GDARD buffer zone may be applicable:

- A **30 m** buffer for wetlands occurring inside urban areas in line with the GDARD Requirements for Biodiversity Assessments.

The respective zones of regulation as stipulated above are depicted in Figures 16 -19 below.

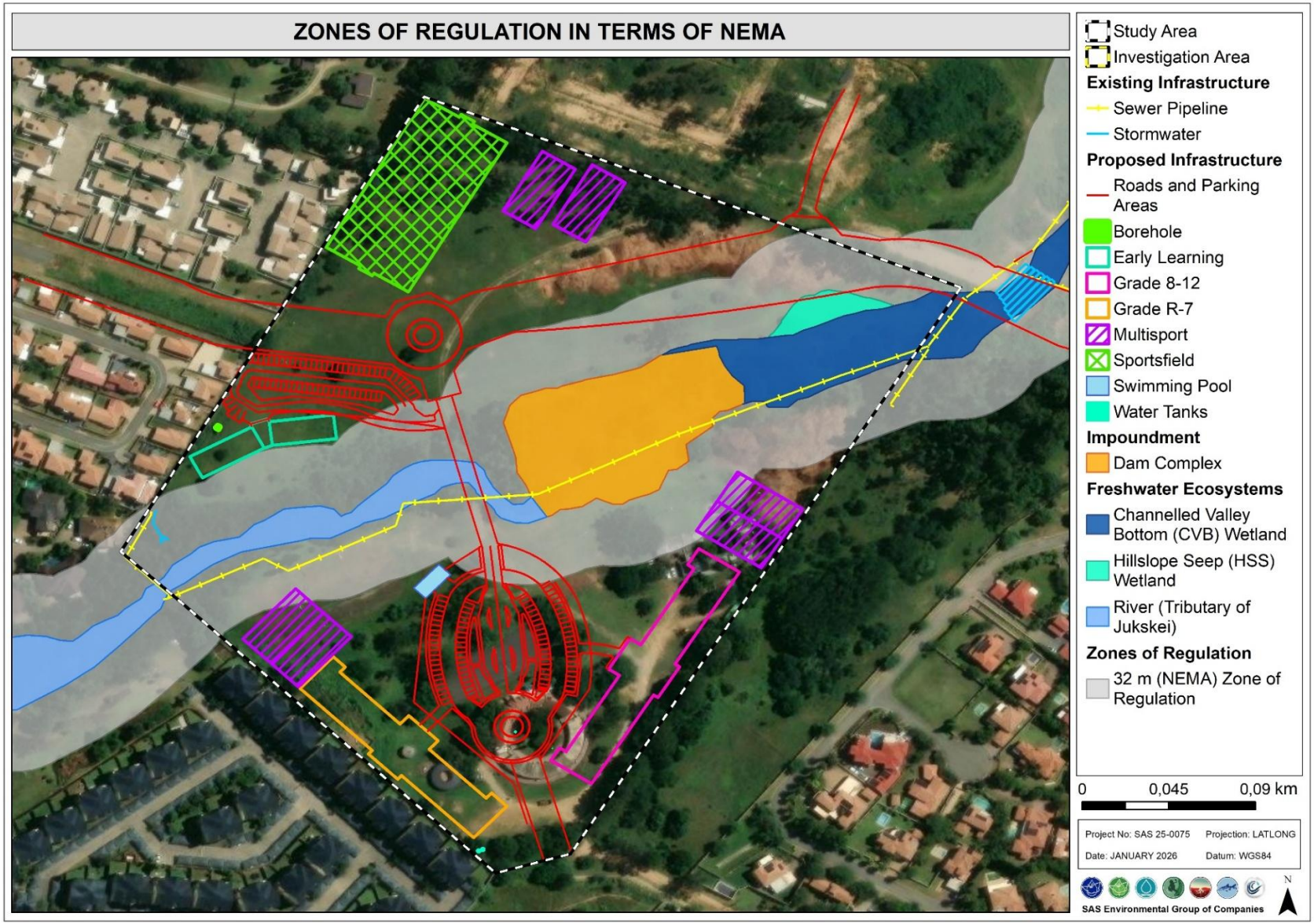


Figure 16: The zones of regulation in terms of NEMA associated with the study area.

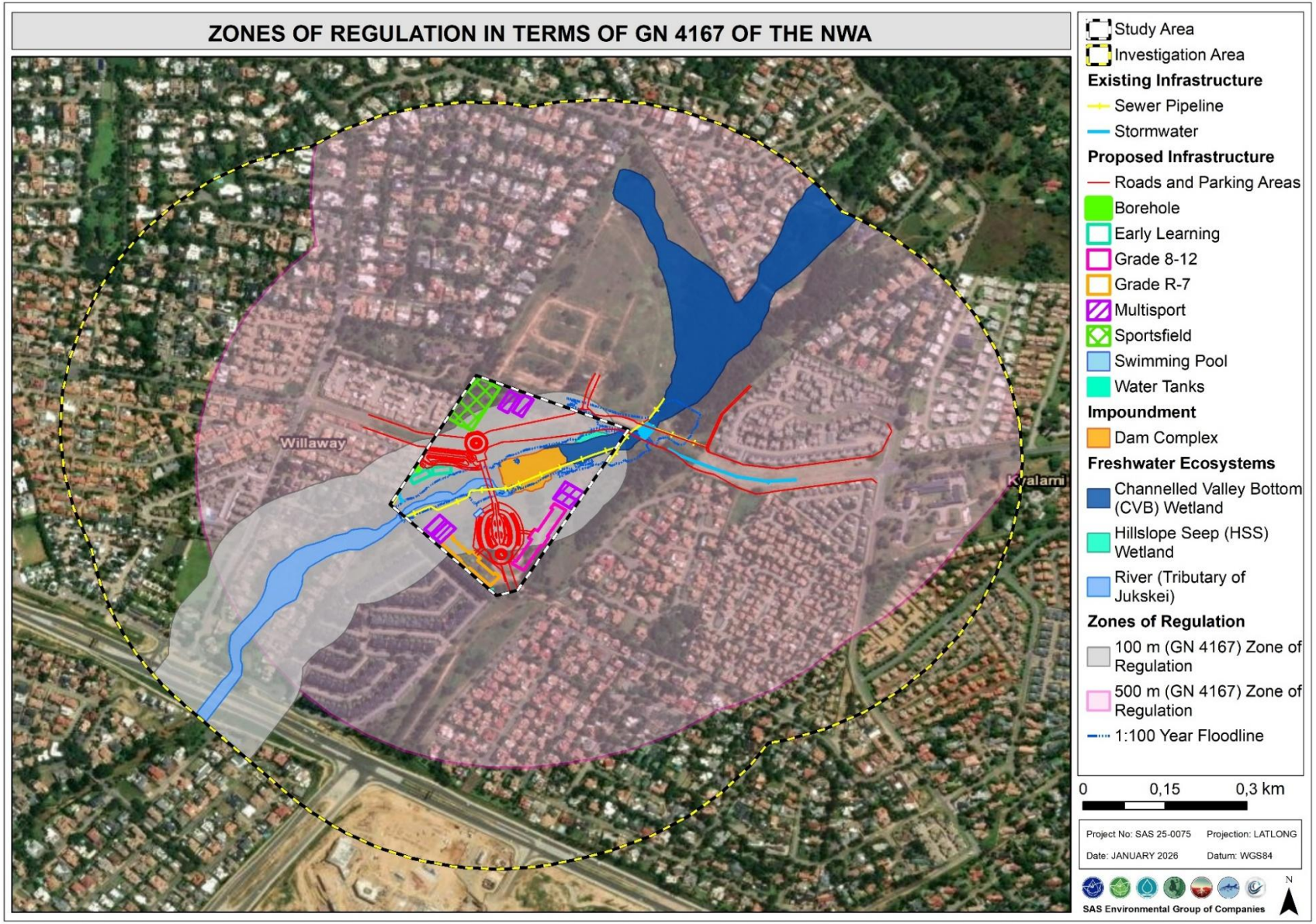


Figure 17: Overview of the the GN 4167 zones of regulation in terms of the NWA associated with the study and investigation area.

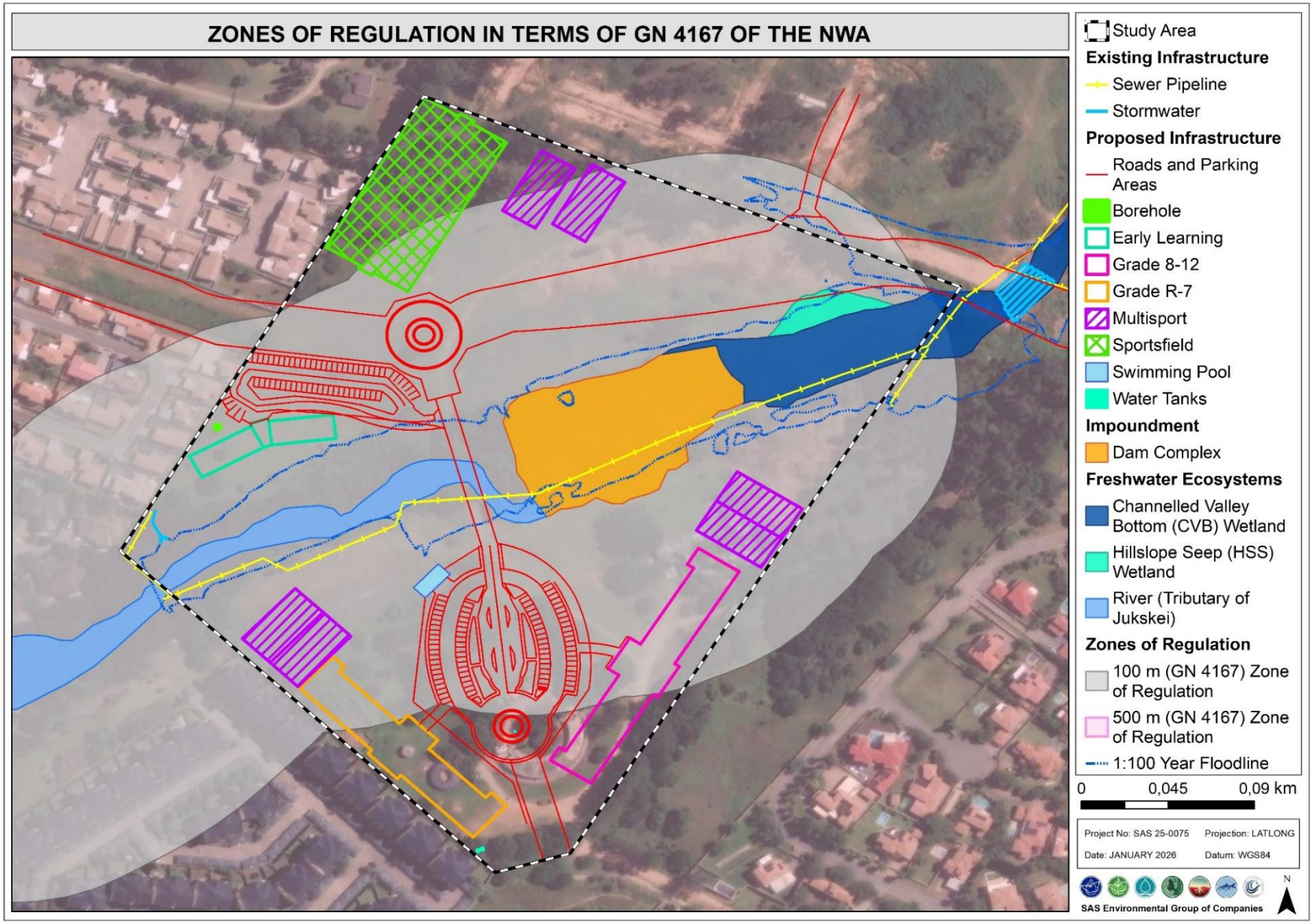


Figure 18: The GN 4167 zones of regulation in terms of the NWA associated with the study area.

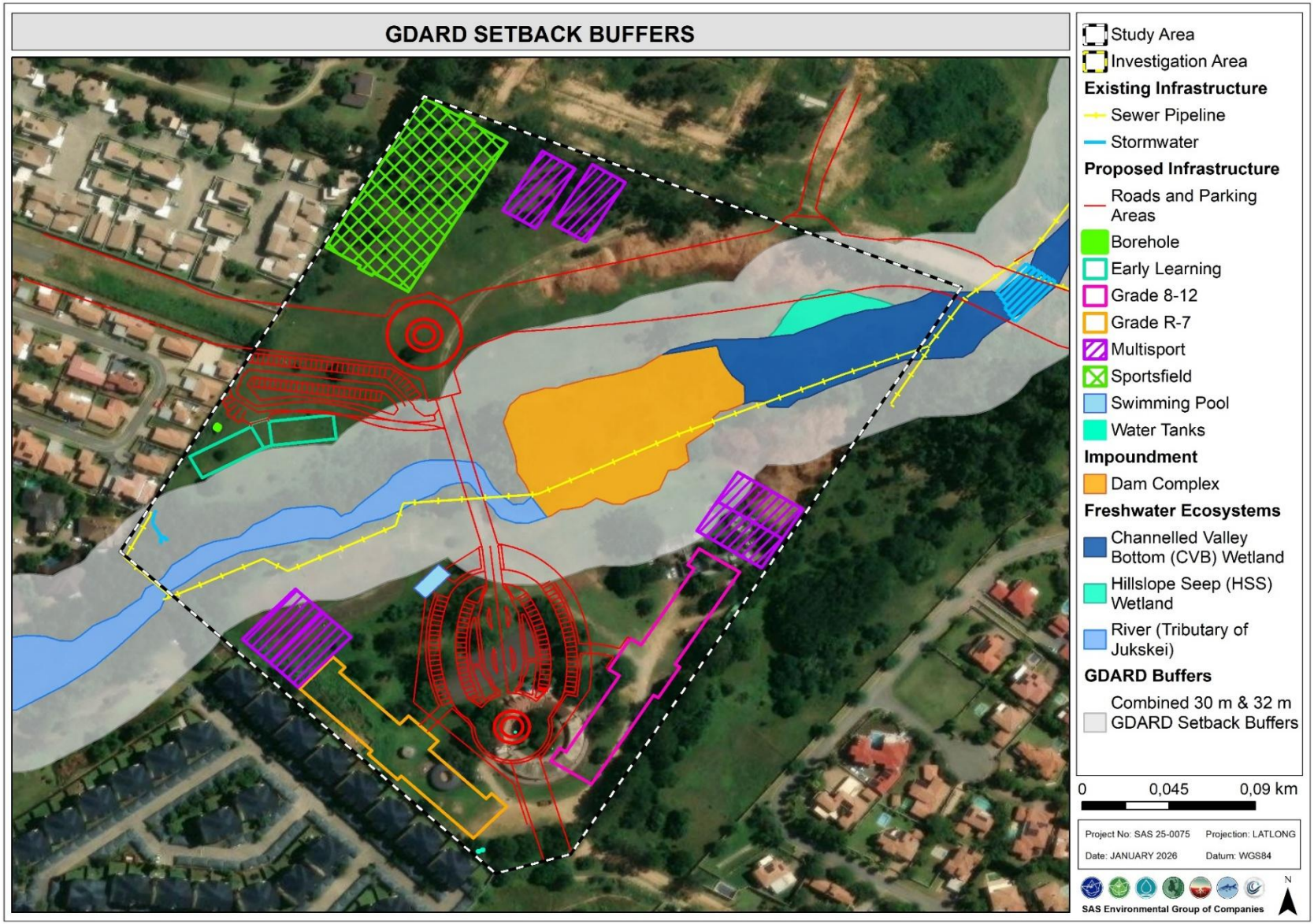


Figure 19: The applicable GDARD buffer zone associated with the study area.

7.2 *Ecological Buffer Zones*

To offer a measure of protection to freshwater ecosystems, non-developable buffer areas are necessary to be designated around all freshwater ecosystems in the study area. According to Macfarlane & Bredin (2017a), the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however in summary, it is considered “a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another”. Buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of wetland ecological services), reduce impacts on water resources arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane & Bredin 2017a). It should be noted however, that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane & Bredin 2017a).

The scientific Buffer Guideline Tool (Macfarlane & Bredin 2017b) was applied to the freshwater ecosystems in the study area. The buffer guideline provides an Excel™ based Buffer Zone Tool to determine suitable buffer zone requirements. The tool includes a rapid desktop tool for determining potential aquatic impact buffer zone requirements together with a site-based tool for determining buffer zone requirements for rivers, wetlands and estuaries. Central to the tool is a buffer model, which is populated automatically from the data inputted. This is based on best available science and is used to generate buffer zone recommendations as part of the assessment process. Figure 20 below outlines an overview of the step-wise assessment process for buffer zone determination as applied through the tool. The buffer assessment was determined using site-based parameters using data collected for the (on-site) detailed assessment of freshwater ecosystems in the study area. Table 11 details the results of the refined buffer assessment.

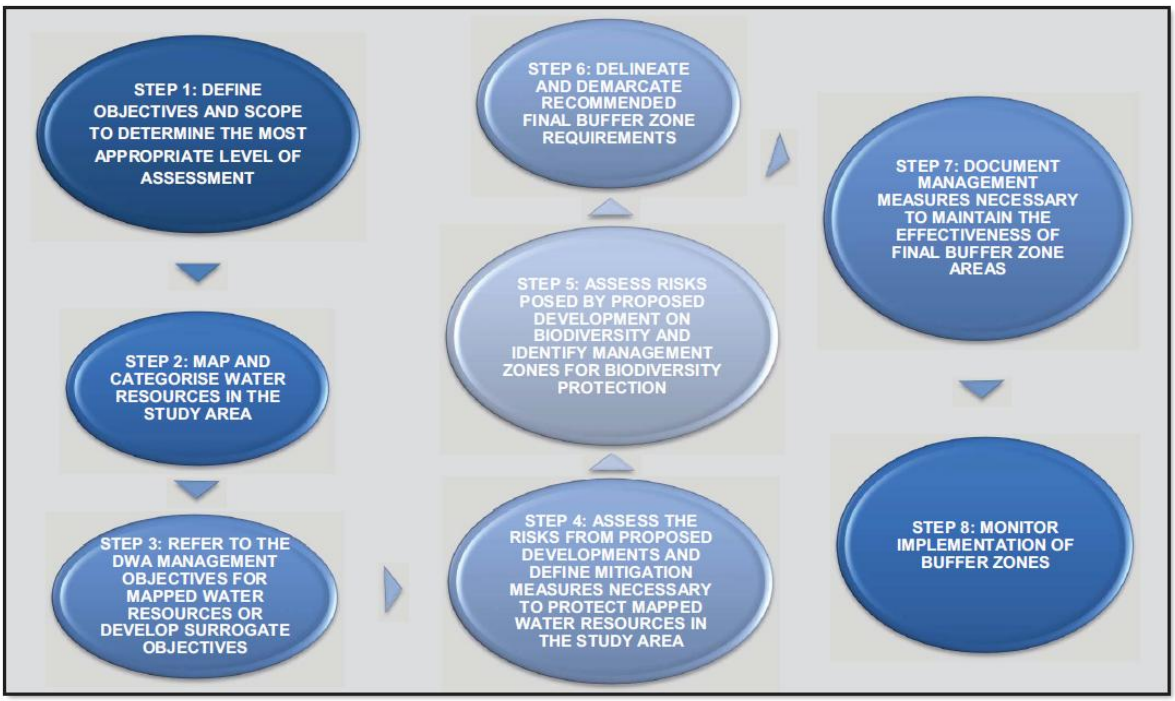


Figure 20: Overview of the step-wise assessment process for buffer zone determination as applied through the buffer tool.

Table 11. Buffers as recommended by the buffer tool for the study area freshwater ecosystems.

Freshwater Ecosystem	Construction phase buffer	Operational Phase buffer	Final aquatic impact buffer
Channelled Valley Bottom (CVB) Wetland	15m	15m	**15m**
Hillslope Seep (HSS) Wetland	15m	15m	**15m**
Non-perennial Drainage Line (NDL)	15m	15m	**15m**

Note that while the dam situated inside the CVB wetland is technically an artificial feature, and does not form part of the natural wetland habitat, a **10 m 'best practice' buffer** was assigned to the dam, given its high connectivity to the natural freshwater ecosystems in the study area.

The combined 15 m and 10 m ecological buffer area for the respective watercourses are illustrated in Figure 21 below. The final aquatic impact buffer requirement is based on the maximum of the recommended buffers for the construction and operational phases and taking practical considerations into account.

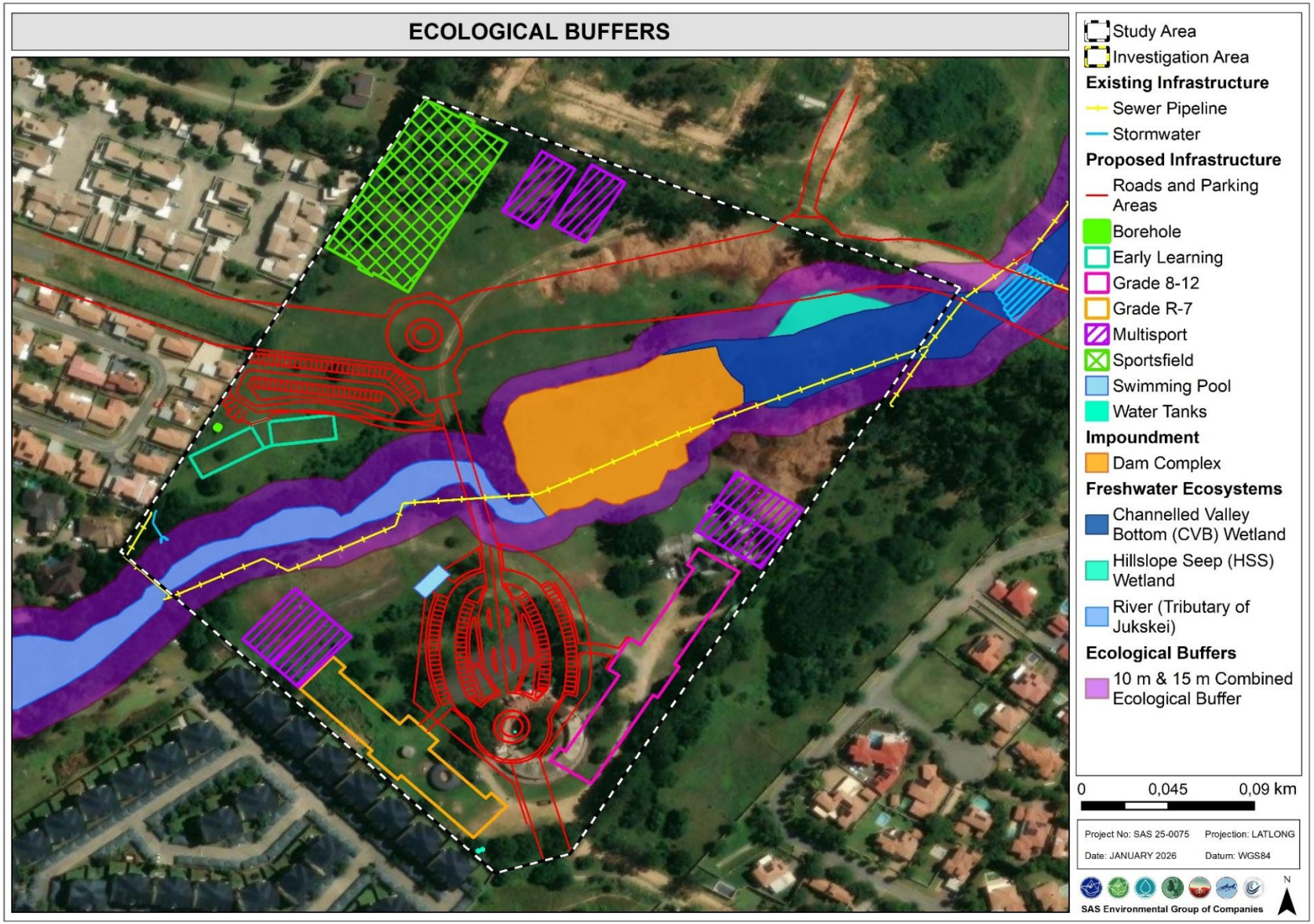


Figure 21: The ecological buffers associated with the freshwater ecosystems located inside the study area.

8 RISK ASSESSMENT

Following the assessment of the freshwater ecosystems associated with the study area, the DWS-prescribed RAM (as prescribed by GN 4167 of December 2023) was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of these freshwater ecosystems.

8.1 *Considerations Taken When Applying the DWS RAM*

The risk assessment was applied to ascertain the significance of perceived risks on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the identified freshwater ecosystems. The points below summarise the considerations made when applying the risk assessment:

- In deciding on the best course of action in terms of the project specific methodology and footprint placement, it was assumed that the mitigation hierarchy would be followed, therefore that freshwater ecosystem habitat would be avoided (the most preferable option), followed by minimisation of impacts (mitigation) if all freshwater ecosystem habitat cannot be avoided;
- The DWS RAM was applied to the proposed layout as provided by the proponent at the time of writing this report. If any additions or alterations are made to the layout as displayed in this report, the RAM assessment must be revised to take into account the amendments made to the proposed layout;
- While the operation of the proposed development will be a long-term to permanent activity, the construction thereof is envisioned to take no more than a few months to a few years. However, the frequency of the construction impacts in a given area may be daily during this time;
- Most impacts are considered to be easily detectable, but with the requirement of continued monitoring of the site throughout the life of the proposed projects.

8.2 *Risk Assessment Discussion of Anticipated Impacts*

There are five key ecological risks on the freshwater ecosystems that were identified, namely:

- Loss of freshwater habitat and ecological structure resulting in impacts to biota;
- Changes to the socio-cultural and service provision;
- Impacts on the hydrology and sediment balance of the freshwater ecosystems;
- Impacts on water quality; and
- Proliferation of alien and invasive plant species.

The results of the risk assessment are summarised in Table 12 overleaf, and the recommended mitigation measures, which must be implemented to reduce the impacts of the proposed activities are presented in Table 13.

The majority of the footprint areas have been optimised to avoid the delineated extent of the watercourses and associated 15 m buffer areas. The proposed infrastructure is also mostly located outside the 1 in 100 year floodlines of the watercourse habitat. Some activities are proposed within the delineated extents of the watercourses. These include the upgrade of the crossing over a section of the Non-Perennial Drainage line, in the position of the existing small earth dam wall, thus reducing impact, and a marginal portion of an access road that encroaches on a small section of the HSS wetland. While there is a 100% probability that these watercourses would be impacted should the proposed activities commence, these impacts are likely to be very localised if the mitigation measures outlined in Table 13 below are strictly implemented to minimise edge effects. Despite the low risk significance outcome, it is highly recommended that the layout of the proposed roadway be further revised to avoid the HSS wetland and its associated ecological buffer area if possible.

All construction and operational phase activities are considered to pose a ‘Low’ risk significance to the watercourses inside the study area.

Kindly refer to **Appendix G** for the full DWS risk assessment table scorings and **Appendix I** for general good housekeeping practices that must be implemented.

Table 12: Summary of the results of the DWS risk assessment matrix applied to the freshwater ecosystems associated with the study area.

Phase	Activity	Impact	Potentially affected watercourses			Overall Intensity (max = 10)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
			Name/s	PES	Overall Watercourse Importance								
CONSTRUCTION	Site clearing and commencement of construction activities for the proposed development, which may include: • Removal of vegetation leading to exposure of soils and associated disturbances to soils. • Increased likelihood of dust generation due to exposed soils. • Removal of topsoil and creation of topsoil stockpiles. • Possible indiscriminate driving through watercourse areas by construction vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from construction vehicles.	• Compaction of soils, in turn potentially leading to increased runoff and erosion. • Potential sedimentation of the watercourses as a result of sediment laden runoff, leading to smothering of freshwater ecosystem vegetation and potentially altering surface water quality. • Disturbances of soils leading to increased alien vegetation proliferation, which may spread to the adjacent freshwater ecosystem habitat. • Potential hydrocarbon contamination of the watercourse areas. • Potential altered flow regime as a result of solid waste disposal in proximity to the freshwater ecosystems and within the freshwater ecosystems themselves. • Potential altered water quality due to chemical waste disposal. • Potential decreased ecoservice provision and reduction of PES as a result of the abovementioned impacts.	Channelled Valley Bottom (CVB) wetland	D	Moderate	**6**	**9**	**3**	**27**	40%	**10,8**	**L**	High
			Hillslope Seep (HSS) wetland	D	Low	**6**	**9**	**2**	**18**	60%	**10,8**	**L**	High
			Non-perennial Drainage Line	E	Moderate	**6**	**9**	**3**	**27**	40%	**10,8**	**L**	High

Phase	Activity	Impact	Potentially affected watercourses			Overall Intensity (max = 10)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
			Name/s	PES	Overall Watercourse Importance								
	Activities to occur **outside the 15 m ecological buffer areas and 1 in 100 year floodline** of watercourses.												
	Site clearing and construction of the roads and road crossing, which may include: • Disturbance of soils inside the watercourse channel bed. • Removal of vegetation leading to exposure of soils and associated disturbances to soils. • Removal of topsoil and creation of topsoil stockpiles. • Possible indiscriminate driving through watercourse areas by construction vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from	• Potential sediment laden runoff into the watercourse with disturbance of soil. • Potential loss/damage of additional freshwater habitat as a result of indiscriminate movement outside the demarcated footprint area. • Potential riverbank destabilisation as a result of road upgrading activities. • Disturbances of soil, potentially leading to increased AIP proliferation and altered freshwater habitat. • Potential for deterioration of water quality as a result of contaminated runoff from construction area to adjacent freshwater ecosystem environment. • Potential loss of hydraulic connectivity if flow obstructions are created during the construction process.	Non-perennial Drainage Line	E	Moderate	**6**	**9**	**3**	**27**	100%	**27**	**L**	High
			Hillslope Seep (HSS) wetland	D	Low	**6**	**10**	**2**	**20**	100%	**20**	**L**	High

Phase	Activity	Impact	Potentially affected watercourses			Overall Intensity (max = 10)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
			Name/s	PES	Overall Watercourse Importance								
	construction vehicles • Potential creation of flow obstructions inside the watercourse channel during the road upgrading process. Activities to occur **inside the 15 m ecological buffer area and 1 in 100 year floodline** of a watercourse.												
OPERATION	• Operation and maintenance of the proposed development, which include: • Increased runoff of stormwater into the receiving freshwater environment from increased extent of impermeable surfaces. • Periodic maintenance to infrastructure, which may involve small-scale	• Increased catchment yield and altered flow regime may lead to changed wetland zonation, and possible impacts on vegetation as a result. • Potential local changes to the water retention patterns, timing and flows of watercourses. • Potential unattenuated discharge of stormwater into the receiving environment, potentially leading to sedimentation and erosion of the receiving environment. • Potential soil and water contamination	Channelled Valley Bottom (CVB) wetland	D	Moderate	**6**	**12**	**3**	**36**	80%	**28,8**	**L**	High
			Hillslope Seep (HSS) wetland	D	Low	**6**	**12**	**2**	**24**	80%	**19,2**	**L**	High

Phase	Activity	Impact	Potentially affected watercourses				Overall Intensity (max = 10)		Severity (max = 20)	Importance rating (max = 5)		Consequence (max = 100)		Likelihood (Probability) of impact		Significance (max = 100)	Risk Rating	Confidence level
			Name/s	PES	Overall Watercourse Importance													
	construction activities. • Possible indiscriminate driving through watercourse areas by maintenance vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from maintenance vehicles • Potential creation of flow obstructions inside the watercourse channel by the road crossing (i.e. blockages of the culvert systems). • General increased anthropogenic activity within proximity to the wetlands, with increased probability of disturbance to freshwater habitat soils, fauna and flora.	by waste and hydrocarbons from vehicles. • Potential eutrophication of the freshwater ecosystems as a result of increased nitrates and phosphate loads from untreated effluent (from the sewer infrastructure) due to potential leakage of the pipelines in the event of a leak of damage to the pipeline infrastructure. Altered breeding and feeding habits of fauna as a result of disturbance. • Potential decreased ability of the watercourses to provide ecosystem services. • Potential degradation of watercourse habitat.	Non-perennial Drainage Line	E	Moderate		**6**		**12**	**3**		**36**		80%		**28,8**	**L**	High

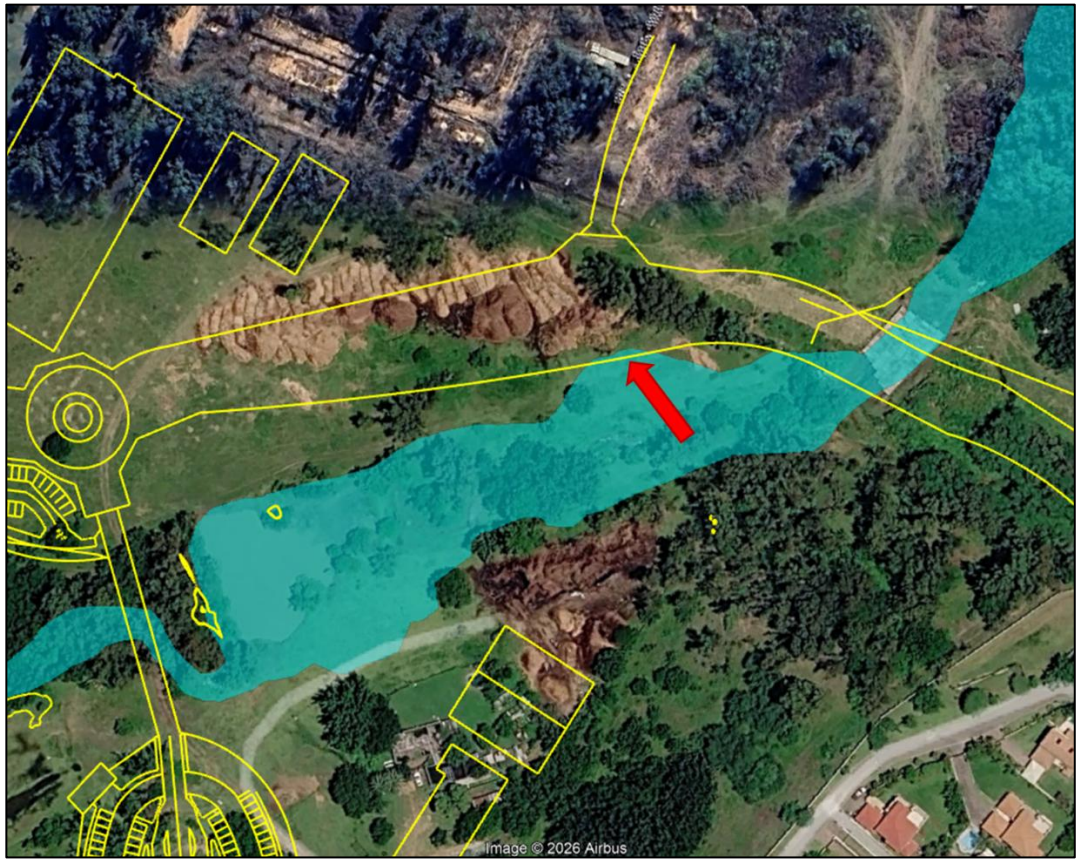
Table 13: Mitigation measures developed for the project.

Phase	Activity	Impact	Mitigation Measures
PRE-CONSTRUCTION (PLANNING)	NA	NA	**The following aspects must be considered before construction commences, during the planning phase of the project:** ➢ Construction works must preferably be undertaken during the driest period of the year when there is reduced risk of significant stormwater runoff from the construction site to the receiving environment. ➢ In terms of planning of construction phase activities and vegetation restoration, cognisance must be given to the best time for construction (winter months) and the best time for re-vegetation (spring/early summer). Preferably, construction must be timed to finish at the end of the winter dry season, so that re-vegetation can commence soon after to minimise the time that soils are exposed. ➢ The placement of linear infrastructure (e.g. powerlines, cables or pipelines) must avoid the freshwater ecosystem habitat as far as possible. If crossings over the freshwater ecosystems are unavoidable, free-spanning aboveground structures must be preferred to trenching, unless infrastructure can be installed by means of directional drilling or pipe-jacking (whilst considering the depth of interflow and groundwater tables). ➢ Powerlines, pipes or cables may be aligned with existing crossings (i.e. road infrastructure) to limit the creation of additional footprint areas. ➢ A formal Stormwater Management Plan (SWMP) must be designed by a suitably qualified engineer/hydrologist which must consider the increased runoff potential and increased sedimentation potential of the areas permanently kept clear of vegetation. ➢ As part of the SWMP, it must be ensured that all stormwater discharge is done in an attenuated manner. The stormwater infrastructure and outlets must therefore be appropriately designed to achieve this (also refer to construction phase mitigation measures below). ➢ It is highly recommended that stormwater attenuation ponds be designed for the proposed development to ensure pre- and post development runoff is curtailed on site. ➢ Consideration should be given to using materials which will assist in increasing the surface roughness within the bioswales and stormwater attenuation ponds (such as stone cobbles) to assist with energy dissipation and prevent sedimentation and erosion as well as improve habitat provision. ➢ Other examples of these which may be applicable to this development include permeable paving, rainwater harvesting, soakaways and swales to ensure that post-development runoff does not exceed pre-development runoff volumes and lead to altered flood peaks. ➢ It is highly recommended that the design for the road crossing be in the form of a free-span bridge (examples in Figure 22 below). A free-span bridge would allow the stream to flow uninterrupted under the crossing and therefore ensure the greatest level of hydraulic connectivity.

Figure 22: Examples of a free-span bridge design, which will eliminate the need for culvert systems and minimise flow obstruction inside the watercourse.

- If the crossing needs to be designed with a culvert system, the following summary points summarise the key aspects to consider regarding culvert design:
  - Ensure that the construction of the road crossings does not result in a significant water level difference upstream or downstream of the culvert. Ensure that the concrete base slab and culvert inverts are embedded below the natural ground level of the wetland to prevent erosion and scouring and allowing for water flow and prevention of ponding as well as facilitate migrational movement of aquatic fauna even under low flow conditions and to minimise or prevent the need for bed or bank reinforcement. or road weirs or aprons.
  - The crossing width must ensure that no concentration of flow occurs which increases velocity and turbulence and which would lead to erosion and scour.
  - The size of the culvert openings must be designed to at least accommodate a 1 in 10 year flood, although it is preferable that the culverts are designed to withstand a 1 in 100 year flood to avoid overtopping of the bridge, which may cause structural damage to the road infrastructure.
  - It must be ensured as far as possible that the culvert is never more than 80% full during peak flows. This will reduce the need to clear debris from the culverts, which may eventually cut off flows and result in structural damage of the road.
  - Avoid locating the culvert at an acute angle to the stream. Thus, the road and associated culvert crossings must be designed at a 90° angle which would ensure the shortest distance over the stream and thus reduce the disturbance area.
  - All designs and method statements must be signed off by the freshwater specialist.

While the proposed footprint areas have been optimised to mostly avoid the delineated extents of the freshwater ecosystems and their associated ecological buffer areas, a small section of the HSS wetland is encroached by one of

			the proposed access roads (Figure 23). It is highly recommended that the position of the access road be slightly adjusted to avoid the wetland and its ecological buffer area if possible.  **Figure 23: An area where the proposed infrastructure (yellow outline) encroaches on a section of one of the wetlands in the study area (red arrow). It is recommended that the layout be adjusted in this area to avoid the wetland and 15 m ecological buffer area if possible.**

Phase	Activity	Impact	Mitigation Measures
CONSTRUCTION	Site clearing and commencement of construction activities for the proposed development, which may include: • Removal of vegetation leading to exposure of soils and associated disturbances to soils. • Increased likelihood of dust generation due to exposed soils. • Removal of topsoil and creation of topsoil stockpiles. • Possible indiscriminate driving through watercourse areas by construction vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from construction vehicles. Activities to occur **outside the 15 m ecological buffer areas and 1 in 100 year floodline of watercourses**.	• Compaction of soils, in turn potentially leading to increased runoff and erosion. • Potential sedimentation of the watercourses as a result of sediment laden runoff, leading to smothering of freshwater ecosystem vegetation and potentially altering surface water quality. • Disturbances of soils leading to increased alien vegetation proliferation, which may spread to the adjacent freshwater ecosystem habitat. • Potential hydrocarbon contamination of the watercourse areas. • Potential altered flow regime as a result of solid waste disposal in proximity to the freshwater ecosystems and within the freshwater ecosystems themselves. • Potential altered water quality due to chemical waste disposal. • Potential decreased ecoservice provision and reduction of PES as a result of the abovementioned impacts.	**Limit the footprint area and edge effects:** ➢ The entire construction area (development site) must be fenced prior to the commencement of construction and vegetation clearing to ensure that no vehicle or other construction personnel access occurs off the approved site. ➢ Contractor laydown areas and stockpiles must be established outside of the delineated watercourses and the applicable 15 m buffer area. ➢ The development footprint areas must remain as small as possible and clearing of vegetation within the study area must be kept to a minimum and only within areas under active construction (i.e. the entire plot of land should not be cleared of vegetation unless active construction is to commence. ➢ Vehicles must be parked at the contractor laydown area on an impermeable surface. ➢ Access to the study area is available through the use of existing roads and as such no indiscriminate movement of construction equipment is allowed within the watercourses. ➢ Dust suppression measures must be implemented throughout construction to prevent excessive dust which may impact wetland vegetation. ➢ Erosion control must be strictly implemented in all construction areas where soil is exposed. Sediment traps (i.e. drifts fences/silt curtains or sandbags) should be used to prevent runoff from exposed soil into the adjacent freshwater environment. **Waste management and pollution control:** ➢ All re-fueling and servicing of construction vehicles should be undertaken off-site. ➢ Suitable waste disposal facilities must be provided. These facilities must be located outside of the delineated freshwater ecosystems and the associated 15 m buffer areas, should be safely cordoned off, and be out of sight (where possible) to limit the visual impact. ➢ These facilities must regularly be emptied and taken to a registered waste disposal facility and waybill slip for the disposed waste must be kept in the onsite Environmental file. ➢ An emergency spill response plan must be developed by the contractor to deal with any spills, especially in sensitive areas near the freshwater ecosystem boundaries. **AIP control:** ➢ An Alien Invasive Management Plan must be developed before construction commences, and the requirements therein must be strictly implemented throughout the construction process. ➢ Monitoring for AIP proliferation within the construction site must be done on a regular basis during the construction period. ➢ Should AIPs be identified, they must be removed and disposed of as per the development's alien and invasive species control plan, and the area must be revegetated with suitable indigenous vegetation.
	Site clearing and construction of the roads and road crossing, which may include:	• Potential sediment laden runoff into the watercourse with disturbance of soil.	**In addition to the recommendations on the crossing design described above, the following mitigation measures are given for the crossing construction:** ➢ The construction activities must take place as far as possible along the existing road surface. ➢ Flow must be maintained in the stream channel at all times during the construction process.

Phase	Activity	Impact	Mitigation Measures
	• Disturbance of soils inside the watercourse channel bed. • Removal of vegetation leading to exposure of soils and associated disturbances to soils. • Removal of topsoil and creation of topsoil stockpiles. • Possible indiscriminate driving through watercourse areas by construction vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from construction vehicles • Potential creation of flow obstructions inside the watercourse channel during the road upgrading process. Activities to occur **inside the 15 m ecological buffer area and 1 in 100 year floodline of a watercourse.**	• Potential loss/damage of additional freshwater habitat as a result of indiscriminate movement outside the demarcated footprint area. • Potential riverbank destabilisation as a result of road upgrading activities. • Disturbances of soil, potentially leading to increased AIP proliferation and altered freshwater habitat. • Potential for deterioration of water quality as a result of contaminated runoff from construction area to adjacent freshwater ecosystem environment. • Potential loss of hydraulic connectivity if flow obstructions are created during the construction process.	➢ Under no circumstances must construction related rubble, waste and soil be deposited inside the stream channel. ➢ Erosion control must be strictly implemented for construction activities to occur within the delineated extent of the watercourse. **All other mitigation measures relating to the prevention of edge effects, pollution control and AIP control described above also applies.**

Phase	Activity	Impact	Mitigation Measures
OPERATION	• Operation and maintenance of the proposed development, which include: • Increased runoff of stormwater into the receiving freshwater environment from increased extent of impermeable surfaces. • Periodic maintenance to infrastructure, which may involve small-scale construction activities. • Possible indiscriminate driving through watercourse areas by maintenance vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from maintenance vehicles • Potential creation of flow obstructions inside the watercourse channel by the road crossing (i.e. blockages of the culvert systems). • General increased anthropogenic activity within proximity to the wetlands, with increased probability of disturbance to freshwater habitat soils, fauna and flora.	• Increased catchment yield and altered flow regime may lead to changed wetland zonation, and possible impacts on vegetation as a result. • Potential local changes to the water retention patterns, timing and flows of watercourses. • Potential unattenuated discharge of stormwater into the receiving environment, potentially leading to sedimentation and erosion of the receiving environment. • Potential soil and water contamination by waste and hydrocarbons from vehicles. • Potential eutrophication of the freshwater ecosystems as a result of increased nitrates and phosphate loads from untreated effluent (from the sewer infrastructure) due to potential leakage of the pipelines in the event of a leak of damage to the pipeline infrastructure. Altered breeding and feeding habits of fauna as a result of disturbance. • Potential decreased ability of the watercourses to provide ecosystem services. • Potential degradation of watercourse habitat.	**Management of the wetland areas**: ➢ To increase the socio-economic value of the freshwater habitat, it is proposed that the wetland areas be instated as green spaces, with benches/picnic areas and recreational facilities to encourage low-impact recreational utilisation of the space. This will add incentive for the upkeep and maintenance of the open space areas, and add value to the development rather than representing unused and unsightly areas on the property. Some sporadic shade trees may be planted outside the immediate wetland extents, although only native species (e.g. *Celtis africana*, *Combretum erythrophyllum* and *Searsia lancea*) must be planted. The planting of invasive groundcover species such as Kikuyu (*Cenchrus clandestinus*) must be avoided. **Management of flow in the landscape:** ➢ The outlet structures from stormwater pipes must be at ground level so as to prevent erosion and gully formation. Suitable engineering solutions (such as a concrete apron or gabion mattress) should be utilised at all outlet structures. ➢ The outlet structure should have cobbles from the release point for a minimum of 5 m to assist in energy dispersal and dispersal of water across the attenuation pond. ➢ Regular inspection of the stormwater outlet structures, and attenuation ponds should be undertaken (specifically after large storm events) to monitor the occurrence of erosion. If erosion has occurred, it should immediately be rehabilitated through stabilisation of the embankments and revegetation. **Waste management and pollution control:** ➢ It is recommended that the managing authority test the integrity of sewer pipelines at least once every five years or more often should there be any sign or reports of a leak. ➢ Should a blockage occur, all possible steps must be taken to prevent the pollution of the nearby watercourses during repair, including the placement of sheeting around the manhole used for access as well as containment barrels for any effluent withdrawn. ➢ An emergency plan should be compiled to ensure a quick response in case of a leakage or bursting of the pipeline. ➢ All mitigation measures relating to the construction phase also applies to the operational phase of the project. **Limit the footprint area and edge effects:** ➢ Only existing roadways should be utilised during maintenance activities to avoid indiscriminate movement of vehicles within any of the freshwater ecosystems. ➢ As far as possible, the recommended 15 m buffer area should be implemented around the watercourses and must be revegetated with indigenous terrestrial vegetation where vegetation may have been lost during construction or during maintenance activities ➢ A Rehabilitation Maintenance and Management Plan must be developed to include site specific details for the rehabilitation requirements. **AIP control:** ➢ An Alien Invasive Plant (AIP) management plan should be developed and implemented following construction.

9 CUMULATIVE IMPACT STATEMENT

Cumulative impacts are activities and their associated impacts on the past, present and foreseeable future, both spatially and temporally, considered together with the impacts identified in Section 8.2 above. Freshwater ecosystems within the region are under continued threat due to rapid land use transformation in the surrounding landscape, with specific mention of large-scale urbanisation. Direct and indirect impacts associated with the proposed development on the identified freshwater ecosystems can predominantly be attributed to vegetation clearing and earthworks inside freshwater ecosystems, the disturbance to the hydrological connectivity and functioning of the freshwater ecosystems (through altering the timing and patterns of flow in the landscape) and alien and invasive species establishment. Such transformation may be highly localised at the scale of the individual development, but cumulatively this may represent a larger area of freshwater ecosystem habitat loss or alteration.

Such edge effects relating to the development (and future developments in the region) may have cumulative impacts on the freshwater ecosystems, with specific mention of alien and invasive species establishment, increased sediment loads and increased availability of hydrocarbons which may contribute negatively to water quality. However, with the proposed management and mitigation measures implemented during the construction phase, including appropriate erosion control, and monitoring of infrastructure areas for any erosion and AIP proliferation during the operational phase, the direct and indirect negative impacts can be reduced, thus the proposed project is considered unlikely to result in significant cumulative impacts on the larger catchment.

10 CONCLUSION

Scientific Aquatic Services (SAS) (Pty) Ltd was appointed to conduct a freshwater ecological assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Vorna Valley Spark School, in the Carlswald suburb of Midrand, Gauteng Province. The proposed development is located on the TLC Stables property. The proposed development area was referred to in this report as the "study area".

Freshwater ecosystem assessment:

The freshwater ecosystem assessment was undertaken in June 2025 during which a freshwater ecosystem complex was identified within the central portion of the study area. This freshwater ecosystem consisted of several Hydrogeomorphic (HGM) units, namely, a Channelled Valley Bottom (CVB) wetland, a Hillslope Seep (HSS) wetland and a river (Non-Perennial Drainage Line) system. The freshwater ecosystem HGM units have a moderate to low Ecological Importance and Sensitivity (EIS), and a Present Ecological State (PES) which ranged between largely modified and seriously modified. In terms of ecoservice provisioning, the freshwater ecosystem HGM units were considered to be of moderate to low importance, as a result of their degraded state. Ecosystem services such as sediment trapping, and to a lesser extent, assimilation of nutrients and toxicants are provided by the freshwater ecosystems on a local scale. The results of the ecological assessment of the freshwater ecosystems are discussed in Section 4 of this report and summarised in the table below.

Table B: Summary of the results of the freshwater ecological assessment.

Freshwater Ecosystem	PES	Ecoservice Provisioning	EIS	REC / RMO / BAS*
Channelled Valley Bottom (CVB) Wetland	Category D (Largely Modified)	Moderately Low-Very Low	Moderate	REC Category: D; RMO: D (Maintain); BAS: D
Hillslope Seep (HSS) Wetland	Category D (Largely Modified)	Moderate-Very Low	Low	REC Category: D; RMO: D (Maintain); BAS: D
Non-Perennial Drainage Line	Riparian IHI: Category D/E (Largely to Seriously Modified) VEGRAI: Category E (Seriously Modified)	Moderately Low-Very Low	Moderate	REC Category: D; RMO: D (Improve); BAS: D

Water Quality Results:

Basic water quality parameters were recorded at two sites situated on the freshwater ecosystem complex (upstream and downstream of the study area). The pH can be regarded as within acceptable ranges at the time of the assessment for both sites (DWS, 2021). Measured Electrical Conductivity (EC) was elevated at both sites and therefore did not comply

with the RWQOs considered (DWS, 2021). The Dissolved Oxygen (DO) levels were within the stipulated recommended ranges (DWS, 2021) at both sites. The diatom analysis revealed that both upstream and downstream sites have a moderate to high diatom species diversity with a relatively even distribution of taxa. Based on the Specific Pollution Sensitivity Index (SPI) score, the upstream site is considered to be in moderate ecological quality (Category C/D); however, the downstream site was indicated to be in a poor ecological condition (Category D). The dominant diatom species, functional groups, ecological guilds, size classes, and index scores suggest a mesotrophic to eutrophic condition for the upstream site and a eutrophic condition for the downstream site. The presence of pollution-tolerant but not metal-sensitive species suggest that the site is mainly impacted by nutrient enrichment rather than metals. Impacts at the site are likely due to urban runoff and diffuse anthropogenic inputs from the surrounding catchment.

DWS Risk Assessment:

Following the freshwater ecosystem assessment, the Department of Water and Sanitation (DWS) Risk Assessment Matrix (2023) (RAM) was applied to determine the significance of impacts of the proposed development on the identified freshwater ecosystem habitats (confirmed to conform to the definition of a watercourse as per the NWA). The majority of the footprint areas have been optimised to avoid the delineated extent of the watercourses and associated 15 m buffer areas. The proposed infrastructure is also mostly located outside the 1 in 100 year floodlines of the watercourse habitat. Some activities are proposed within the delineated extents of the watercourses. These include the upgrade of the crossing over a section of the Non-Perennial Drainage Line, in the position of the existing small earth dam wall, thus reducing impact, and a marginal portion of an access road that encroaches on a small section of the HSS wetland. While there is a 100% probability that these watercourses would be impacted should the proposed activities commence, these impacts are likely to be very localised if the mitigation measures outlined in Section 8 of this report are strictly implemented to minimise edge effects. Despite the low risk significance outcome, it is highly recommended that the layout of the proposed roadway be further revised to avoid the HSS wetland and its associated ecological buffer area if possible.

Conclusion:

If all mitigation measures as stipulated in Section 8 of this report are implemented to prevent any edge effects and cumulative impacts from occurring on the sensitive freshwater ecosystems, it is the opinion of the freshwater specialist that the proposed development project may be authorised by the respective authorities.

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APPENDIX A – Terms of Use and Indemnity

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

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APPENDIX B – Legislation

LEGISLATIVE CONSIDERATIONS

The Constitution of the Republic of South Africa, 1996	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
National Environmental Management Act (Act No. 107 of 1998) (NEMA)	The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
National Environmental Management: Biodiversity Act (2004) (Act 10 of 2004) (NEMBA)	**Ecosystems that are threatened or in need of protection** (1) (a) The Minister may, by notice in the Gazette, publish a national list of ecosystems that are threatened and in need of protection. *(b)* An MEC for environmental affairs in a province may, by notice in *the Gazette,* publish a provincial list of ecosystems in the province that are threatened and in need of protection. (2) The following categories of ecosystems may be listed in terms of subsection (1): *(a)* critically endangered ecosystems, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation; *(b)* endangered ecosystems, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems; (c) vulnerable ecosystems, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and *(d)* protected ecosystems, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed in terms of paragraphs (a), (b) or (c).
The National Water Act 1998 (Act No. 36 of 1998) (NWA)	The National Water Act (NWA) (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
Government Notice 4167 as published in the Government Gazette 49833 of 08 December 2023 as it relates to the NWA (Act 36 of 1998) as amended	GN 4167 outlines the parameters and process of a General Authorisation (GA), which replaces the need to apply for a licence in terms of Section 40 of the NWA, provided that the water use is within the limits and conditions of the GA. The notice replaces GN 509 of 2016. The GA sets out the need to determine the regulated area of a watercourse, as well as the degree of risk posed by an activity/ies related to a particular water use. In accordance with GN 4167 of December 2023, the regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: a) the outer edge of the 1 in 100-year flood line or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake, or dam;

	b) in the absence of a determined 1 in 100-year flood line or riparian area the area within 100 m distance from the edge of a watercourse where the edge of the watercourse (excluding flood plains) is the first identifiable annual bank fill flood bench; or c) In respect of a wetland, a 500 m radius around the delineated boundary (extent) of any wetland, including pans. The GA only applies to the use of water in terms of Section 21(c) and (i) of the NWA where the risk class is LOW as determined through the application of the Risk Matrix as prescribed in the Notice. The GA also does not apply where other Section 21 water uses are triggered, does not apply for most sewage infrastructure and pipelines carrying hazardous materials, water uses associated with hazardous materials, water uses associated with water and wastewater treatment works, and for most mining-related water uses. The GA may be exercised as follows: i) Section 21(c) or (i) water use activities that are determined to pose a LOW Risk as determined through the application of the Risk Matrix as prescribed in the Notice can be undertaken subject to the general conditions of the GA; ii) Section 21(c) or (i) water use activities set out in Appendix D1 of the Notice can be undertaken without being subject to the requirement of a risk assessment and subject to the general conditions of the GA. Such water use activities in Appendix D1 include inter alia emergency river crossings, fence erection, solar renewable infrastructure that has no direct impact on watercourses and mini-scale hydropower developments; iii) Prescribed water use activities undertaken by certain State Owned Entities as detailed in Appendix D2 of the Notice can be undertaken without being subject to the requirement of a risk assessment and subject to the general conditions of the GA; iv) Maintenance work associated an existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix can be undertaken ; v) River and stormwater management activities including maintenance of infrastructure as contained in a river management plan or similar management plan, may be conducted subject to the approval of such a plan by the relevant DWS regional office or catchment management agency; vi) Rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix can be conducted; and vii) Emergency work arising from an emergency situation and or incident associated with the persons' existing lawful water use entitlement can be undertaken, provided that all work is executed and reported in the manner prescribed in the Emergency protocol contained in Appendix C of the GA. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.
Specific guidelines for meeting minimum requirements for CBA and ESA wetlands (MBSP, 2014).	➢ All wetlands are protected under the National Water Act, 1998 (Act No. 36 of 1998). ➢ In terms of the National Water Act, freshwater ecosystems (all wetlands included) should not be allowed to degrade to an unacceptably modified condition (E or F ecological category). ➢ Conduct a buffer determination assessment around all wetlands, regardless of ecological condition or ecosystem threat status. ➢ Any further loss of area or ecological condition must be avoided, including if needed, a 100 m generic buffer around the wetlands.

APPENDIX C – Freshwater Ecosystems Method of Assessment

1. Desktop Study

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

1.1 National Freshwater Ecosystem Priority Areas (NFEPA, 2011)

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

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

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

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

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

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

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

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

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

From the Classification System, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[10] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There is

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

a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

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

Level 3: Landscape Setting

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

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

Level 4: Hydrogeomorphic Units

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

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

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the recently developed tools produced as part of the Wetland Management Series including

WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2020).

3. WET-Health

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

Level of Evaluation

Two levels of assessment are provided by WET-Health:

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

Framework for the Assessment

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

Units of Assessment

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

Quantification of Present State of a wetland

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

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

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

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

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

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

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

4. General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C5 below.

Table C5: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.*2008]

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

5. Watercourse Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[11] The assessment of the ecosystem services supplied by the identified freshwater features was conducted according to the guidelines as described by Kotze *et al.* (2020). An assessment was undertaken that examines and rates 16 different ecosystem services, selected for their specific relevance to the South African situation, as follows:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate assimilation;
- Nitrate assimilation;
- Toxicant assimilation;
- Erosion control;
- Carbon storage;
- Biodiversity maintenance;
- Provision of water for human use;
- Provision of harvestable resources;
- Food for livestock;
- Provision of cultivated foods;
- Cultural and spiritual experience;
- Tourism and recreation; and
- Education and research.

For each ecosystem service, indicator scores are combined automatically in an algorithm given in the spreadsheet that has been designed to reflect the relative importance and interactions of the attributes represented by the indicators to arrive at an overall supply score. In addition, the demand for the ecosystem service is assessed based on the wetland's catchment context (e.g. toxicant sources upstream), the number of beneficiaries and their level of dependency, which are also all rated on a five-point scale. Again, an algorithm automatically combines the indicator scores relevant to demand to generate a demand score.

*It is important to note that when assessing riparian zones associated with riverine habitats, the contribution of the riparian zone to streamflow regulation is omitted, owing to a lack of relevant studies (Kotze *et al*, 2020).

Table C6: Integrating scores for supply and demand to obtain and overall importance score

Integrating scores for supply & demand to obtain an overall importance score						
		Supply				
		Very Low	Low	Moderate	High	Very High
Demand		0	1	2	3	4
Very Low	0	0,0	0,0	0,5	1,5	2,5
Low	1	0,0	0,0	1,0	2,0	3,0
Moderate	2	0,0	0,5	1,5	2,5	3,5
High	3	0,0	1,0	2,0	3,0	4,0
Very High	4	0,5	1,5	2,5	3,5	4,0

A single overall importance score is generated for each ecosystem service by combining the supply and demand scores. This aggregation therefore places somewhat more emphasis on supply than demand, with the supply score acting as the starting score for a "moderate" demand scenario. The importance score is, however, adjusted by up to one class up where demand is "very high" and by up to one class down where demand is "very low". The overall importance score can then be used to derive an importance category for reporting purposes.

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

Table C7: Classes for determining the likely extent to which a benefit is being supplied.

Importance Category		Description
Very Low	0-0.79	The importance of services supplied is very low relative to that supplied by other wetlands.
Low	0.8 – 1.29	The importance of services supplied is low relative to that supplied by other wetlands.
Moderately-Low	1.3 – 1.69	The importance of services supplied is moderately-low relative to that supplied by other wetlands.
Moderate	1.7 – 2.29	The importance of services supplied is moderate relative to that supplied by other wetlands.
Moderately-High	2.3 – 2.69	The importance of services supplied is moderately-high relative to that supplied by other wetlands.
High	2.7 – 3.19	The importance of services supplied is high relative to that supplied by other wetlands.
Very High	3.2 - 4.0	The importance of services supplied is very high relative to that supplied by other wetlands.

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

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

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

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

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C8) of the wetland system being assessed.

Table C8: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999)

EIS Category	Range of Mean	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate	>1 and <=2	C

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

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

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

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

Table C9: Recommended management objectives (RMO) for water resources based on PES & EIS scores

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

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

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

Table C10: Description of Recommended Ecological Category (REC) classes

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

APPENDIX D – Aquatic Method of Assessment

The sections that follow describe the methodology used to assess the aquatic ecological integrity of the various sites based on water quality.

The sections that follow describe the methodology used to assess the aquatic ecological integrity of the various sites based on water quality.

Physio-Chemical Water Quality Data

On-site testing of biota specific water quality variables took place. Parameters measured include pH value, electrical conductivity (EC) concentration, dissolved oxygen (DO) concentration and temperature. Results are discussed against the Resource Water Quality Objectives (RWQO) of the Lower Wilge River (DWS, 2018).

Diatom Analysis

Diatom slides were prepared through pipetting three drops of the diatom samples onto microscope plates and covering with a microscope cover slide. Diatom taxa were identified to the lowest possible level of identification and diatom valves counted (400 counts) for ecological conclusions to be drawn. Dominant species ecology was inferred from Taylor *et al*. (2007) and Omnidia software (Lecointe *et al.,* 1993) were used to calculate diatom index scores with score interpretation presented in Tables D1 to D4. The following indices were calculated for the present report:

- Specific Pollution sensitivity Index (SPI) (CEMAGREF, 1982) (Tables D1 & D2): This index is the most comprehensive as it includes >1400 species to calculate its final score and provides a measure of organic pollution.
- Generic Diatom Index (GDI) (Coste and Ayphassorho, 1991) (Table D2): Final score is based on genus level and is a measure of organic pollution.
- Trophic Diatom Index (TDI) (Kelly and Whitton, 1995) (Table D3): The index's final score is quantified based on the degree of organic and inorganic pollution.
- Percentage Pollution Tolerant Valves (%PTV) (Kelly and Whitton, 1995) (Table D4): Indicates the diatoms in the sampled community that are tolerant to pollution, thus indicating the degree of eutrophication vs organic pollution. The %PTV score indicates whether nutrients or organic pollution contributed to the TDI final score.

Values for the SPI and GDI were transformed to a score out of 20 where a score of 0 indicates eutrophication and very heavy pollution and a score of 20 indicates no pollution and oligotrophic conditions (Tables D1 & D2). The TDI score is worked off a maximum of 100, where a score of <20% infers that the site is oligotrophic and free from pollution and a score >60% infers that the site is eutrophic with pollution present (Table D3). The %PTV is worked off a maximum score of 100%, where a score of <20% infers that the site is free from organic pollution and a score >60% infers that the site is heavily contaminated with organic pollution (Table D4). For the diatom frustule abnormality assessment, if the percentage of deformed frustules is greater than 2% of the population it is considered that there is significant impact from either pesticides or metals and further assessment is recommended, especially where mining is a related concern.

Further to the calculated index scores, the diatom results are also discussed based on functional groups (diatom species grouped together based on ecological and morpho-physiological features). Diatoms are grouped and discussed based on life-forms (benthic, colonial, mobile, mucous tubules, pedunculate, pioneer and planktonic), ecological guilds (high profile, low profile, motile), and size classes (Size 1 to Size 5) (Passy, 2007; Rimet & Bouchez, 2011; Viktória *et al.,* 2017). Diatoms have

adapted to these different groups as a strategy to survive and resist a large set of environmental stressors. Knowledge on these functional groups and diatom ecology allows us to make precise conclusions on environmental health and stressors based on the adaptability of the diatoms.

Table D1: Interpretation of Ecological Categories from the SPI index scores.

Index Score (up to 20)	Ecosystem quality	Ecological Category
18 – 20	High quality	A
17 – 18		A/B
15 – 17	Good quality	B
14 – 15		B/C
12 – 14	Moderate quality	C
10 – 12		C/D
8 – 10	Poor quality	D
6 – 8		D/E
5 – 6	Bad quality	E
4 – 5		E/F
< 4		F

Table D2: Interpretation of both the SPI and GDI scores to determine the Ecosystem Quality and Trophic level of the sampled site.

Index Score (up to 20)	Trophic Level
>17	Oligotrophic (No Pollution)
15 - 17	Oligo-mesotrophic
12 - 15	Mesotrophic
9 - 12	Meso-eutrophic
< 9	Eutrophic

Table D3: Interpretation of the TDI score to determine the Trophic level of the sampled site.

Index Score	Trophic Level
0 – 20	Oligotrophic (No Pollution)
21 – 40	Oligo-mesotrophic
41 – 60	Mesotrophic
61 – 80	Meso-eutrophic
>80	Eutrophic

Table D4: Interpretation of the %PTV score to determine the Ecological Status of the site.

Index Score (up to 20)	Ecological Status
< 20	Site free from organic pollution
21 – 40	Some evidence of organic pollution
41 – 60	Organic pollution likely to contribute to eutrophication
>60	Heavily contaminated with organic pollution

Table D5: Interpretation of the different diatom ecological groups, guilds and size classes.

Category	Name	Key Features	Ecological Role	Typical Habitat	Examples
Functional Group	**Benthic**	Live on/in substrate (sediments, rocks)	Nutrient cycling, biofilm formation	Stream beds, lake bottoms	*Navicula*, *Cymbella*
	Colonial	Form chains or colonies (often planktonic)	Buoyancy, resistance to grazing	Pelagic or littoral zones	*Asterionella*, *Fragilaria*
	Mobile	Glide using raphe	Access to resources, avoid stress	Benthic habitats, biofilms	*Nitzschia*, *Navicula*
	Mucous Tubules	Secrete tubes for protection	Shelter, nutrient filtering	Benthic, periphytic	*Berkeleya*, *Encyonema*
	Pedunculate	Stalked diatoms; elevate above substrate	Avoid burial; better light access	Vegetated, stable benthic zones	*Gomphonema*, *Rhoicosphenia*
	Pioneer	Fast colonizers of new substrates	Early succession species	Recently disturbed surfaces	*Achnanthidium*, *Nitzschia*
	Planktonic	Free-floating in water column	Primary production in open water	Lakes, oceans	*Cyclotella*, *Thalassiosira*
Guild	**High Profile**	Tall, erect, or chain-forming forms	Good light access, sensitive to disturbance	Stable, low-disturbance zones	*Fragilaria*, *Gomphonema*
	Low Profile	Small, adnate, or prostrate	Tolerate disturbance and low light	High-shear or nutrient-poor areas	*Achnanthidium*, *Cocconeis*
	Motile	Glide over substrate	Avoid stress; access nutrients	Fine sediments, biofilms	*Navicula*, *Nitzschia*
Size Class	**Size 1**	Very small (<15 µm)	Tolerant to stress; high surface area	Oligotrophic or disturbed systems	*Achnanthidium minutissimum*
	Size 2	Small (15–30 µm)	Efficient resource use	Common in most environments	*Fragilaria*, *Eunotia*
	Size 3	Medium (30–60 µm)	Balanced traits	Mid-succession or stable zones	*Navicula*, *Cymbella*
	Size 4	Large (60–100 µm)	Competitive in stable, rich habitats	Low flow or high productivity sites	*Gomphonema*, *Surirella*
	Size 5	Very large (>100 µm)	Sensitive; low colonization rate	Undisturbed, nutrient-rich zones	*Gyrosigma*, *Didymosphenia*

APPENDIX E – Risk Assessment Methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The methods to be used for assessing risks/impacts is outlined in the sections below.

DWS Risk Assessment (2023) Methodology:

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that are possessed by an organisation;
- **Environmental impacts** are the consequences of these impacts on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is;
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems;
- **Resources** include components of the biophysical environment;
- **Intensity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards;
- **Spatial scale** refers to the geographical scale of the impact; and
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The intensity, spatial scale and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 75. The likelihood of the impact occurring is determined by assigning a likelihood score of between 20% and 100%. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[12].

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act, 1998 (Act No. 107 of 1998) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

[12] Some risks/impacts that have low significance will however still require mitigation.

"RISK ASSESSMENT KEY" (Based on DWS 2023 publication: Section 21 c and i water use Risk Assessment Protocol) GN4167 of December 2023 published in Government Gazette 49833 of 8 December 2023) (p208).

Table E1: Intensity (What is the intensity of the impact on the resource quality - hydrology, water quality, geomorphology, biota?)

Negative impacts	
Negligible / non-harmful; no change in PES	0
Very low / potentially harmful; negligible deterioration in PES (<5% change)	+1
Low / slightly harmful; minor deterioration in PES (<10% change)	+2
Medium / moderately harmful; moderate deterioration in PES (>10% change)	+3
High / severely harmful; large deterioration in PES (by one class or more)	+4
Very high / critically harmful; critical deterioration in PES (to E/F or F class)	+5
Positive impacts	
Negligible; no change in PES	0
Very low / potentially beneficial; negligible improvement in PES (<5% change)	-1
Low / slightly beneficial; minor improvement in PES (<10% change)	-2
Medium / moderately beneficial; moderate improvement in PES (>10% change)	-3
Highly beneficial; large improvement in PES (by one class or more) and/or increase in protection status	-4
Very highly beneficial; improvement to near-natural state (A or A/B class) and/or major increase in protection status	-5

*PES of affected watercourses must be considered when scoring Impact Intensity

Table E2: Spatial Scale (How big is the area that the activity is impacting on, relative to the size of the impacted watercourses?)

Very small portion of watercourse/s impacted (<10% of extent)	1
Moderate portion of watercourse/s impacted (10-60% of extent)	2
Large portion of watercourse/s impacted (60-80%)	3
Most or all of watercourse/s impacted (>80%)	4
Impacts extend into watercourses located well beyond the footprint of the activities	5

Table E3: Duration (How long does the aspect impact on the resource quality?)

Transient (One day to one month)	1
Short-term (a few months to 5 years) OR repeated infrequently (e.g. annually) for one day to one month	2
Medium-term (5 – 15 years)	3
Long-term (ceases with operational life)	4
Permanent	5

Table E4: Likelihood of impact (What is the probability that the activity will impact on the resource quality?)

Improbable / Unlikely	20%
Low probability	40%
Medium probability	60%
Highly probable	80%
Definite / Unknown	100%

Table E5: Rating Classes.

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 29	**(L) Low Risk OR (+) Positive (+ +) Highly positive**	Acceptable as is or or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.
30 – 60	**(M) Moderate Risk**	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
61 – 100	**(H) High Risk**	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

Table E6: Calculations.

Intensity = Maximum Intensity Score (negative value for positive impact)	MAX = 5
Severity = Intensity + Spatial Scale + Duration (<Intensity - Spatial Scale - Duration> for positive impact)	MAX = 15 (MIN = -15 for +ve impacts)
Consequence = Severity X Importance rating	MAX = 75
Significance\Risk = (Consequence X Likelihood) X (100/75)	MAX = 100

In applying the DWS Risk Assessment Matrix (Section 8.3), the mitigation hierarchy as advocated by the DEA *et al* (2013) was consulted and implemented. In line with the mitigation hierarchy, the following actions were undertaken:

- **Avoid:** Impacts to the valley bottom freshwater ecosystems were largely avoided by the optimisation of the PV footprint areas to avoid the obvious extent of the wetlands based on desktop methods. Note that with the field-verification of the extent of the CVB wetland (CVB L1), it was noted that marginal portions of the wetland is encroached by the proposed PV footprint areas, and the layout in this area must preferably be adjusted to avoid the delineated extent of the valley bottom freshwater ecosystems, along with their 21m or 15m ecological buffers;
- **Minimise:** In instances where the freshwater ecosystems could not be avoided, such as where PV areas overlap with the HSS wetlands, suitable mitigation measures have been provided to best minimise the potential impacts to the affected freshwater ecosystems.
- **Rehabilitate:** Suitable rehabilitation measures and stormwater management systems have been defined to ensure that all disturbed areas within the freshwater ecosystems outside the final physical footprint areas of the infrastructure are suitably rehabilitated. A stormwater management plan, to be developed for the site, will ensure safeguarding of the freshwater ecosystems against possible erosion and sedimentation.
- **Offset:** It is not anticipated that a wetland offset is required as suitable actions have been taken to best avoid, minimise (where avoidance is not possible) and rehabilitate the freshwater ecosystems associated with the proposed PV. This is however subject to the decision of the respective authorities.

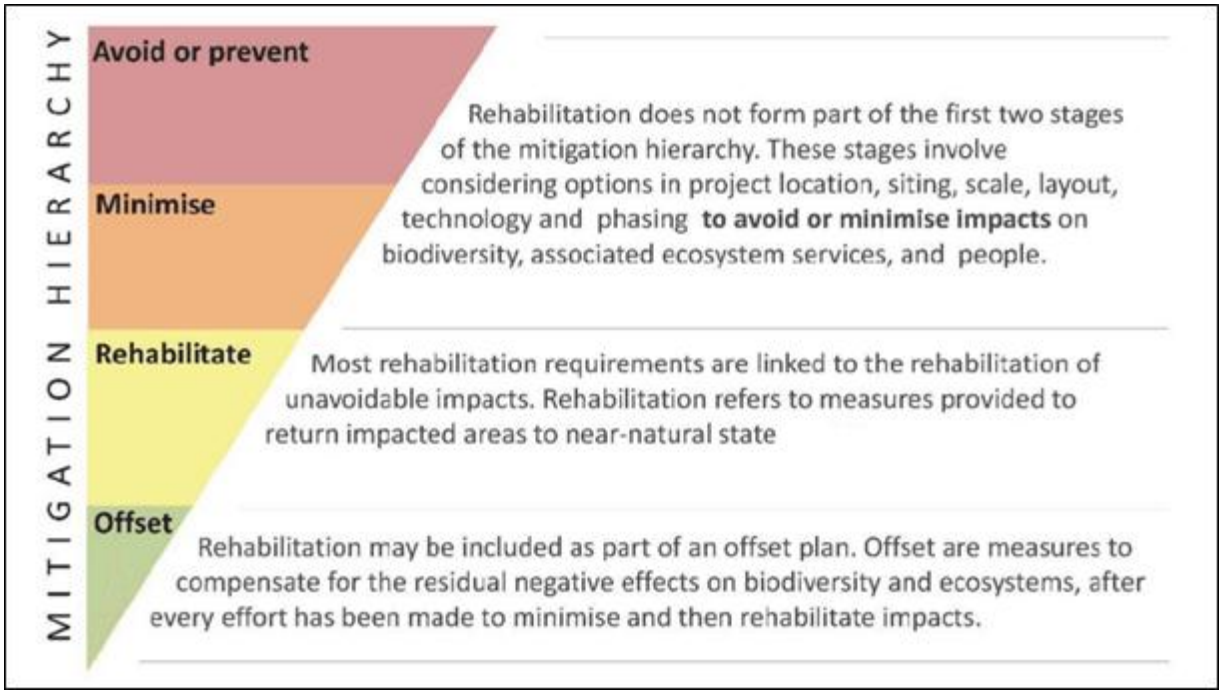

Figure E1: Impact Minimisation hierarchy as advocated by the DEA *et al.*, (2013).

APPENDIX F – Results of Freshwater Field Investigation

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

Table F1: Presentation of the results of the WET-Health PES assessment applied to the Channelled Valley Bottom (CVB) and Hillslope Seep (HSS) wetlands associated with the study area.

Freshwater Ecosystems	Hydrology		Geomorphology		Vegetation		Overall score
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	
CVB & HSS wetland	6,0	0,0	4,3	0,0	3,6	0,0	4.84
	E	→	D	→	C	→	D

Table F2: The results of the riparian IHI assessment applied to the non-perennial drainage line associated with the study area.

	MRU
RIPARIAN IHI	
Base Flows	-2,0
Zero Flows	2,0
Moderate Floods	-2,0
Large Floods	-2,0
HYDROLOGY RATING	**2,0**
Substrate Exposure (marginal)	3,0
Substrate Exposure (non-marginal)	3,0
Invasive Alien Vegetation (marginal)	5,0
Invasive Alien Vegetation (non-marginal)	5,0
Erosion (marginal)	4,0
Erosion (non-marginal)	4,0
Physico-Chemical (marginal)	0,0
Physico-Chemical (non-marginal)	0,0
Marginal	5,0
Non-marginal	5,0
BANK STRUCTURE RATING	**5,0**
Longitudinal Connectivity	1,0
Lateral Connectivity	1,0
CONNECTIVITY RATING	**1,0**
RIPARIAN IHI %	**37,8**
RIPARIAN IHI EC	**D/E**
RIPARIAN CONFIDENCE	**2,0**

Table F3: The results of the VEGRAI assessment applied to the non-perennial drainage line associated with the study area.

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	23,7	14,8	3,3	1,0	100,0
NON MARGINAL	23,0	8,6	0,0	2,0	60,0
	2,0				160,0
LEVEL 3 VEGRAI (%)				23,4	
VEGRAI EC				**E**	
AVERAGE CONFIDENCE				1,7	

Table F4: Presentation of the results of the Ecoservices of the Channelled Valley Bottom (CVB) wetland.

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

Table F5: Presentation of the results of the Ecoservices of the Hillslope Seep (HSS) wetland.

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

Table F6: Presentation of the results of the Ecoservices of the Non-Perennial Drainage Line (NDL).

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0,3	0,6	0,0	Very Low
	Stream flow regulation	-	-	#VALUE!	#VALUE!
	Sediment trapping	0,8	4,0	1,3	Low
	Erosion control	0,6	0,0	0,0	Very Low
	Phosphate assimilation	0,8	3,0	0,8	Low
	Nitrate assimilation	1,0	3,0	1,0	Low
	Toxicant assimilation	0,9	3,0	0,9	Low
	Carbon storage	0,7	2,7	0,5	Very Low
	Biodiversity maintenance	0,5	2,0	0,0	Very Low
PROVISIONING SERVICES	Water for human use	1,0	0,0	0,0	Very Low
	Harvestable resources	1,5	0,0	0,0	Very Low
	Food for livestock	0,0	0,0	0,0	Very Low
	Cultivated foods	3,0	0,0	1,5	Moderately Low
CULTURAL SERVICES	Tourism and Recreation	0,6	0,0	0,0	Very Low
	Education and Research	0,6	0,0	0,0	Very Low
	Cultural and Spiritual	0,0	0,0	0,0	Very Low

Table F7: Presentation of the results of the Ecological Importance and Sensitivity of the Channelled Valley Bottom (CVB) wetland, Hillslope Seep (HSS) wetland and Non-perennial Drainage Line (NDL).

Freshwater Ecosystem	CVB wetland	HSS wetland	NDL	
Ecological Importance and Sensitivity	Score (0-4)	Score (0-4)	Score (0-4)	*Confidence (1-5)*
Biodiversity support	A (average)	A (average)	A (average)	(average)
	0,67	0,33	0,67	4,00
Presence of Red Data species	0	0	0	4
Populations of unique species	0	0	0	4
Migration/breeding/feeding sites	2	1	2	4
Landscape scale	B (average)	B (average)	B (average)	(average)
	1,20	0,60	1,20	4,60
Protection status of the wetland	0	0	0	5
Protection status of the vegetation type	1	1	1	5
Regional context of the ecological integrity	1	1	1	4
Size and rarity of the wetland type/s present	2	0	2	5
Diversity of habitat types	2	1	2	4
Sensitivity of the wetland	C (average)	C (average)	C (average)	(average)
	1,67	0,33	1,00	4,00
Sensitivity to changes in floods	2	0	1	4
Sensitivity to changes in low flows/dry season	2	0	1	4
Sensitivity to changes in water quality	1	1	1	4
ECOLOGICAL IMPORTANCE & SENSITIVITY	**(max of A,B or C)**	**(max of A,B or C**	**(max of A,B or C**	*(average of A, B or C)*

Freshwater Ecosystem			CVB wetland	HSS wetland	NDL	
Fill in highest score:			C	B	B	1,20
			1.67 Moderate	0.6 Low	1.20 Moderate	
Hydro-Functional Importance			Score (0-4)	Score (0-4)	Score (0-4)	*Confidence (1-5)*
Regulating & supporting benefits	Flood attenuation		2	1	1	4
	Streamflow regulation		2	0	0	4
	Water Quality Enhancement	*Sediment trapping*	2	1	1	4
		Phosphate assimilation	2	1	1	4
		Nitrate assimilation	2	1	1	4
		Toxicant assimilation	2	1	1	4
		Erosion control	1	1	1	4
	Carbon storage		2	2	1	3
HYDRO-FUNCTIONAL IMPORTANCE			**(average score)**	**(average score)**	**(average score)**	**(average confidence)**
			2	1	1	4
Direct Human Benefits			Score (0-4)	Score (0-4)	Score (0-4)	Confidence (1-5)
Subsistence benefits	*Water for human use*		0	0	0	4
	Harvestable resources		2	0	1	4
	Cultivated foods		0	0	0	4
Cultural benefits	*Cultural heritage*		0	0	0	4
	Tourism and recreation		0	0	0	4
	Education and research		0	0	0	4
DIRECT HUMAN BENEFITS			(average score)	(average score)	(average score)	(average confidence)
			0.33	0	0.17	4

APPENDIX G – Risk Assessment Outcome

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)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
						Abiotic Habitat (Drivers)			Biota (Responses)											
			Name/s	PES	Overall Watercourse Importance	Hydrology	Water Quality	Geomorphology	Vegetation	Fauna										
CONSTRUCTION	Site clearing and commencement of construction activities for the proposed development, which may include: • Removal of vegetation leading to exposure of soils and associated disturbances to soils. • Increased likelihood of dust generation due to exposed soils. • Removal of topsoil and creation of topsoil stockpiles. • Possible indiscriminate driving through watercourse areas by construction vehicles. • Potential	• Compaction of soils, in turn potentially leading to increased runoff and erosion. • Potential sedimentation of the watercourses as a result of sediment laden runoff, leading to smothering of freshwater ecosystem vegetation and potentially altering surface water quality. • Disturbances of soils leading to increased alien vegetation proliferation, which may spread to the adjacent freshwater ecosystem habitat. • Potential hydrocarbon contamination of the watercourse areas. • Potential altered flow regime as a result of solid waste disposal in proximity to the freshwater ecosystems and within the freshwater ecosystems themselves. • Potential altered water quality due to chemical waste disposal. • Potential decreased ecoservice provision and reduction of PES as a result of the abovementioned impacts.	Channelled Valley Bottom (CVB) wetland	D	Moderate	2	2	2	3	3	**6**	1	2	**9**	**3**	**27**	40%	**10,8**	**L**	High
			Hillslope Seep (HSS) wetland	D	Low	1	2	2	3	1	**6**	1	2	**9**	**2**	**18**	60%	**10,8**	**L**	High
			Non-perennial Drainage Line	E	Moderate	1	2	2	3	3	**6**	1	2	**9**	**3**	**27**	40%	**10,8**	**L**	High

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)		Likelihood (Probability) of impact		Significance (max = 100)	Risk Rating	Confidence level
							Abiotic Habitat (Drivers)			Biota (Responses)																	
			Name/s	PES	Overall Watercourse Importance		Hydrology	Water Quality	Geomorphology	Vegetation	Fauna																
	indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from construction vehicles. Activities to occur **outside the 15 m ecological buffer areas and 1 in 100 year floodline** of watercourses.																									
	Site clearing and construction of the roads and road crossing, which may include: • Disturbance of soils inside the watercourse channel bed. • Removal of vegetation leading to exposure of soils and associated disturbances to soils. • Removal of topsoil and creation of topsoil stockpiles. • Possible indiscriminate	• Potential sediment laden runoff into the watercourse with disturbance of soil. • Potential loss/damage of additional freshwater habitat as a result of indiscriminate movement outside the demarcated footprint area. • Potential riverbank destabilisation as a result of road upgrading activities. • Disturbances of soil, potentially leading to increased AIP proliferation and altered freshwater habitat. • Potential for deterioration of water quality as a result of contaminated runoff from construction area to adjacent freshwater ecosystem environment. • Potential loss of hydraulic	Non-perennial Drainage Line	E	Moderate		2	1	3	3	2		**6**	1	2		**9**	**3**		**27**		100%		**27**	L	High
			Hillslope Seep (HSS) wetland	D	Low		3	1	3	3	1		**6**	2	2		**10**	**2**		**20**		100%		**20**	L	High

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)		Likelihood (Probability) of impact		Significance (max = 100)	Risk Rating	Confidence level
							Abiotic Habitat (Drivers)			Biota (Responses)																	
			Name/s	PES	Overall Watercourse Importance		Hydrology	Water Quality	Geomorphology	Vegetation	Fauna																
	driving through watercourse areas by construction vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from construction vehicles • Potential creation of flow obstructions inside the watercourse channel during the road upgrading process. Activities to occur **inside the 15 m ecological buffer area and 1 in 100 year floodline** of a watercourse.	connectivity if flow obstructions are created during the construction process.																								

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)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating	Confidence level
						Abiotic Habitat (Drivers)			Biota (Responses)											
			Name/s	PES	Overall Watercourse Importance	Hydrology	Water Quality	Geomorphology	Vegetation	Fauna										
OPERATION	• Operation and maintenance of the proposed development, which include: • Increased runoff of stormwater into the receiving freshwater environment from increased extent of impermeable surfaces. • Periodic maintenance to infrastructure, which may involve small-scale construction activities. • Possible indiscriminate driving through watercourse areas by maintenance vehicles. • Potential indiscriminate waste disposal within the vicinity of the watercourses. • Potential spillage from maintenance vehicles • Potential	• Increased catchment yield and altered flow regime may lead to changed wetland zonation, and possible impacts on vegetation as a result. • Potential local changes to the water retention patterns, timing and flows of watercourses. • Potential unattenuated discharge of stormwater into the receiving environment, potentially leading to sedimentation and erosion of the receiving environment. • Potential soil and water contamination by waste and hydrocarbons from vehicles. • Potential eutrophication of the freshwater ecosystems as a result of increased nitrates and phosphate loads from untreated effluent (from the sewer infrastructure) due to potential leakage of the pipelines in the event of a leak of damage to the pipeline infrastructure. Altered breeding and feeding habits of fauna as a result of disturbance. • Potential decreased ability of the watercourses to provide ecosystem services. • Potential degradation of watercourse habitat.	Channelled Valley Bottom (CVB) wetland	D	Moderate	3	2	3	3	3	**6**	1	5	**12**	**3**	**36**	80%	**28,8**	L	High
			Hillslope Seep (HSS) wetland	D	Low	3	2	1	3	1	**6**	1	5	**12**	**2**	**24**	80%	**19,2**	L	High
			Non-perennial Drainage Line	E	Moderate	3	2	1	3	3	**6**	1	5	**12**	**3**	**36**	80%	**28,8**	L	High

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)		Likelihood (Probability) of impact		Significance (max = 100)	Risk Rating	Confidence level
							Abiotic Habitat (Drivers)			Biota (Responses)																	
			Name/s	PES	Overall Watercourse Importance		Hydrology	Water Quality	Geomorphology	Vegetation	Fauna																
	creation of flow obstructions inside the watercourse channel by the road crossing (i.e. blockages of the culvert systems). • General increased anthropogenic activity within proximity to the wetlands, with increased probability of disturbance to freshwater habitat soils, fauna and flora.																									

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APPENDIX H – Site Sensitivity Verification

FRESHWATER ECOSYSTEM SITE SENSITIVITY VERIFICATION REPORT FOR THE PROPOSED VORNA VALLEY SPARK SCHOOL, GAUTENG PROVINCE.

Introduction

According to the "Protocols for the Assessment and Minimum Criteria for Reporting on identified Environmental Themes ("the Protocols") published in Government Gazette No. 43110 on 20 March 2020 and Government Gazette No. 43855 on 30 October 2020, the Environmental Assessment Practitioner (EAP) must verify the current use of the site in question and its environmental sensitivity as identified by the Screening Tool to determine the need for specialist inputs in relation to the themes included in the Protocols. The Protocols are allowed for in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) ("NEMA"). The Protocols must be complied with for every new application for Environmental Authorisation that is submitted after 9 May 2020.

This document serves as the Freshwater Ecosystem Site Sensitivity Verification Report for the proposed Vorna Valley Spark School, in the Carlswald suburb of Midrand, Gauteng Province. The proposed development is located on the TLC stables property. The proposed development area will henceforth be referred to as the "study area" (Figure H1).

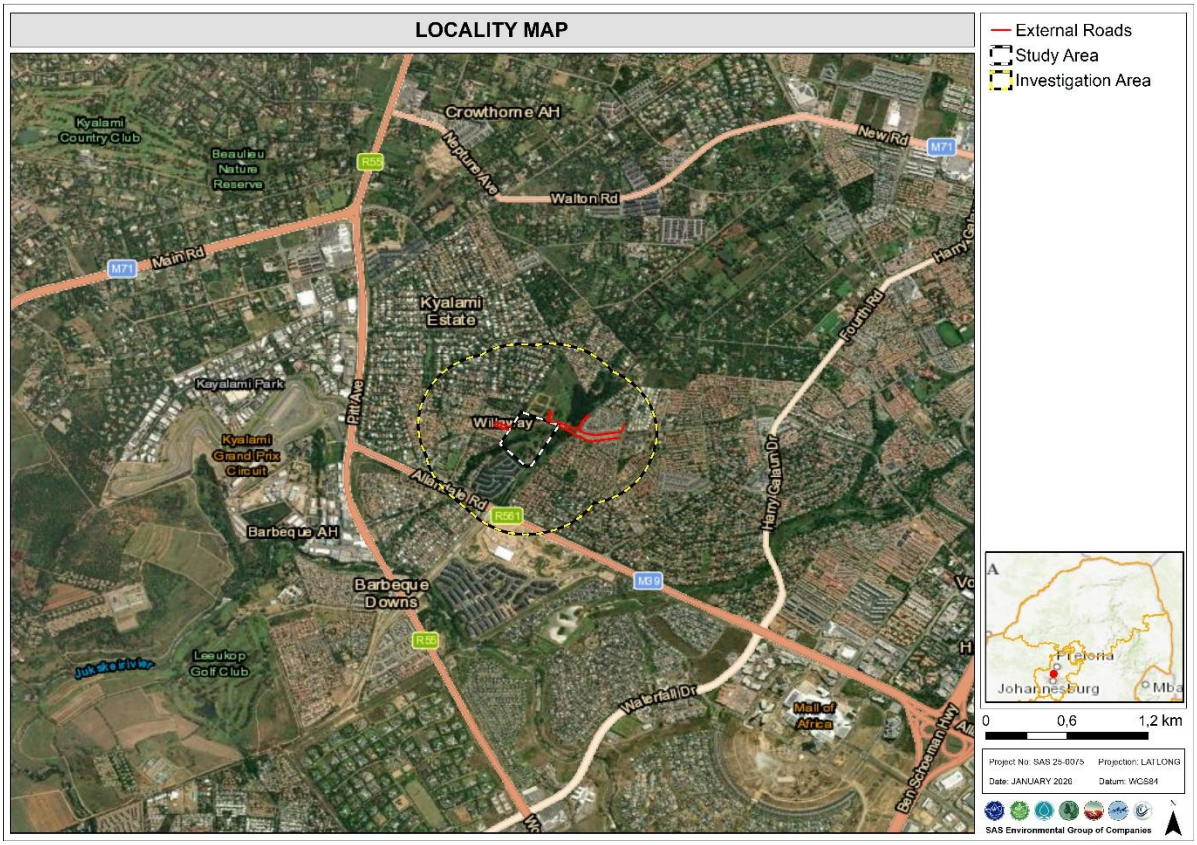


Figure H1: Digital satellite image depicting the location of the study area.

This Freshwater Ecosystem site sensitivity verification report relates to a Screening Tool Report (STR) completed for the site in January 2026.

Site Verification Methodology

A site visit was conducted by the specialist to inform the specialist reports required for the proposed project.

Aquatic Biodiversity Site Verification

The table below provides information regarding the outcome of the Screening Tool in terms of the aquatic biodiversity theme sensitivity associated with the proposed project as well as a brief summary of the outcome of the freshwater ecosystem specialist report in response.

Table H1: Aquatic Biodiversity Theme Sensitivity analysis for the proposed project.

Environmental Theme	Applicable Protocol	Response
Aquatic Biodiversity **Screening Tool Sensitivity Rating:** According to the screening tool, the majority of study area is located within an area of low aquatic/freshwater biodiversity sensitivity, however, the freshwater features indicated as seep and channelled valley bottom wetlands (per the draft National Wetland Map 6; 2024) are located within areas of very high aquatic/ freshwater biodiversity sensitivity. **Actual Sensitivity:** The designation of very high sensitivity to freshwater features by the DFFE Screening Tool is confirmed through the findings of the freshwater assessment, in the context of the inherently sensitive freshwater ecosystems. The designation of low freshwater sensitivity for the remainder of the study area where no freshwater ecosystems have been delineated is confirmed. Given that the proposed development involves activities inside the delineated extents of watercourses and sensitive buffer areas, a Freshwater Ecosystem Assessment is required.	3(b) Protocol for the assessment and reporting of environmental impacts on aquatic biodiversity (GG 43110 of 20/03/2020).	A Freshwater Ecosystem Assessment was conducted by Scientific Aquatic Services (SAS, 2025). During the assessment and associated field verification it was determined that portions within the assessment area and investigation area are of high aquatic biodiversity (freshwater) sensitivity due to the confirmed presence of valley bottom and seep wetlands and a non-perennial drainage line. A detailed study was required to support both the authorisation process required in terms of NEMA as well as the NWA. The study and associated comprehensive report from a site visit in June 2025 provide a detailed description of the freshwater ecosystems associated with the proposed project and considered the potential impacts applicable to the freshwater ecosystems and provided suitable mitigation measures to best minimise the potential impact on the freshwater ecosystems.

Figure H2: Representative photographs of the Freshwater Ecosystems in the study area, consisting of a Channelled Valley Bottom (CVB) wetland (a), a Hillslope Seep (HSS) wetland (b) and a Non-Perennial Drainage Line (NDL) (c).

APPENDIX I – General "Good Housekeeping" Mitigation Measures

General construction management and good housekeeping practices

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

Development footprint

- All development footprint areas must remain as small as possible and must not encroach into the freshwater areas unless absolutely essential and part of the proposed development. It must be ensured that the freshwater habitat is off-limits to construction vehicles and non-essential personnel;
- The boundaries of footprint areas, including contractor laydown areas, must be clearly defined and all activities must remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes must avoid freshwater ecosystems and be restricted to existing roads where possible;
- Appropriate sanitary facilities must be provided for the life of the construction phase and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles must be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- All hazardous storage containers and storage areas must comply with the relevant SABS standards to prevent leakage;
- No fires must be permitted in or near the construction area; and
- Ensuring that an adequate number of waste and "spill" bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place offsite on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and spillage must be p prevented near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly. Contaminated soil must be bagged and disposed of in hazardous waste receptacles.

Vegetation

- Removal of the alien and weed species encountered within the wetlands must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, and maintenance phases; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas must be kept as small as possible when removing alien plant species; and

- No vehicles must be allowed to drive through designated sensitive watercourse areas during the eradication of alien and weed species.

Soil

- Sheet runoff from access roads and the walk ways must be slowed down by the strategic placement of berms;
- As far as possible, all construction activities must occur in the low flow season, during the drier winter months;
- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soil;
- No stockpiling of topsoil must take place within close proximity to the watercourse, and all stockpiles must be protected with a suitable geotextile to prevent sedimentation of the watercourse;
- All soil compacted as a result of construction activities as well as ongoing operational activities falling outside of project footprint areas must be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence must be implemented to prevent erosion and incision.

Rehabilitation

- Construction rubble must be collected and disposed of at a suitable landfill site;
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed development must be removed. Alien vegetation control must take place for a minimum period of two growing seasons after rehabilitation is completed; and
- Side slope and embankment vegetation cover must be monitored to ensure that sufficient vegetation is present to bind the soil and prevent further erosion.

APPENDIX J – Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

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

Amanda Mileson Postgraduate Diploma Nature Conservation (UNISA)
Stephen van Staden: MSc (Environmental Management) (University of Johannesburg)
Monique Botha PhD (Environmental Sciences) (North-West University)

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

Company of Specialist:	Scientific Aquatic Services (Pty) Ltd		
Name / Contact person:	Monique Botha		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	1401	Cell:	0727670435
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	monique@sasenvgroup.co.za		
Qualifications	Ph. D Environmental Science		
Registration / Associations	Registered Candidate Member of the South African Council for Natural Scientific Professions (SACNASP)		

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

I, Amanda Mileson, declare that -

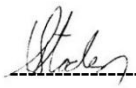
- I act as the **independent specialist (reviewer)** in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise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

Signature of the Specialist

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

I, Stephen van Staden, declare that -

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



Signature of the Specialist

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

I, Monique Botha, declare that -

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

Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –
SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF AMANDA MILESON

PERSONAL DETAILS

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

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Wetland Society (SAWS)

Member of the International Society of Wetland Scientists

Member of the Gauteng, Western Cape and Northern Cape Wetland Forums

EDUCATION

Qualifications

N. Dip Nature Conservation (UNISA)	2017
Advanced Diploma Nature Conservation (UNISA)	2020
Postgraduate Diploma Nature Conservation (UNISA)	2023

Short Courses

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

AREAS OF WORK EXPERIENCE

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

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

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

Biodiversity Assessments

- Biodiversity Ecological Assessments
- Biodiversity Offset Plans

SAS ENVIRONMENTAL GROUP OF COMPANIES

SPECIALIST CONSULTANT INFORMATION - CURRICULUM VITAE OF

STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Director, Group CEO, Water Resource Discipline Lead, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SEGC	2003 (year of establishment)
Other Business	Trustee of several Trusts focusing on property and stock investment on behalf of beneficiaries

MEMBERSHIP IN PROFESSIONAL SOCIETIES

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

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000

Short Courses

Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017
Tools for Wetland Assessment (Rhodes University)	2017
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2018
Wetland Management: Introduction and Delineation (WLID1502S) (University of the Free State)	2018

Hydropedology and Wetland Functioning (TerraSoil Science and Water Business Academy) 2018

DEVELOPMENT SECTOR EXPERIENCE

1. Mining: Coal, chrome, Platinum Group Metals (PGMs), mineral sands, gold, phosphate, river sand, clay, fluorspar
2. Linear developments (energy transmission, telecommunication, pipelines, roads)
3. Minerals beneficiation
4. Renewable energy (Hydro, wind and solar)
5. Commercial development
6. Residential development
7. Agriculture
8. Industrial/chemical

CORE FIELDS OF EXPERTISE

Legislative Requirements, Processes and Assessments

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

Freshwater Assessments

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

Aquatic Ecological Assessment and Water Quality Studies

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

Biodiversity Assessments

- Floral and faunal Assessments
- Biodiversity Offset planning
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Biodiversity Offset Plan

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Hydropedological Assessment

**SAS ENVIRONMENTAL GROUP OF COMPANIES –
SPECIALIST CONSULTANT INFORMATION**

CURRICULUM VITAE OF MONIQUE BOTHA

PERSONAL DETAILS

Position in Company	Freshwater Specialist
Joined SAS Environmental Group of Companies	2022

MEMBERSHIP IN PROFESSIONAL SOCIETIES

SACNASP Candidate Natural Scientist (Environmental Sciences) #126160

EDUCATION

Qualifications	
B.Sc. Environmental and Biological Sciences (North-West University)	2010
Hons. B.Sc. Environmental Sciences (North-West University)	2011
M.Sc. Environmental Sciences (North-West University)	2014
Ph.D. Environmental Sciences (North-West University)	2016
Training Courses	
Basic Soil Properties: Analysis and Interpretation of Results (ARC-SCW)	2022
Wetland Legislation Course (WETREST)	2023

DEVELOPMENT SECTORS OF EXPERIENCE

1. Mining
2. Commercial development
3. Residential development
4. Water supply infrastructure (dams)
5. Linear development (pipelines, energy transmission, roads);
6. Sewage effluent management
7. Landfill
8. Renewable energy (solar and wind)

AREAS OF WORK EXPERIENCE

All provinces of South Africa; with extensive experience in Gauteng and Mpumalanga

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

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

Biodiversity Assessments

- Biodiversity Ecological Assessments
- Alien Invasive Plant Control Plans (AIPCP)