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WATERCOURSE ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED LETHABONG MIXED HOUSING DEVELOPMENT IN SEBOKENG, GAUTENG PROVINCE.

Prepared for

SLM Developments

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EXECUTIVE SUMMARY

A large unchanneled valley bottom (UCVB) and two seep HGM units were identified within the study area associated with the propose mixed housing development. During the assessment, the UCVB and seep 2 were assessed to be largely modified while seep 1 was seriously modified.

Based on the findings of the watercourse ecological assessment and the risk assessment findings, it is the opinion of the freshwater ecologist that the proposed development poses a moderate risk to the freshwater resources present. Impacts associated with ground-breaking activities, installation of sewer lines and construction of access roads within the wetland are anticipated to pose the highest risk to the ecological integrity and functional extent of the wetland. Adherence to cogent, well-conceived and ecologically sensitive site development plans, the mitigation measures provided in this report, as well as general good construction practice and ongoing management, maintenance and monitoring, are essential if the significance of the perceived impacts are to be reduced to limit further degradation to the freshwater environment.

It is the opinion of the specialist that the proposed development can be considered acceptable on the proviso that strict adherence to mitigation measures is enforced to ensure that the ecological integrity of the freshwater environment is not further compromised. In addition, it is highly recommended that where possible, no new roads be constructed within the wetland. Road crossings should be minimised as far as possible. Should these be unavoidable, careful planning and consideration of the design should take place to ensure free flow of water and to ensure that no upstream inundation, downstream desiccation, and the creation of preferential flow paths takes place. Wherever possible, existing roads should be utilized for the proposed development to minimize direct impacts on the wetland and no construction of access roads for the purposes of construction activities should be permitted.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a watercourse ecological assessment as part of the Environmental Impact Assessment (EIA) and Authorisation Process into the Water Use License Application (WULA) for the proposed Lethabong mixed housing development on the remaining extent of the farm Quaggasfontein Alias Lapdoorn 548 IQ. The proposed development is located 3 km east of the R553 Roadway, 200 m east of Sebokeng Unit 10 and it is traversed by the Houtkop Road in Sebokeng, Gauteng Province.

During the field assessment undertaken on the 26th March 2020, an unchanneled valley bottom and two seep HGM units were identified within the area associated with the proposed development.

The delineated wetland has been impacted by historical agricultural activities, disturbances of soils and dumping of foreign materials, infilling, proliferation of alien and invasive species, construction and excavation activities within the wetland, compaction, encroachment of informal settlements and by urbanisation within the greater catchment.

The results of the assessments of the UCVB and seep HGM units are presented in Section 5 of this report and summarised in Table A below.

Table A: Summary of the results of the field assessment as discussed in Section 5.

Watercourse	Present Ecological State (PES)	Ecological Importance and Sensitivity	Ecoservices	Recommended Ecological Category (REC) / Best Attainable State (BAS) / Recommended Management Objective (RMO)
Unchanneled valley bottom	Category D: (Largely Modified)	Moderate	Intermediate	REC Category: D BAS Category: D RMO: Maintain
Seep 1	Category E: (Seriously Modified)	Low / Marginal	Moderately Low	REC Category: D* BAS Category: D RMO: Maintain
Seep 2	Category D: (Largely Modified)			REC Category: D BAS Category: D RMO: Maintain

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

Following the assessment of the wetland, the DWS Risk Assessment Matrix (as promulgated in Government Notice 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)) was applied to ascertain the significance of possible impacts which may occur as a result of the proposed development. The risk assessment includes the activities associated with the pre-construction geotechnical studies, which will require the drilling of boreholes within the wetlands and/or their 500 m zones of regulation. The results of the risk assessments are summarised in Table B and C below.

Table B: Summary of the risk assessment associated with the proposed development as discussed in Section 7.

Phase	No	Activity	Aspect	Impact	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE	PES /EIS
Pre-construction Phase	1	Geotechnical studies including drilling	*Movement of heavy machinery within wetlands and/or within 500 m of wetlands. *Drilling within wetlands	*Compaction of soils *Disturbance of soils and loss of natural vegetation *Alteration of natural flow paths and the creation of preferential flow paths *Proliferation of alien and invasive vegetation	L	*Ensure movement of machinery within wetland areas is minimised as far as possible. Wherever possible, existing roads should be used. *Any areas of disturbance should be closed, re-profiled and re-seeded if necessary; *Monitoring of all disturbed areas should take place to monitor for erosion or the proliferation of alien and invasive species and if any impacts in this regard are identified, these should be immediately remedied through active prevention of erosion or in the case of alien and invasive species, through manual removal before dense stands can take hold; *No debris associated with the geotechnical drilling should remain behind on completion of the drilling activities; *Ensure geotechnical studies take place in winter when the seasonal and temporary zones are likely to be drier and more resilient to disturbance; *Ensure no movement of machinery takes place through any permanent and if possible seasonal wetland areas; *Only authorised personnel should be authorised to conduct the proposed geotechnical studies; and *A spill prevention and emergency spill response plan should be compiled to guide the construction works; and an emergency response contingency plan should be put in place to address clean-up measures should a spill or leak occur.	NA	PES: UCVB (D); Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate); Seeps (Low)

Phase	No	Activity	Aspect	Impact	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE	PES /EIS
Construction Phase	2	Site clearing prior to commencement of construction activities.	*Removal of vegetation and associated disturbances to soils; and *Possible indiscriminate driving through the wetland by construction vehicles.	*Potential increased runoff and erosion, and thus increased sedimentation; *Proliferation of alien and invasive species due to their rapid establishment following disturbance; and *Decreased ecoservice provision.	M	*Ensure contractor laydown areas, storage facilities and all other non-essential activities are placed outside of the wetland and the approved buffer area to avoid water and soil contamination which would affect the structure and functioning of the wetland. A designated area should be approved by the Environmental Control Officer (ECO) prior to use; *No indiscriminate movement of construction vehicles or personnel is allowed within the wetland. Careful planning of the construction footprint must be undertaken beforehand to ensure that the minimum impact on the wetland occurs; and *Areas which are to be cleared of vegetation, must remain as small as possible to reduce the risk of proliferation of alien vegetation.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)
	3	Ground-breaking: excavation of foundations, earthworks and building activities.	*Excavation of soil and creation of stockpiles; *Compaction of soils as a result of movement of construction vehicles; and *Construction of houses and other infrastructure associated with mixed housing development.	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to altered wetland habitat; *Altered stormwater runoff patterns leading to increased erosion and *Sedimentation of the wetland.	M	*Dust suppression measures must be implemented throughout construction to prevent excessive dust which may smother freshwater vegetation; *Soils must be stockpiled according to their natural sequence in order to ensure that topsoil and subsoils are not mixed during backfilling process; and *Exposed soils, including topsoil, must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent erosion and sedimentation of the wetland.	N/A	
	4	Potential indiscriminate waste disposal and/or spillage from construction vehicles.	*Disposal of construction-related waste (such as rubble, hazardous chemicals, and litter).	*Potential further loss of scenic beauty of the wetland due to increased rubble and construction debris; *Altered hydrological regime and vegetation structure as a result of disposed rubble; *Creation of preferential flow paths; and *Altered soil / sediment conditions due to chemical waste disposal or spills.	L	*No waste disposal is to be permitted in the delineated wetland and the variable GDARD setback area; *All waste must be removed from the site and disposed at a registered disposal facility; *Vehicles must be regularly inspected for leaks and be refuelled on sealed surfaces to prevent ingress into soils; *All spills are to be immediately cleaned up and must be treated accordingly; and *When not in use, all vehicles must be parked on a non-permeable surface or have drip trays under to prevent any leakage into the nearby wetlands.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; See s (Low)

Phase	No	Activity	Aspect	Impact	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE	PES /EIS
	5	Construction of infrastructure (buildings and roads outside of the delineated wetland).	*Movement of construction equipment adjacent to the delineated wetland; *Stockpiling of construction materials; and *Increased likelihood of dust generation due to exposed soils.	*Loss of freshwater habitat and ecological structure as a result of edge effects associated with the development. *Impacts to the ecoservice provision of the wetland. *Potential impacts on the hydrology and sedimentation of the wetland.	**M**	*Any concrete mixing/temporary storage must be undertaken in bunded areas or on batter boards only. Care must be taken to prevent any spillage within the wetland or surrounding environment; *Dust suppression measures must be implemented throughout construction to prevent excessive dust which may smother freshwater vegetation; and *If feasible, construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities.	N/A	
	6	Construction of sewer line infrastructure within the delineated wetland.	*Movement of construction equipment adjacent to the delineated wetland; *Removal of topsoil and creation of topsoil stockpiles;	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to altered freshwater habitat; *Altered stormwater runoff patterns, leading to increased erosion and sedimentation of the wetland; *Impacts to the ecoservice provision of the wetland; and *Potential impacts to water quality as a result of oil spills/ solid wastes entering the wetland.	**M**	*The duration of impacts within the wetland should be minimised as far as possible by ensuring that the duration of time in which sedimentation will take place is minimised. Therefore, the construction period should be kept as short as possible; *Contaminant spillage outside of the demarcated area must be promptly removed and taken to a suitably licensed waste disposal site; *Construction must be scheduled for the drier winter period to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities; and *Excavations associated with the sewer pipeline route must be suitably backfilled and compacted. Any excess soil must be levelled on site or removed.		
	7	Construction of road crossings within the delineated wetland.	*Movement of construction equipment adjacent to the delineated wetland; and *Stockpiling of construction materials.		**M**	*No indiscriminate movement of vehicles or personnel is allowed within the wetland or associated variable setback. Careful planning of all construction equipment must be undertaken beforehand to ensure that the minimum impact on the wetland occurs; *Any concrete mixing/temporary storage must be undertaken in bunded areas or on batter boards only. Care must be taken to prevent any spillage within the wetland or surrounding environment; *Dust suppression measures must be implemented throughout construction to prevent excessive dust which may smother freshwater vegetation; *Construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities; *It is highly recommended that existing access roads must be used in order to reduce the impacts associated with the creation of new roads within the wetland.		PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)

Phase	No	Activity	Aspect	Impact	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE	PES /EIS
	8	Construction of stormwater attenuation features within the wetland.	*Movement of construction equipment adjacent to the delineated wetland; *Removal of topsoil and creation of topsoil stockpiles;	*Altered stormwater runoff patterns, leading to increased erosion and sedimentation of the wetland; *Impacts to the ecoservice provision of the wetland; and *Potential impacts to water quality as a result of oil spills/ solid wastes entering the wetland.	M	*Construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities; *No indiscriminate movement of vehicles or personnel is allowed within the wetland or associated variable setback. Careful planning of all construction equipment must be undertaken beforehand to ensure that the minimum impact on the wetland occurs; and *The attenuation structures must be suitably constructed in order to ensure rehabilitation and recharge of the wetland. *Mitigation measures and methods as described in the plant species and rehabilitation plan (Habitat Landscape Architects, 2020).		PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)
Operation	9	Increased impermeable surfaces within the study area and the wetland's surrounding catchment areas.	*Potential change in surface runoff patterns due to increased impermeable surfaces.	*Decreased infiltration and increase surface runoff from impervious surfaces; *Increased water inputs to the freshwater environment at unnatural rates; and *Potential change in wetland hydrograph due to modified surrounding landscape.	M	*An adequate stormwater management plan should be incorporated into the design of the development; *Release of stormwater into the wetland must not result in further incision or erosion; *Sustainable Drainage Systems (SuDS) must be used to manage stormwater as there will be an increase in hardened surfaces in proximity to the system. SuDS will assist in preventing significant impacts on the hydrological functioning of the system, reduce the risk of flooding during high flow periods and reduce the risk of increased erosion (Figure A); and *SuDS must include a swale with side walls lined with stones and vegetated with indigenous vegetation in order to reduce the velocity of water within the system and dissipate energy thereby reducing erosion and incision.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)
	10		Potential risk of contaminated runoff from the increased impermeable surfaces (parking areas and access roads).	*Pollution of freshwater soils, groundwater, and surface water.	M	*Attenuation facilities for the stormwater management be designed to be as natural as possible (earth) and vegetated to function as a constructed wetland for water quality filtration; *Any spills to be immediately cleaned up and treated accordingly.	N/A	
	11	Operation and associated maintenance of the proposed sewer pipeline.	*Potential leakage of proposed sewer pipeline and discharge of sewage into the wetland; and *Miscellaneous activities by construction personnel associated with	*Increased water input into the wetland thus altering the natural hydrological regime of the wetland; *Sedimentation of the wetland resulting from sediment-laden stormwater runoff entering the wetland, and associated disturbances to vegetation;	M	*It is recommended that the managing authority test the integrity of the pipeline at a reasonable frequency; and *Should areas need to be excavated for maintenance purposes, all mitigation measures as stipulated above are deemed applicable; *Only existing roadways should be utilised during maintenance and monitoring activities to avoid indiscriminate movement of vehicles; and *It should be ensured that the wetland is not inundated as a result of leaks or bursting of the proposed sewer pipeline, and that an emergency plan should be compiled to ensure a quick response and attendance to the matter in case of	N/A	

Phase	No	Activity	Aspect	Impact	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE	PES /EIS
			maintenance of the proposed sewer pipeline.	*Potential risk of contaminated runoff and litter entering the wetland thus altering water quality; and *Potential erosion and incision within the wetland as a result of the concentrated flow of water.		a leakage or bursting of the proposed sewer the pipeline.		
	12	Potential indiscriminate disposal of waste.	*Disposal of solid household waste within the wetland.	*Impacts on the habitats and biota within the receiving environment; and *A reduction in water quality of water and soil.	L	*No vehicles are permitted to enter into the wetland. Any maintenance works must be undertaken by foot or the relevant authorisations obtained beforehand; *Litter bins and signages must be placed at various places within the study area particularly within potential wetland crossing areas in order to educate the public about the importance of waste management and wetland systems at large; and *Waste from the litter bins must be collected by the local service provider at the beginning of each week.	N/A	
	13	Inadequate capacity and/or maintenance of stormwater and/or sewage systems.	*Failure of the stormwater and/or sewage systems; *Unmanaged stormwater and/or sewage entering the wetland.	*A reduction in water quality, with a subsequent impact on biota; *Impacted soil and water quality condition within the wetland and *Altered hydroperiod of the wetland.	M	*Sewage systems must be consistently managed, and a response plan must be in place in order to minimise impact in the event of sewer pipe leakage; *Stormwater culverts must be maintained by removing debris which might block culverts or wetland crossings; and *Stormwater from surrounding impervious surfaces must pass through SUDs before entering the delineated wetland.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)
Rehabilitation	14	Rehabilitation of affected portions of the wetland (road crossings, sewer pipeline).	*Re-vegetate all areas where vegetation removal took place; *Remove any obstructions to flow; and *Alien and invasive plant removal.	*No negative impacts are identified for the proposed rehabilitation actions.	M	*A detailed rehabilitation plan was undertaken as part of the proposed development as required by the competent authority; *As much indigenous vegetation growth as possible must be promoted in order to protect soils and to reduce the percentage of impermeable surfaces. All invasive and alien vegetation located within the footprint area should be removed and monitored; *The variable GDARD setback area must be rehabilitated with indigenous vegetation and can be utilised as an open space/recreational area for the development; *Litter bins and signage should be put up along the road crossings to inform staff and the community of the importance of wetland systems to people and biodiversity; and *Monitoring, maintenance and management of the rehabilitated areas must take place after construction, during the operation phase. It is proposed that a **3-month maintenance** period (Growing-in Phase) be included in the contract of the rehabilitation contractor.	N/A	

DOCUMENT GUIDE

The following table indicates the requirements for Specialist Studies as per Appendix 6 of Government Notice 326 of 2017, amendments to the Environmental Impact Assessment (EIA) Regulations, 2014 as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998), promulgated in Government Notice 40772 of 2017.

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix G
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix G
b)	A declaration that the specialist is independent	Appendix G
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
cA)	An indication of the quality and age of base data used for the specialist report	Section 4
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5.2 and 7
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 5.2
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Appendix C
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 5 and 6
g)	An identification of any areas to be avoided, including buffers	Section 6
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 6
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.3
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 5, 6 and 7
k)	Any mitigation measures for inclusion in the EMPr	Section 7 and Appendix F
l)	Any conditions for inclusion in the environmental authorisation	Section 7 and Appendix F
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 9
n)	A reasoned opinion -	Section 10
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 10
(iA)	Regarding the acceptability of the proposed activity or activities	Section 10
(ii)	If the opinion is that the proposed activity, activities, or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 10
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

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GLOSSARY OF TERMS

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, 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 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.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
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 soils).
Hydrology:	The study of the occurrence, distribution, and movement of water over, on and under the land surface.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Intermittent flow:	Flows only for short periods.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	The outer zone of a wetland characterised by saturation within 50cm 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 in 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 soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius.
BAR	Basic Assessment Report
BAS	Best Attainable Sate
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
C-Plan	Conservation Plan
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMP	Environmental Management Program
ESA	Ecological Support Area
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
GDARD	Gauteng Department of Agriculture and Rural Development
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
IHI	Index of Habitat Integrity
m	Meter
MAP	Mean Annual Precipitation
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
REC	Recommended Ecological Category
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SAIIAE	South African Inventory of Inland Aquatic Ecosystems
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SA RHP	South Africa River Health Programme
SAS	Scientific Aquatic Services
SQR	Sub quaternary catchment reach
subWMA	Sub-Water Management Area
UCVB	Unchannelled Valley Bottom
VEGRAI	Riparian Vegetation Response Assessment Index
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WMS	Water Management System
WRC	Water Research Commission
WULA	Water Use License Application

1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a watercourse ecological assessment as part of the Environmental Impact Assessment (EIA) and Authorisation Process into the Water Use License Application (WULA) for the proposed Lethabong mixed housing development on the remaining extent of the farm Quaggasfontein Alias Lapdoorn 548 IQ, Gauteng Province, hereafter referred to as the 'study area' (Figure 1 and Figure 2) (Please refer to Section 2 for the project description).

To identify all possible watercourses that may potentially be impacted by the proposed development, a 500 m "zone of investigation" around the study area in accordance with General Notice (GN) 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) was used as a guide in which to assess possible sensitivities of the receiving environment. This area – i.e. the 500 m zone of investigation around the study area- will henceforth be referred to as the "investigation area" (Figure 1 and Figure 2).

The purpose of this report is to define the ecology of the area in terms of watercourse characteristics, including mapping of the watercourses, defining areas of increased Ecological Importance and Sensitivity (EIS), and to define the Present Ecological State (PES) of the watercourses associated with the proposed development. Additionally, this report aims to define the socio-cultural and ecological service provision of the watercourses and provide the Recommended Management Objectives (RMO), Best Attainable State (BAS) and Recommended Ecological Category (REC) for the watercourses. It is a further objective of this study to provide detailed information to be considered during the construction and operation of the proposed development in the vicinity of the watercourses, to ensure the ongoing functioning of the ecosystems such that local and regional conservation requirements and the provision of ecological services in the local area are supported, while considering the need for sustainable economic development.

The Department of Water and Sanitation (DWS) Risk Assessment Matrix as promulgated in GN 509, published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA) was applied to determine the significance of the perceived impacts associated with the proposed development. In addition, mitigatory measures were developed which aim to minimise the perceived impacts, followed by an assessment of the significance of the impacts post-mitigation, assuming that they are fully implemented. This report, after consideration and a description of the ecological integrity

associated with the proposed development, must guide the relevant authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed development from a watercourse management point of view.

1.1 Structure of the report

The report provides insights into the current freshwater ecological integrity, investigates the significance of potential impacts on the watercourse ecology and indicates the required mitigatory measures needed to minimise any perceived impacts associated with the project. The report has been structured in the following way:

Chapter 1: Introduction

Provides an introduction, the structure of this report, scope of work, the assumptions and limitations and outlines all the relevant legislation.

Chapter 2: Project background

Provides the location of the project as well as a brief summary of the activities associated with the proposed development.

Chapter 3: Assessment approach

This section outlines the methodologies used to assess the watercourses associated with the proposed development.

Chapter 4: Results from the desktop assessment

This section contains data accessed as part of the desktop assessment and are presented as a “dashboard style” report. The dashboard report aims to present concise summaries of the data to allow the integration of results by the reader. Databases assessed as part of the desktop assessment include the National Freshwater Ecosystem Priority Area (NFEPA) (2011), Gauteng Department of Agriculture and Rural Development (GDARD) Gauteng Conservation Plan (2011) and National Biodiversity Assessment (2018) databases.

Chapter 5: Watercourse assessment

This section provides the results of delineations of all watercourses within the investigation area. This is then followed by dashboard style results summarising results from various field assessments conducted to assess the ecological integrity of the watercourses.

Chapter 6: Legislative requirements and applicable zones of regulation

This section presents legislative requirements in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) and their applicability to the proposed development were also considered herein. In addition, provincial guidelines [Gauteng Department of Agriculture and Rural Development Requirements for Biodiversity Assessments (2014)] are also considered.

Chapter 7: Risk assessment

The section presents the significance of potential impacts and the required mitigatory measures required to minimise the perceived impacts associated with construction, operation and rehabilitation phases of the project. The section also includes a monitoring plan used to define tools and measures to be applied in order to manage any potential impacts.

Chapter 8: Conclusion

The section summarises the key findings and recommendations based on the watercourse assessment and risk assessment conducted. In addition, the section provides a specialist opinion as to whether the proposed activities or portions thereof should be authorised.

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 National Biodiversity Assessment 2018: South African Inventory of Inland Aquatic Ecosystems [NBA 2018: SAIIAE], the Department of Water and Sanitation Research Quality Information Services [DWS RQIS PES/EIS], 2014 database and the Gauteng Department of Agriculture and Rural Development [GDARD] Gauteng Conservation Plan, 2011 database) was undertaken to aid in defining the PES and the EIS of the watercourses;
- Watercourses were delineated according to "DWAF[1] 2008: A practical field procedure for identification of wetlands and riparian areas". Aspects such as soil morphological characteristics, vegetation types and wetness were used to delineate the watercourse resources;

[1] 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, will be used.

- All watercourses within the investigation area were delineated using desktop methods and field verified in accordance with GN509 of 2016 as it relates to activities as stipulated in Section 21 (c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998);
- The watercourse assessment was undertaken according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- The EIS of the watercourses were determined according to the method described by Rountree and Kotze (2013);
- The Wet-Health assessment for the watercourses according to the resource directed measures guideline as advocated by Macfarlane *et. al.* (2008);
- Watercourses were mapped according to the ecological sensitivity of each hydrogeomorphic unit in relation to the proposed development. In addition to the watercourse boundaries, the appropriate provincial recommended buffers and legislated zones of regulation were depicted where applicable;
- Allocation of a suitable RMO, BAS and REC to the watercourses based on the results obtained from the PES and EIS assessments;
- The DWS Risk Assessment Matrix (2016) was applied to identify potential impacts that may affect the watercourses as a result of the proposed development, and to aim to quantify the significance thereof; and
- To present management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact on the receiving environment. This included possible monitoring requirements during the construction and operational phase of the development.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- All watercourses identified within the investigation area were delineated in fulfilment of GN 509 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) using desktop methods and verification thereof was undertaken according to “Department of Water Affairs and Forestry (DWAF) (2008): Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas”;
- Some areas surrounding the study area have undergone significant anthropogenic changes (development of informal settlements, infilled areas and observed construction activities). As a result, identification of the outer boundary of the temporary zone of the watercourses proved difficult in some areas. Therefore, the watercourse delineations as presented in this report are regarded as a best estimate of the

boundaries based on the site conditions present, as observed during the site assessment;

- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. However, the delineations as provided in this report are deemed accurate enough to fulfil the authorisation requirements as well as implementation of the mitigation measures provided. If more accurate assessments are required, the watercourses will need to be surveyed and pegged according to surveying principles;
- Watercourse and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the watercourse boundary may occur. However, if the DWAF (2005; 2008) method is followed, all assessors should get largely similar results; and
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, it is expected that the watercourses associated with the proposed development have been accurately assessed and considered, based on the field observations and the consideration of existing studies and monitoring data in terms of watercourse ecology.

1.4 Legislative Requirements and Provincial Guidelines

The following legislative requirements and relevant provincial guidelines were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in Appendix B:

- The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996);
- National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998); and
- The Gauteng Department of Agriculture and Rural Development's (GDARD) Requirements for Biodiversity Assessments, Version 3 (GDARD, 2014).

2 PROJECT DESCRIPTION

The study area is located 3 km east of the R553 Roadway, 200 m east of Sebokeng Unit 10 and it is traversed by the Houtkop Road in Sebokeng, Vereeniging, Gauteng (Figure 1 and Figure 2). Authorisation was granted for the western portion of the investigation area outside of the study area, for the development of Phase 1-4. Civil construction commenced for phase 2 in October 2017 and was shortly thereafter put on hold. A new civil contractor was appointed in November 2018 to date, continuing with the construction work associated with the western portion for the study area.

The surrounding landscape comprises high-density residential housing to the west and south, with the east and northern region comprising predominantly of residential small holdings. A conceptual layout was used in the compilation of the risk assessment for the development in relation to the watercourses identified (please refer to Section 7 of this report). According to the conceptual layout, the proposed development includes a hospital, mixed residential housing, three access roads, and a sewer line. The purpose for each of the three road crossings have been provided below:

- The northern access road will be constructed as a future road by the municipality or another party.
- The middle access road will be constructed by the developer for access to the development.
- The southern access road will be constructed by the provincial government to gain access to the hospital.

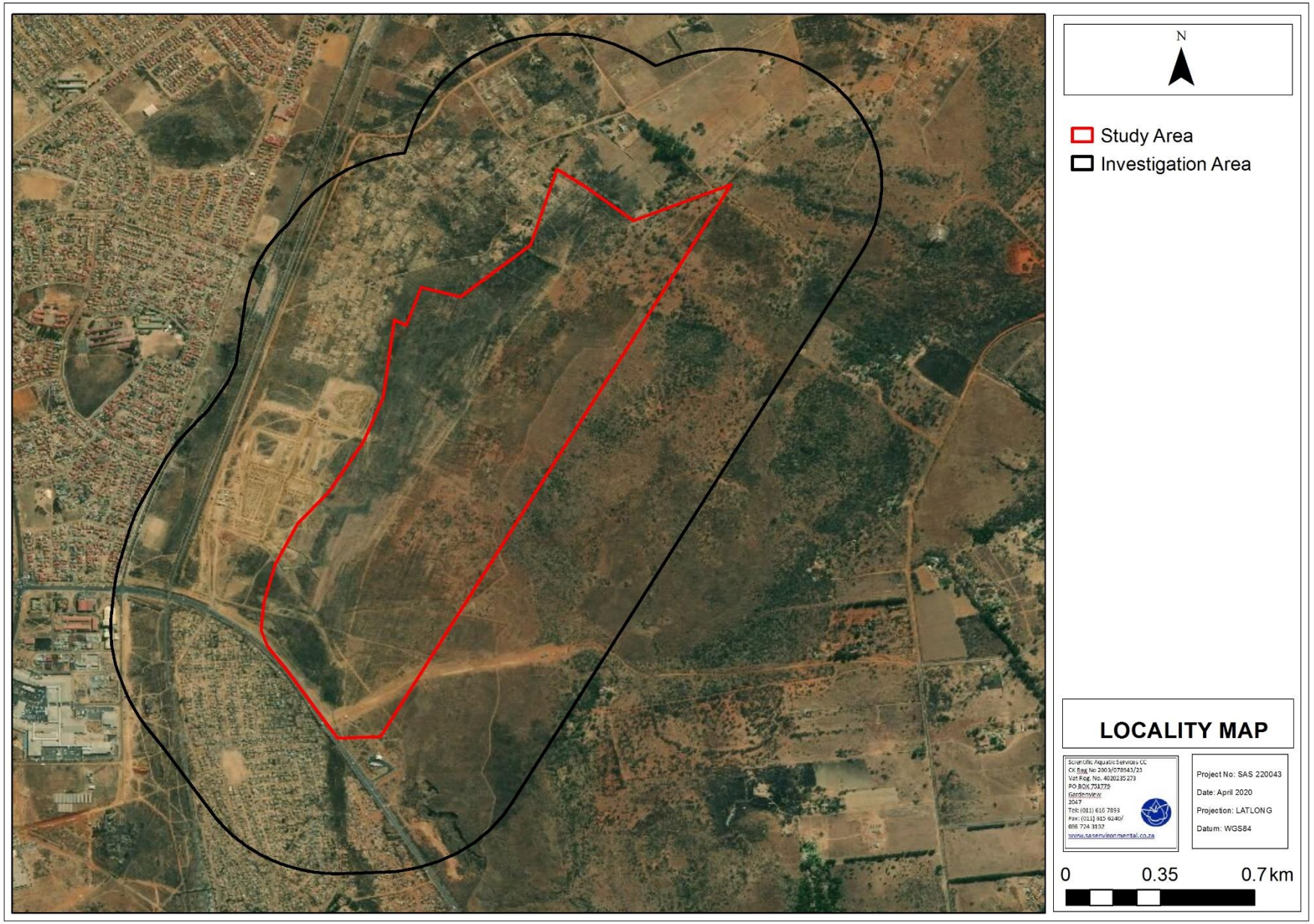


Figure 1: A digital satellite image depicting the location of the study and investigation areas in relation to the surrounding area.

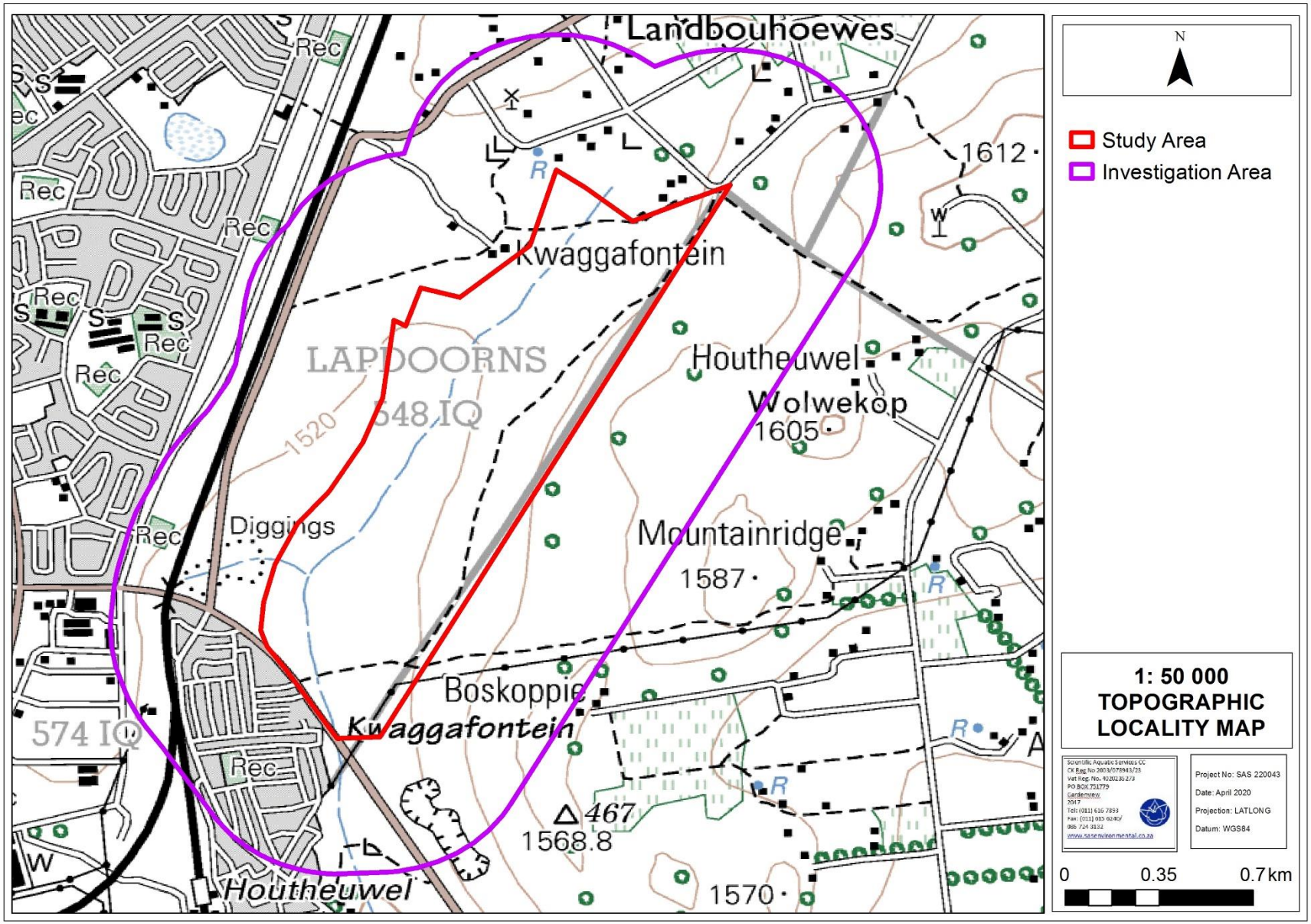


Figure 2: The study and investigation areas depicted on a 1:50 000 topographical map in relation to the surrounding area.

3 ASSESSMENT APPROACH

3.1 Watercourse Field Verification

For the purposes of this investigation, the definition of a watercourse, riparian and wetland habitat were taken as per that in the National Water Act, 1998 (Act No. 36 of 1998). The definition is as follows:

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 to be a watercourse and a reference to a watercourse includes where relevant, its bed and banks.

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".

The watercourse delineation took place, as far as possible, according to the method 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 watercourses 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.

A field assessment was undertaken on the 26th March 2020 during which the presence of any watercourses as defined by DWAF (2008) and by the National Water Act 1998 (Act No. 36 of 1998), were noted (please refer to Section 5 of this report). In addition to the delineation process, a detailed assessment of the delineated watercourses that were potentially at risk from the proposed development was undertaken, where factors affecting the integrity of the watercourses were taken into consideration and aided in the determination of the ecological functioning thereof as well as the provision of ecological and socio-cultural services by the

watercourses. A detailed explanation of the methods of assessment undertaken is provided in Appendix C of this report.

3.2 Sensitivity Mapping

The watercourses associated with the proposed development were delineated with the use of a Global Positioning System (GPS). Geographic Information System (GIS) was used to project the feature onto digital satellite imagery and topographic maps. The sensitivity map presented in Section 6 should guide the all phases of the project.

3.3 Risk Assessment and Recommendations

Following the completion of the watercourse assessment, the DWS Risk Assessment was compiled (please refer to Appendix D for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general 'best practice' management measures, which apply to the proposed development as a whole, and which are presented in Appendix F. Mitigation measures have been developed to address issues in all phases throughout the life of the proposed development (construction, operation and rehabilitation). The detailed site-specific mitigation measures are outlined in Section 7 of this report.

4 RESULTS OF THE DESKTOP ANALYSIS

4.1 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 in order 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 to be of particular 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 study area actual site characteristics at the scale required to inform the Environmental Impact Assessment (EIA) process. Given these limitations, this information is considered useful as background information to the study. It must, however, be noted that site verification of key areas may potentially contradict the information contained in the relevant databases, in which case the site verified information must carry more weight in the decision-making process. Thus, this data was used as a guideline to inform the watercourse assessment and to focus on areas and aspects of increased conservation importance during the site assessment.

Table 1: Desktop data relating to the characteristics of the watercourses and surrounding region associated with the study and investigation areas.

Aquatic ecoregion and sub-regions in which the study area is located	
Ecoregion	Highveld
Catchment	Vaal
Quaternary Catchment	Majority C22F, remaining portion C22H (Figure 3)
WMA	Upper Vaal
subWMA	Downstream Vaal Dam
Dominant characteristics of the Highveld Ecoregion Level 2 (11.01) (Kleynhans *et al.,* 2007)	
Dominant primary terrain morphology	Plains; low relief and moderate relief
Dominant primary vegetation types	Rocky Highveld Grassland, Mixed Bushveld
Altitude (m a.m.s.l)	1300 to 1900
MAP (mm)	500 to 700
Coefficient of Variation (% of MAP)	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 annual simulated runoff (mm)	20 to 60
National Biodiversity Assessment (2018): South African Inventory of Inland Aquatic Ecosystems (SAIIAE) (Figure 6-7) (National Wetland Map 5 is included in the NBA)	
According to the NBA 2018: SAIIAE there are no wetland located within the study area. the NBA 2018 Dataset corresponds with the NFEPA Database, indicating the depression and seep within the investigating area. additionally, the flat wetland identified by NFEPA Dataset, is classified as an unchanneled valley bottom by the NBA 2018 Dataset. The unchanneled valley bottom and depression area considered natural or good (Class AB), while the seep wetland is considered heavily to critically modified (Class DEF). The Ecosystem Threat Status (ETS) of the seep and unchanneled valley bottom are critically endangered, while the depression is least concerned. The ecosystem protection level (EPL) of the unchanneled valley bottom wetland is not protected, while the seep and depression are poorly protected. The seep wetland is furthermore affected by roads. There are no river systems associated with the study area or investigation area.	

Detail of the study area in terms of the Gauteng Conservation Plan (C-Plan V3.3, 2011) (Figure 8-10)	
Critical Biodiversity Area (CBA)	The eastern portion of the study area falls within an area considered to be a Critical Biodiversity Area (CBA). The CBA is considered to be an important area for "Orange" Listed plant habitat, and for primary vegetation. CBAs include natural and near-natural terrestrial and aquatic features that are required to meet targets for biodiversity patterns and ecological processes. Furthermore, CBAs are an area considered important for the survival of threatened species and includes valuable ecosystems such as wetlands, untransformed vegetation and ridges.
Ecological Support Area (ESA)	A portion of the study area is considered ESAs. ESAs are natural, near natural, degraded or heavily modified areas required to be maintained in an ecologically functional state to support CBAs and/or Protected Areas.
Wetland and River Buffers	According to the Gauteng C-Plan there are no wetland buffers within the study area, however a non-perennial river buffer falls within the central portion of the study area. Furthermore, a pan and wetland buffer is situated within the north western portion of the study area.
Gauteng Environmental Management Framework (GEMF, 2014)	The majority (80%) of the study area is situated within the urban development zone [EMF Zone 1] and the remaining portion of the study area falls within the high control zone (inside zone 1)[EMF Zone 2] according to the Gauteng Environmental Management Framework (2014). **EMF Zone 1:** The intention with 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. **EMF Zone 2:** 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.
Detail of the study area terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database (Figure 4-5)	
FEPACODE	The study area falls within a sub quaternary catchment currently not considered important in terms of fish or freshwater ecology.
NFEPA Wetlands	According to the NFEPA Database there are no wetlands situated within the study area, however there are a natural depression, seep and flat wetlands located within the investigation area. The depression and seep are considered heavily to critically modified (Class Z1), while the flat wetland is moderately modified (Class C).
Wetland Vegetation Type	The study area is situated within the Mesic Highveld Grassland Group 3 (least threatened) Wetland Vegetation Type, Mbona et al. (2015).
NFEPA Rivers	According to the NFEPA Database, there are no rivers associated with the study area or investigation area. the Rietspruit River is located approximately 4.3km north northwest of the study area.

Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)	
Sub-quaternary reach	C22H – 01473 (Rietspruit River)
Proximity to study area	±4.3km north northwest of the study area
Assessed by expert?	Yes
PES Category Median	Serious Modification (Class E)
Mean Ecological Importance (EI) Class	Moderate
Mean Ecological Sensitivity (ES) Class	Moderate
Stream Order	1
Default Ecological Class (based on median PES and highest EI or ES mean)	Moderate (Class C)

CBA = Critical Biodiversity Area; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Metres Above Mean Sea Level; MAP = Mean Annual Precipitation; NBA = National Biodiversity Assessment; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State; SAIIAE = South African Inventory of Inland Aquatic Ecosystems; WMA = Water Management Area

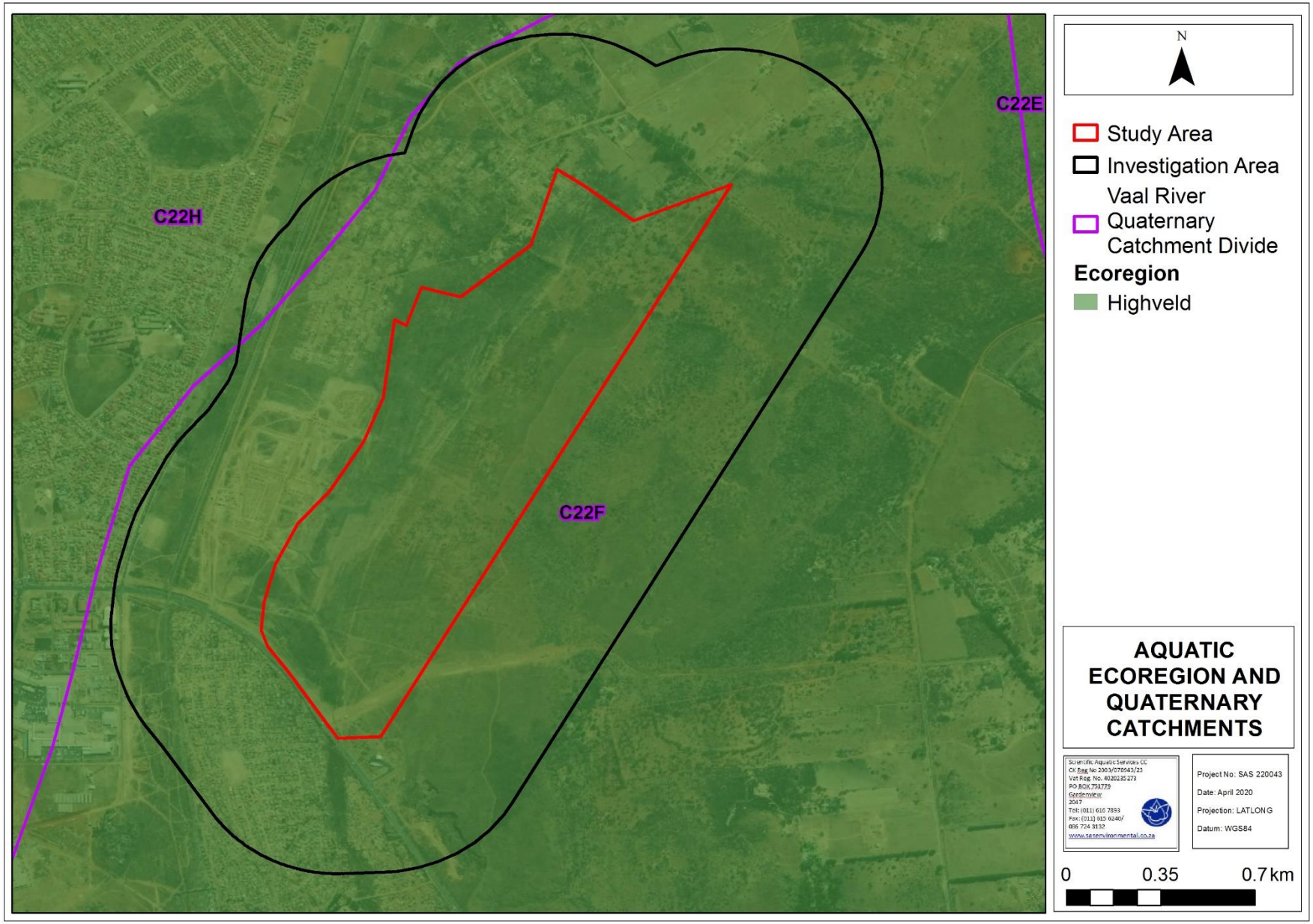


Figure 3: Aquatic ecoregion and quaternary catchments associated with the study and investigation area.

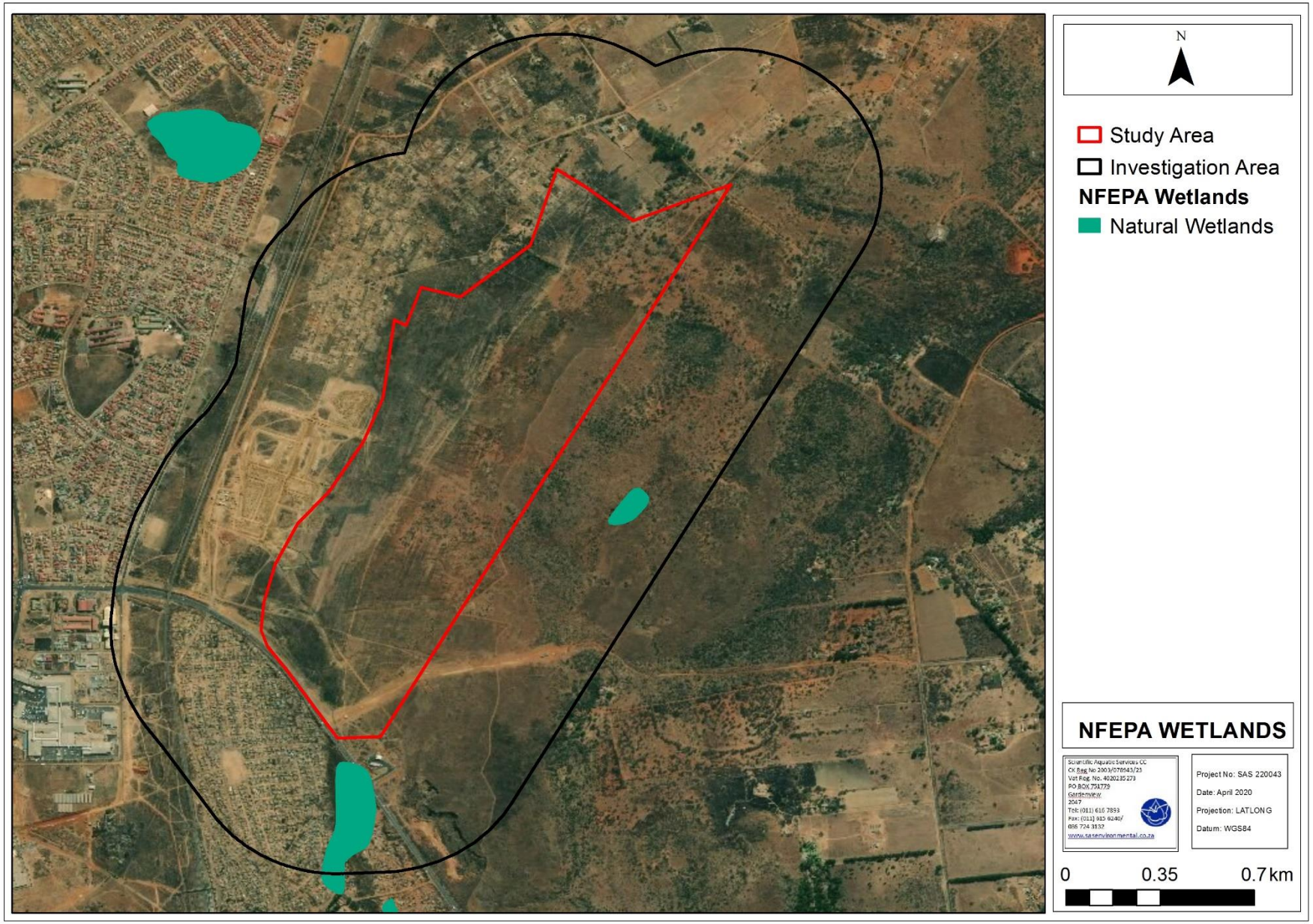


Figure 4: The natural wetland feature associated with the study and investigation areas (NFEPA, 2011).

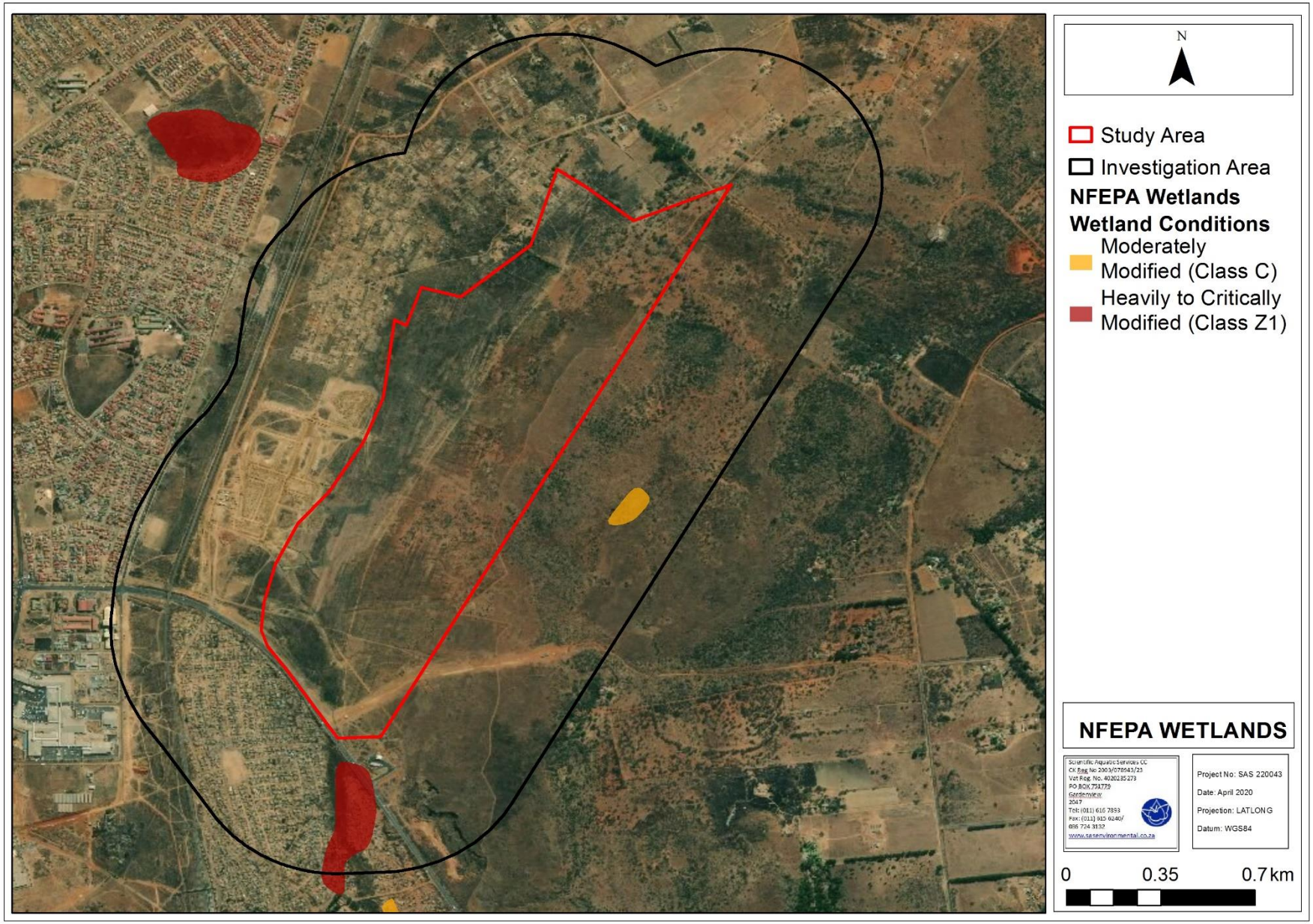


Figure 5: The conditions of wetlands associated with the study and investigation areas (NFEPA, 2011).

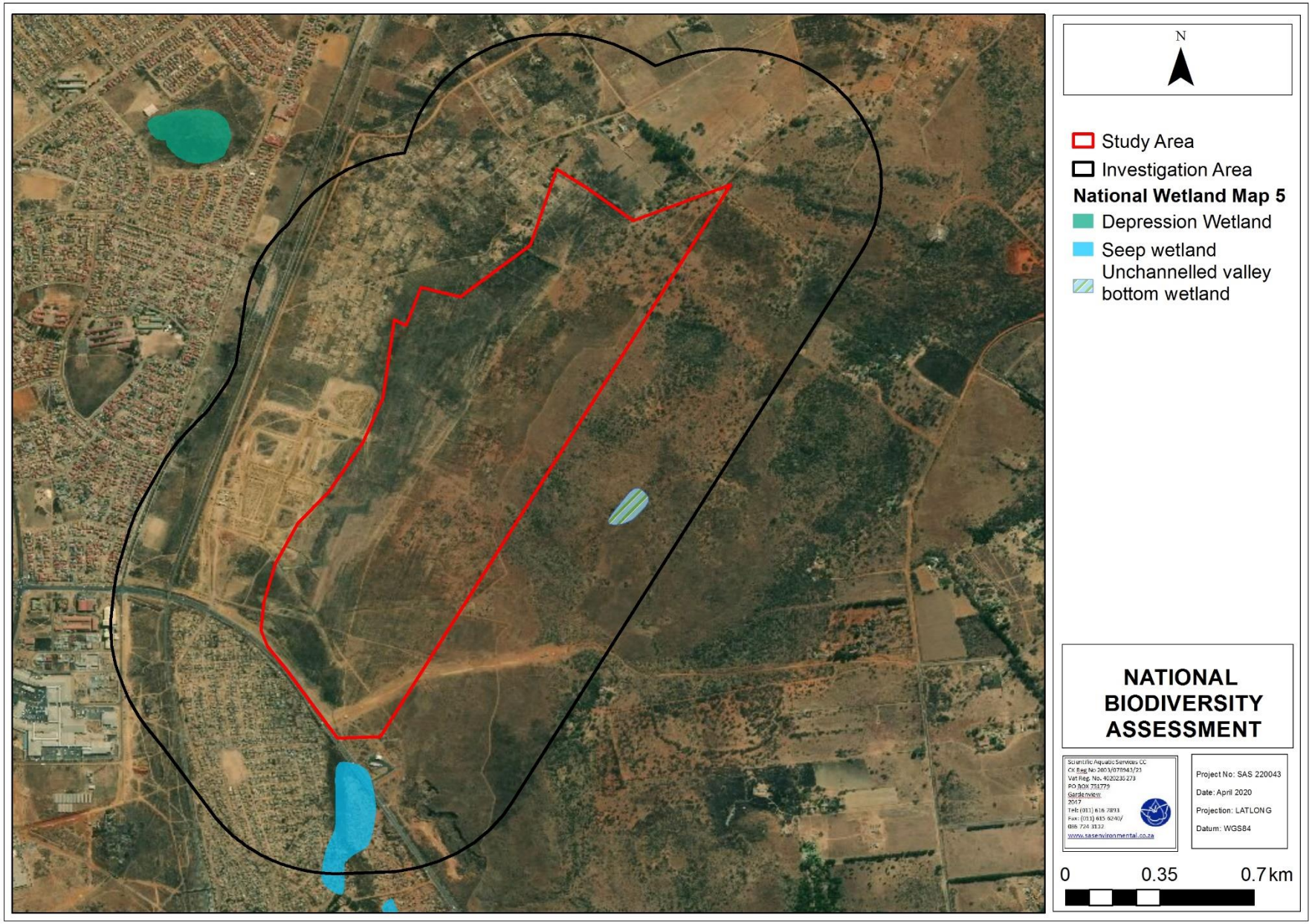


Figure 6: The National Biodiversity Assessment 2018 indicating HGM units associated with the study and investigation areas.

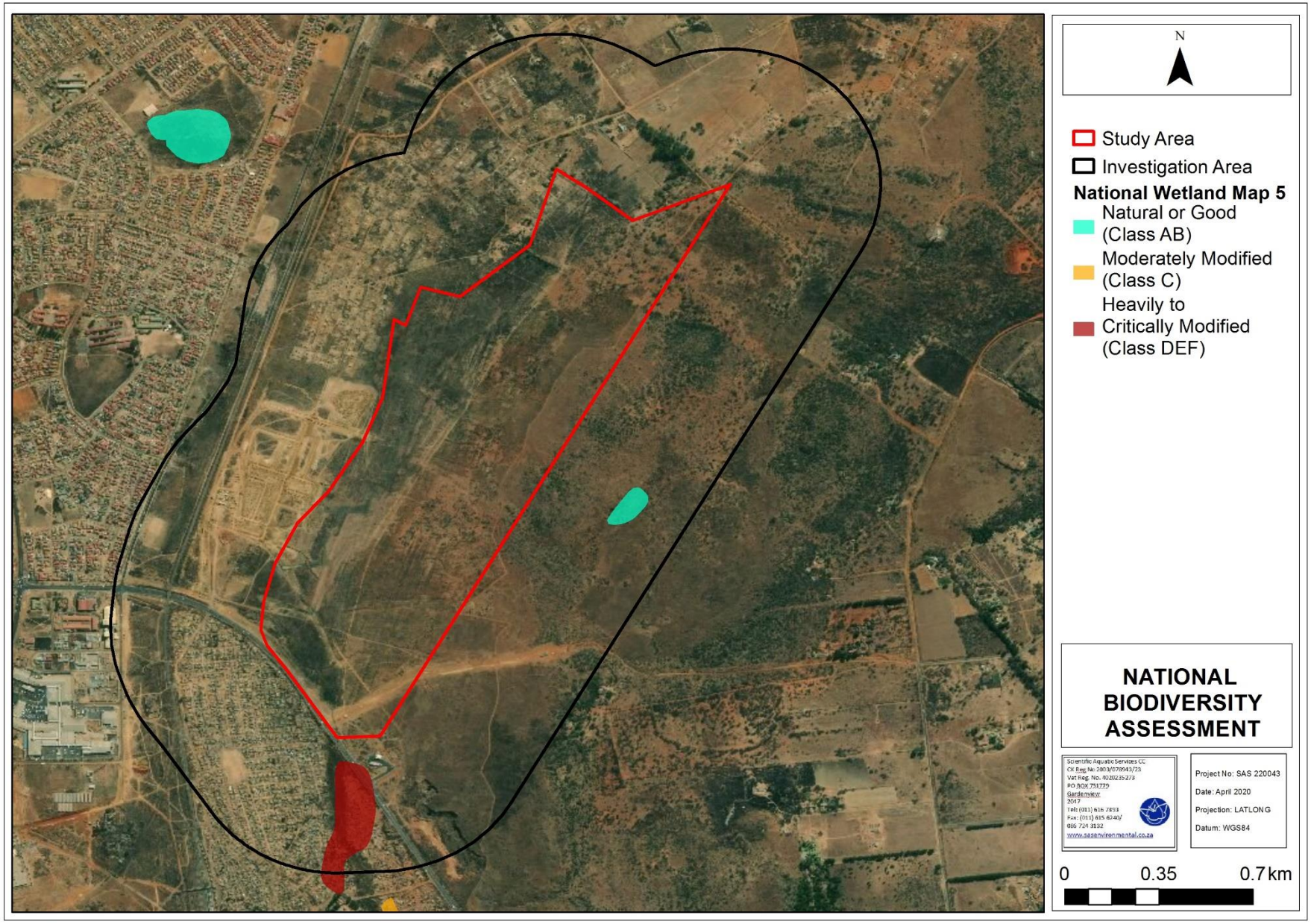


Figure 7: The National Biodiversity Assessment 2018 indicating conditions of wetlands associated with the study and investigation areas

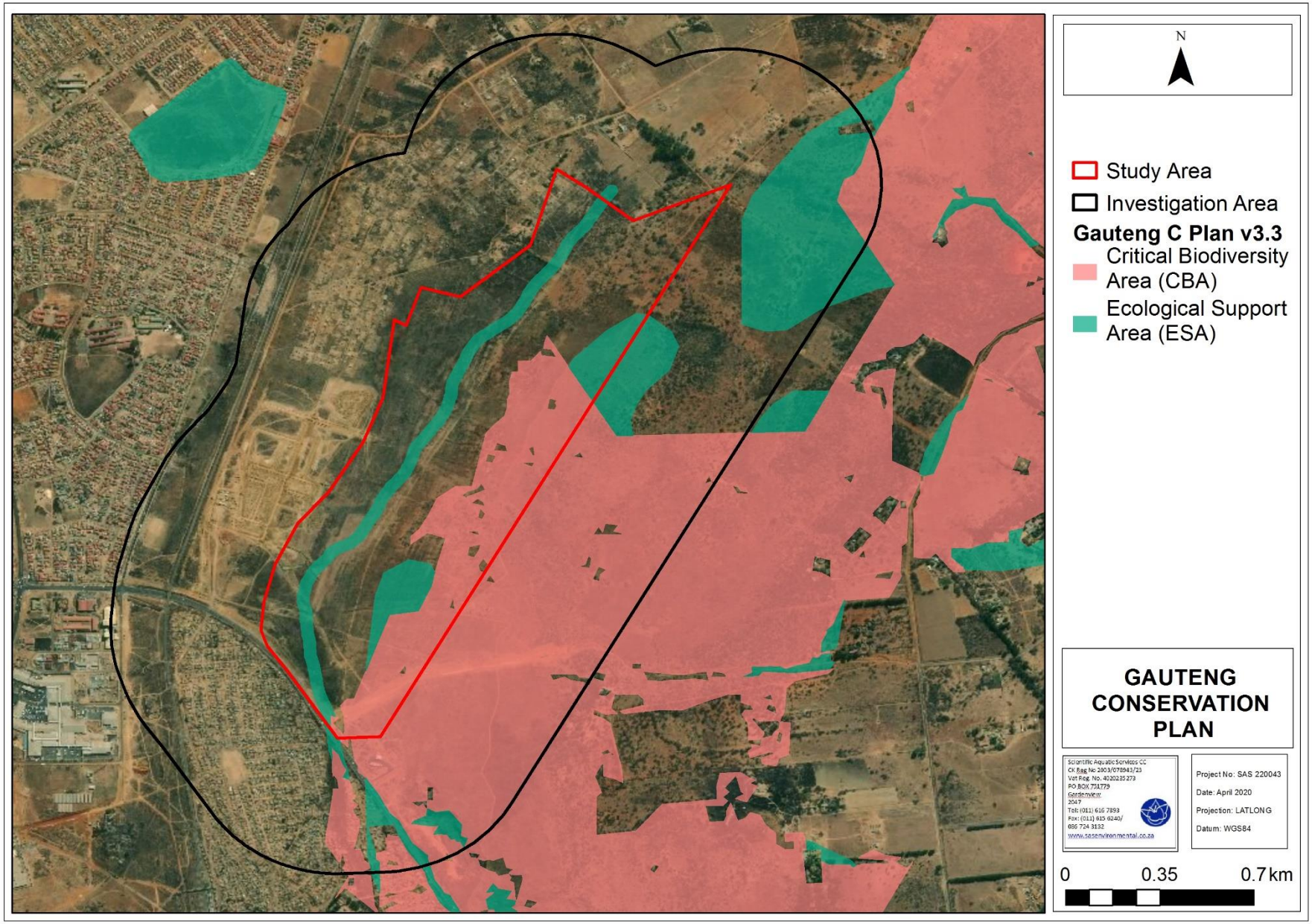


Figure 8: CBAs and ESAs associated with the study and investigation areas according to the Gauteng C-Plan V3.3 (2011).

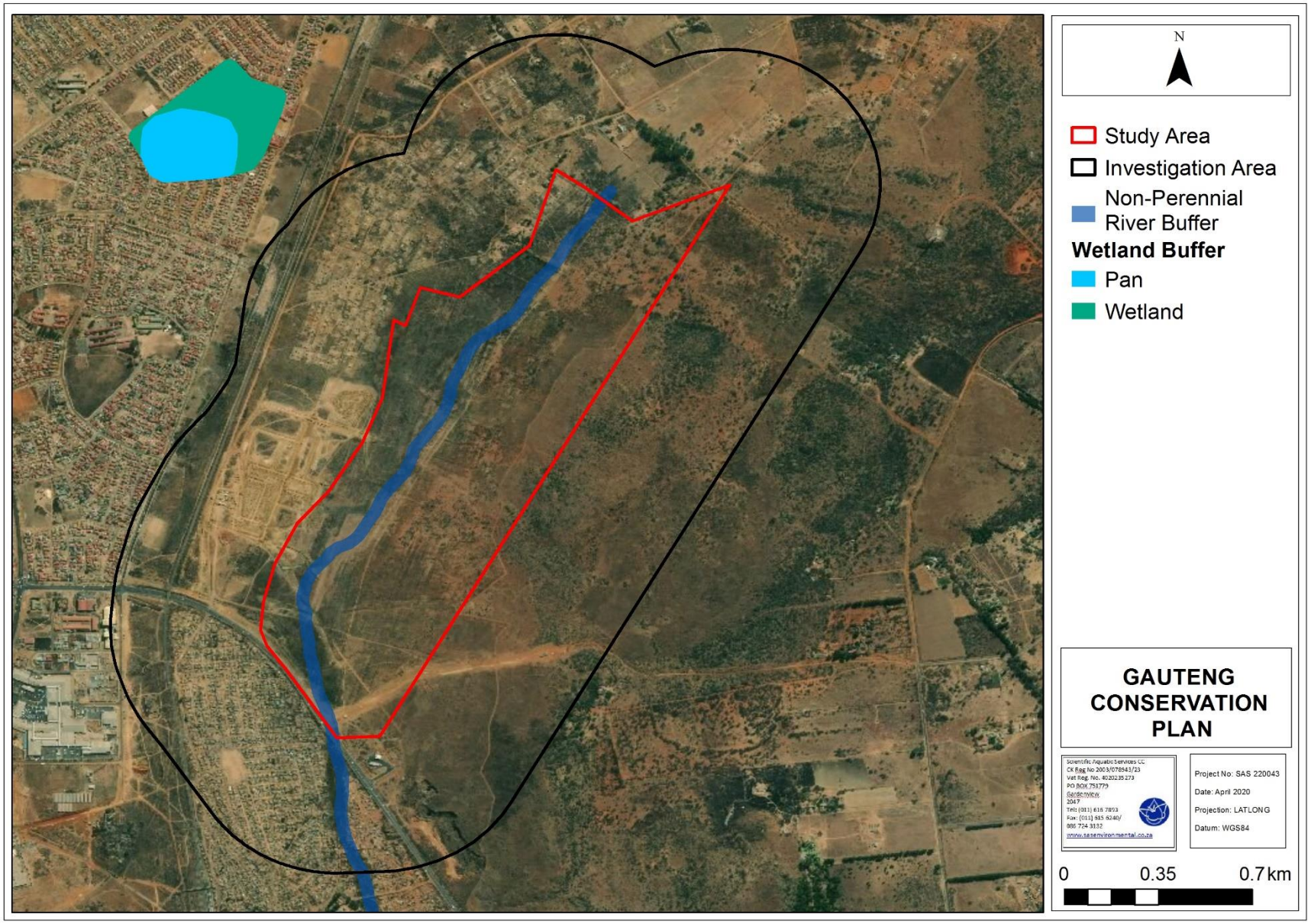


Figure 9: The non-perennial river and wetland buffers associated with the study and investigation areas (Gauteng C-Plan V3.3 (2011)).

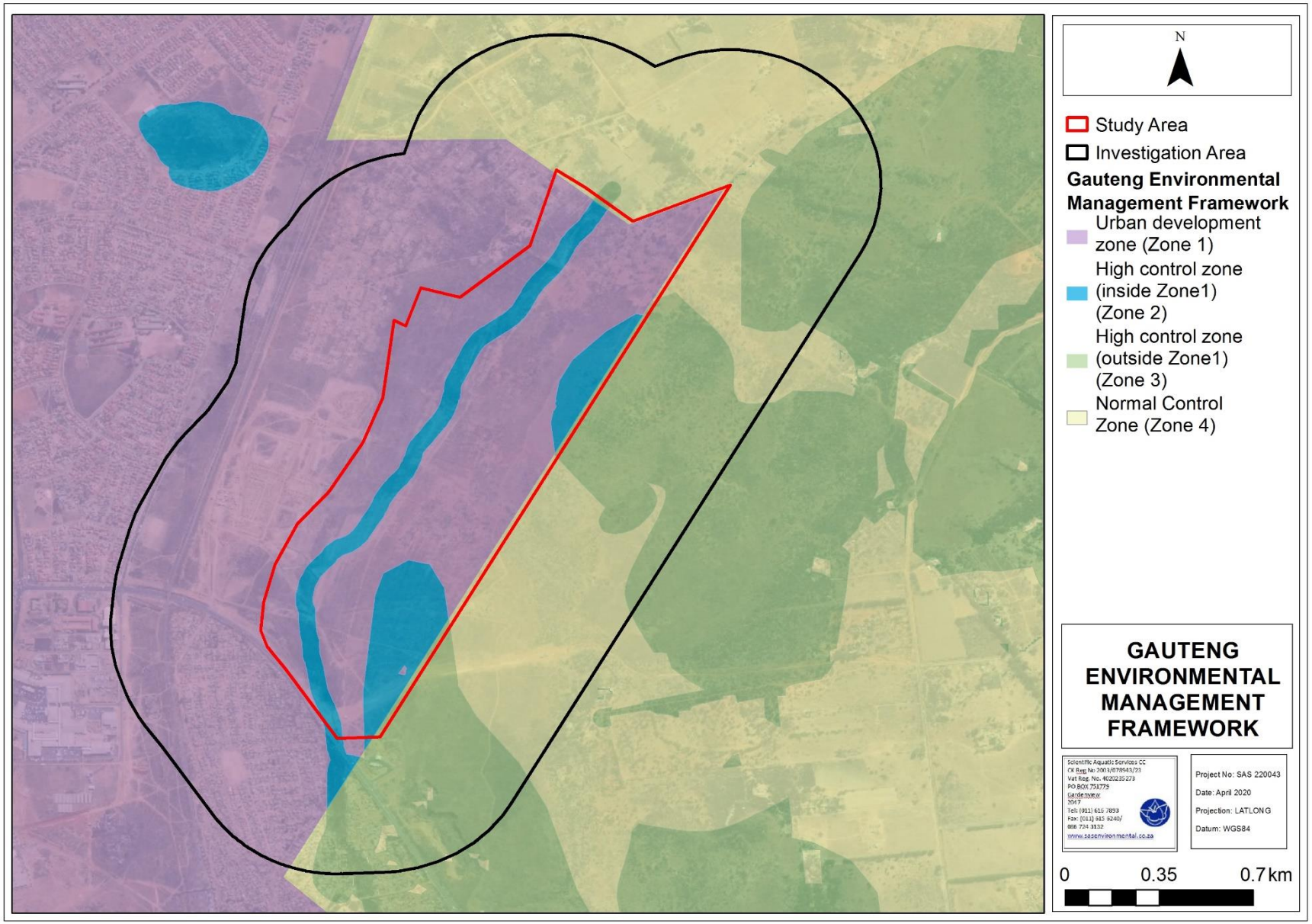


Figure 10: The zones within which the study and investigation areas are situated, according to the Gauteng Environmental Management Framework (2014).

5 RESULTS: WATERCOURSE ASSESSMENT

5.1 Delineation

The wetland was delineated in the field and the delineations subsequently refined with the use of historical imagery, current digital satellite imagery and topographical maps. The delineation as presented in this report are thus regarded as a best estimate of the UCVB and seep HGM unit boundaries based on the site conditions during the site assessment conducted on the 26th March 2020.

During the assessment, various indicators were used to delineate the boundaries of the wetland within the study area.

Terrain units were utilised as the primary determinant to ascertain in which parts of the landscape within the study area the watercourses would be likely to occur. The elevation profile shows the location of the delineated UCVB and seep HGM units within the study area (Figure 11). Given the nature of the landscape within the study area, the wetland is likely driven by seepage from adjacent slopes and groundwater inputs. The elevation decreases in a north to south direction (1534 m to 1511 m).

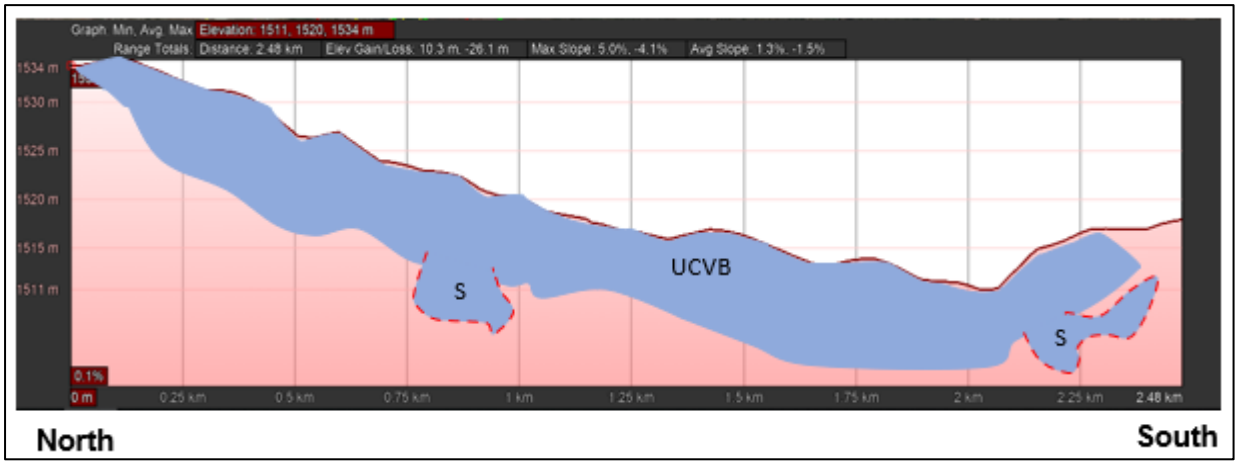


Figure 11: Elevation profile showing general gradient of the study area and the location of the delineated wetland within the landscape. The seep HGM units are denoted as S in the elevation profile.

Obligate and facultative wetland species were used in conjunction with terrain units, as well as the point where a distinct change in the vegetation composition was observed to determine the wetland boundaries. Due to the extent of vegetation clearance which has taken place as a result of informal settlements north-west of the study area, soil disturbances and dumping,

as well as current construction activities (including trenching), the vegetation community composition and hydrology has been notably transformed In addition, given the extensive historical agricultural activities, the vegetation within the study area is considered to be a secondary grassland. Within parts of the study area, *Imperata cylindrica* was observed to be dominant species and other obligate wetland species such *Schoenoplectus muriculatus* were observed within the permanent zone (Figure 12). A full species list is provided in Appendix E.

Figure 12: (Left) *Imperata cylindrica* and *Schoenoplectus muriculatus* species used as indicators during the delineation of the wetland transition zones.

The delineated wetland was largely temporary to seasonal, however, adjacent to the southern road crossing, inundation has resulted in the formation of a large permanently wet area (Figure 13).

Figure 13: Areas within the study area where surface water or ponding was observed.

The soil form indicator was used to determine the presence of soils that are associated with prolonged and frequent saturation with key indicators including gleying, mottling, organic streaking and increased clay content (Figure 14). Where extensive presence of anthrosols (soils that have been modified profoundly by human activities) were observed as a result of disturbance, this indicator was used with caution.

Figure 14: Mottling, an indicator of fluctuating table identified in soil within the seasonal zone of the wetland. Soil profile indicating colour variation in soil at different depths within the first 50 cm the profile.

Areas with expected watercourse habitat and/or increased soil moisture conditions were targeted during the site survey (Figure 15).

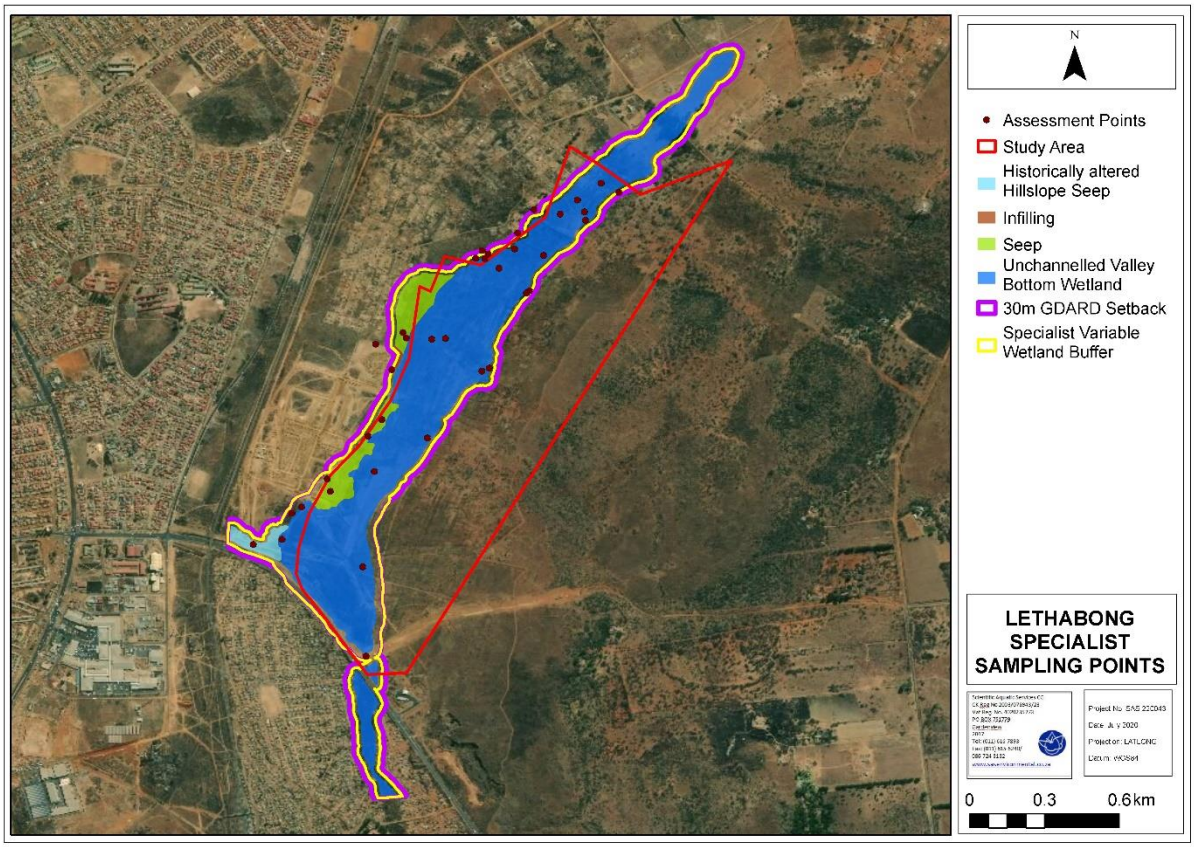


Figure 15: Locations of soil test positions within the study area.

5.2 Watercourse System Characterisation

A single wetland comprising a large unchanneled valley bottom (UCVB) HGM unit located from north to south of the study area and two seep HGM units feeding into the UCVB were delineated within the study area. An additional historically altered seep HGM unit was identified adjacent to the UCVB but outside of the study area and was not fully assessed during the field assessment.

The delineated wetland was characterised according to the Classification System (Ollis, *et al*. 2013) as inland systems (i.e. a system having no existing connection to the ocean, but which is inundated or saturated with water, either permanently or periodically), located in the Highveld Aquatic Ecoregion. The applicable wetland vegetation (WetVeg) group is the Mesic Highveld Grassland Group 3 which is considered to be least threatened by Mbona *et al*. (2015). The characterisation of the identified wetland is summarised in Table 2 below.

Table 2: Characterisation of the watercourses associated with the proposed development according to the Classification System (Ollis *et. al.,* 2013).

Watercourse	Level 3: Landscape unit	Level 4: HGM Type
Wetland	**Valley floor:** The base of a valley, situated between two distinct valley side-slopes**.**	**Unchanneled valley bottom:** A valley-bottom wetland without a river channel running through it.
	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, mid-slopes and foot-slopes.	**Seep:** A wetland located on gently to steeply sloping land and dominated by colluvial (i.e gravity-driven), unidirectional movement of water and material down-slope.

Figure 16 below provides a visual representation of the delineated wetland and associated HGM units in relation to the study and investigation area.

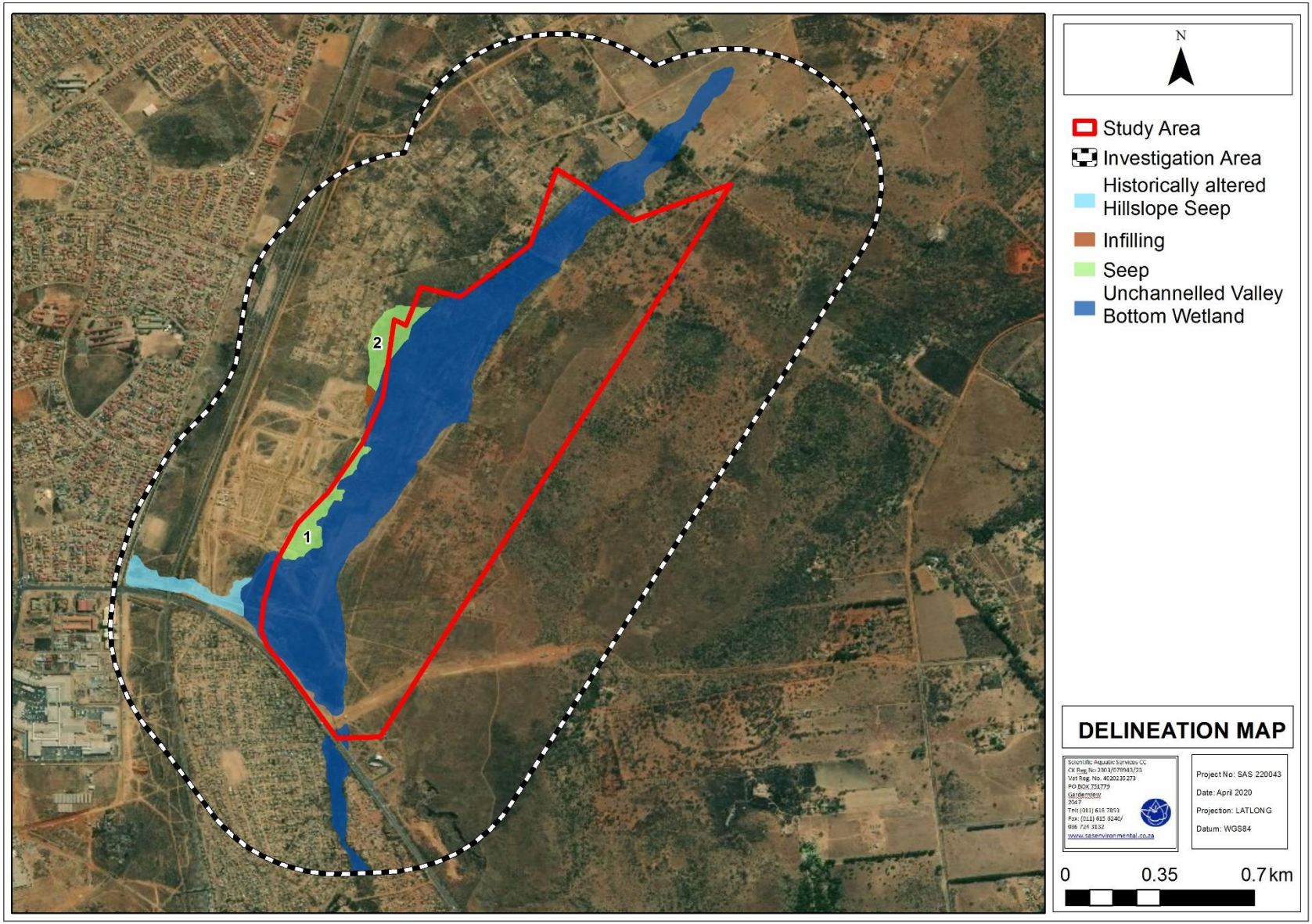


Figure 16: The delineation of the identified UCVB and two seeps associated with the proposed development depicted on digital satellite imagery.

5.3 Field Verification Results

5.3.1 Current impacts

Desktop assessment of historical imagery of the study area shows that a large portion of the study area (approximately 65%) was previously utilised for crop cultivation as far back as the 1970s (Figure 17). As a result of these historic agricultural activities, the vegetation composition and diversity within the wetland was considered to have been severely altered and can best be described as a secondary grassland which is considered to have undergone extensive modification and a fundamental shift from their original state (SANBI 2013).

Figure 17: Historical image (Circa 1968) showing evidence of historical cultivation activities and current digital satellite image (2019) showing establishment of informal settlements (yellow arrow indicates wetland flow direction).

Indiscriminate disposal of foreign soil material was observed within the delineated UCVB and seep HGM units (Figure 18, left). Where infilling with foreign material has occurred, the natural topographical setting has been impacted, resulting in altered overland flow patterns and formation of preferential flow areas as water moves through paths of least resistance. Excavated trenches were observed within the wetland, in addition to impacting on the natural surface runoff patterns, this has the potential to result in increased erosion and sedimentation of the wetland as well as a loss of water retention and distribution profiles, draining of the wetland, and ultimately a lowering of the natural water table at this point (Figure 18, right).

Figure 18: Indiscriminate disposal of foreign soil material within historical trench and open trench likely used to divert stormwater.

The Seep 1 HGM unit has been impacted hydrologically as a result of impacts related to soil compaction and disturbance and well as historical excavations, resulting in some desiccation and alteration of the natural water distribution and retention profiles at this point.

Areas where vegetation clearing and surface compaction has occurred were identified within the study area. Within the delineated UCVB, an informal road traversing the lower reach was identified during the assessment. These impacts increase runoff potential, and in addition have the potential to alter the natural transportation and deposition of sediment (Figure 19).

Figure 19: Impacts resulting in increased runoff within the wetland. (Left) Road crossing traversing the lower reach of the UCVB and areas of compacted surfaces where vegetation has been removed adjacent to the wetland.

5.3.2 Wet-health, Ecoservices and EIS

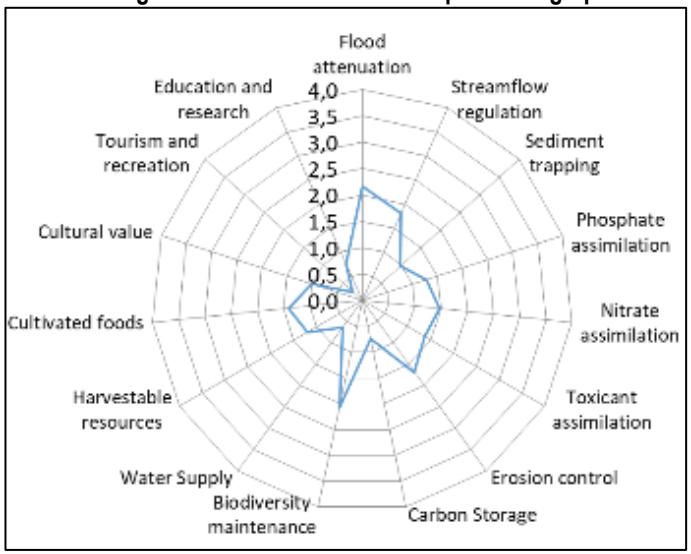
Following the site visit, various assessments were undertaken to determine the following:

- The PES, incorporating aspects such as hydrology, vegetation and geomorphology of the delineated wetland;
- Service provision of the delineated wetland, which incorporates biodiversity maintenance, flood attenuation, streamflow regulation and toxicant assimilation, to name a few;
- The EIS is guided by the results obtained from the assessment of the PES and service provision of the delineated wetland; and
- Allocation of appropriate REC, RMO and BAS based on the PES, service provision, and EIS results to guide the management of the delineated wetland with the intent of enhancing the ecological integrity of the delineated wetland where feasible.

The results of the assessments are presented in the “dashboard style” reports below.

Table 3: Summary of the assessment of the unchanneled valley bottom (UCVB) associated with the proposed development.

Ecological & socio-cultural service provision graph:



Photograph notes

Representative photographs of the UCVB located within the central portion of the study area. Species such as *Seriphium plumosum*, *Pogonarthria squarrosa*, *Aristida congesta*, *Hypoxis argentea* and *Sporobolus africanus* were identified. Within some parts of the wetland, woody species such as *Vachellia karroo* and *Eucalyptus globulus* were found. (Right) Upper reach of the UCVB, the red arrow indicates location of the historical impoundment wall within the wetland.

PES discussion

PES: Largely Modified (D)

Hydrological and vegetation impacts within the UCVB are considered to be the main attributes resulting in the largely modified ecological integrity of the HGM unit. The vegetation community has been severely altered through historic agricultural practices and as a result can be considered secondary vegetation. Impacts on the natural hydrological regime (water distribution and retention) include presence of erosion gullies and artificial drainage channels within the wetland. Other modifiers identified can be associated with urbanisation and road infrastructure crossings which have resulted in the fragmentation.

Ecoservice provision

Intermediate

The ecological service provision by the UCVB was assessed to be intermediate mainly for functions including flood attenuation, streamflow regulation and erosion control. This is largely a result of the urban expansion surrounding the system and the relatively good vegetation cover within the wetland.

Watercourse drivers:

a) Hydrology

The hydrology of the UCVB has been impacted to a limited extent by reduced water flows as a result of the proliferation of *Eucalyptus globulus* (bluegum) within the study area. Urbanisation and increased impermeable surfaces within the larger catchment have on the contrary resulted in additional water inputs to the wetland due to increased runoff and decreased water infiltration potential. Within the wetland, the natural distribution and retentions patterns of water have been altered by an historical impoundment, artificial drainage channels and road crossings (informal and formal) which have impacted on the hydrological connectivity of the of the upper and lower reaches of the UCVB.

b) Water quality

Although water quality parameters were not assessed as part of this study, since the UCVB occurs within a highly urbanised setting and is likely to be impacted by contaminated runoff (in the form of hydrocarbons and sediment amongst others) from the surrounding catchment activities.

c) Topography: Geomorphology and sediment balance

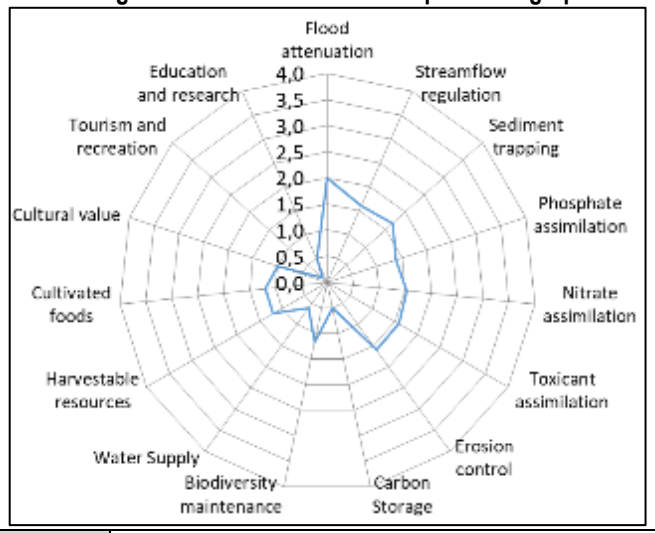
Infilling and excavation within the UCVB some parts of the UCVB have had localised impacts on the geomorphological processes of the system since these increase the vulnerability of the UCVB to soil erosion. Small berms, likely associated with the historical cultivation and farming activities were observed throughout the HGM unit and in some areas, the creation of preferential flow paths and where trenching has occurred, there is a loss of water retention and a lowering of the water table.

<table>
<tr><td></td><td></td><td colspan="2">d) Habitat and biota
The vegetation within the UCVB is considered largely modified as a result of historical intensive agricultural activities within the study area, as a result of these activities the vegetation community present within the UCVB is considered to be secondary and the species composition was indicative of historical as well as current disturbance. Wide distribution of Seriphium plumosum, a shrub known to occur in areas where disturbance has occurred was observed within the temporary zone. This is one of the indicators of the historical disturbances which have occurred within the wetland. In addition to that, encroachment of infrastructure and infilling within the UCVB have impacted on the composition of species.</td></tr>
<tr><td></td><td></td><td>EIS discussion</td><td>EIS Category: Moderate
The EIS was assessed to be moderate, primarily as a result of the wetland sensitivity to changes in flow and floods. Edge effects such as encroachment of alien and invasive species and historical agricultural activities have contributed to the decreased ecological integrity of the wetland, thereby limiting the potential of the UCVB to be of increased ecological importance and sensitivity particularly from a biodiversity support perspective. Despite this, according to the Gauteng Conservation Plan V3.3 (2011), the central portion of the UCVB is considered to be important for maintenance of stream connectivity.</td></tr>
<tr><td>REC Category</td><td colspan="3">REC Category: D (Largely modified)
BAS: Category D (Largely modified)
RMO: D (Maintain)
The recommended management objective (RMO) for the UCVB based on the PES and EIS scores is to maintain an ecological Category D (Largely modified) of the UCVB. No further degradation should be permitted and thus, mitigation measures should be implemented during all phases of the proposed development to minimise the risk of further negative impacts on the wetland. Furthermore, small scale rehabilitation of the UCVB should be incorporated as part of the greater development plan.</td></tr>
<tr><td colspan="4">Possible significant impacts, Business case, Conclusion and Mitigation Requirements:
The results of the risk assessment are presented in Section 6 of this report and show that, assuming mitigation measures are strictly enforced, impact significance is moderate during both construction and operational phases. Impacts associated with ground-breaking activities for foundation, construction of sewer lines and access roads within the delineated UCVB associated with the proposed development are anticipated to pose the highest risk to the integrity of the UCVB during the construction phase. As such, the use of already existing roads to prevent the creation of new roads within the UCVB is considered to be an important mitigation measures.

It is considered imperative that suitable mitigation measures, as provided for in Section 6 and Appendix F of this report, are strictly adhered to, to minimise the impacts associated with the proposed development and decrease the significance of cumulative impacts on the UCVB. In addition, the incorporation of a full rehabilitation is considered important and will aid in protecting the development from potential floods, as well as enhancing the aesthetic value of the property.</td></tr>
</table>

Table 4: Summary of the seep 1 associated with the proposed development.

Ecological & socio-cultural service provision graph:



Photograph notes	Representative photographs of seep 1 which had begun to show signs of desiccation and alterations to the water storage and water distribution profiles. Some excavations were observed in this area showing signs of wetness.
PES discussion	**PES: Seriously Modified (E)** The ecological integrity of the seep has been seriously modified mainly due to observed impacts on the hydrology and the vegetation composition as well as some disturbances to the soils. The vegetation within the seep 1 showed some signs of moisture stress with a reduced occurrence of hydrophytic vegetation in relation to the surrounding seep areas as well as a reduced basal cover. Excavations and soil disturbance was observed in some areas, with some patches of alien and invasive species.
Ecoservice provision	**Moderately Low** Ecological services provided by the seep include flood attenuation, sediment trapping, erosion control and toxicant and nutrient assimilation.

Watercourse drivers:

a) Hydrology

The upper reaches of the seep have been destroyed over time as a result of compaction, soil disturbances, urban encroachment and excavation activities. These impacts over time have resulted in alterations to the natural water retention and water distribution profiles and signs of desiccation were evident in some parts of the seep.

b) Water quality

Water quality parameters were not assessed as part of this study, however, since the seep occurs within an urbanised setting, it is likely to be impacted by contaminated runoff (in the form of hydrocarbons and sediment amongst others) from the surrounding catchment activities.

c) Topography: Geomorphology and sediment balance

Desiccation of the soils in some areas and loss of hydrophytic vegetation and basal cover, has the potential to result in impacts to the sediment balance of the wetland. Some impacts to the natural topography were also observed. The combined effects of these impacts is the creation of preferential flow paths in the wetland, further altering the distribution of water and sediment within the wetland.

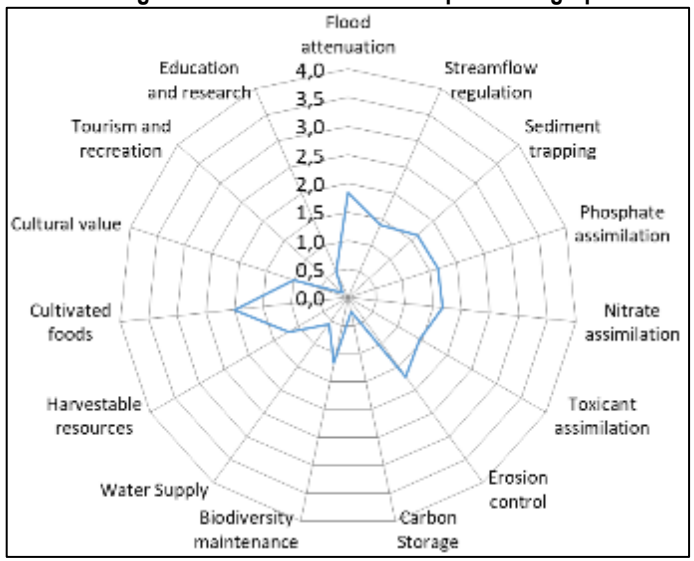
d) Habitat and biota

The vegetation within seep was found to comprise of a mix of hydrophytic and terrestrial vegetation species, with a higher incidence of temporary and facultative wetland species than in other portions of the wetland.

		EIS discussion	**EIS Category: Low/Marginal** Loss of hydrophytic vegetation, alterations to the natural hydrology and the proliferation of alien and invasive vegetation has contributed to the lowered ecological sensitivity of the of the seep HGM unit.
REC Category	**REC Category: D Largely modified)** **BAS: Category D (Largely modified)** **RMO: D (Improve)** According to Malan and Day, 2012, PES Categories E and F are considered ecologically unacceptable and, should a freshwater resource fall into one of these PES categories, a REC Category D is allocated by default, as the minimum acceptable PES category. As such, the recommended management objective of the seep is automatically assigned as a Category D. Therefore, once activities within the HGM unit are complete, particularly the construction of the access road, a rehabilitation plan must be carried out and implemented in such a way as to facilitate an improvement in the system once rehabilitation has been completed.		
Possible significant impacts, Business case, Conclusion and Mitigation Requirements: Despite the largely impacted ecological integrity of the HGM unit, the supply of water from this seep to the UCVB should be protected and no further impacts should be permitted during all phases of the proposed development. Infrastructure such as the southern-most access road to traverse the seep must be kept as small as possible to minimise impacts on the wetland. Small scale rehabilitation of the seep is further considered important given the potential ecological services provided the seep which could be enhanced.			

Table 5: Summary of the assessment of the seep 2 associated with the proposed development.

Ecological & socio-cultural service provision graph:



Photograph notes	Representative photograph of the seep located along the south-western reach of the UCVB. The seep has been encroached by the development of informal settlements which are indicated by the arrow and shown in the photograph on the right. As a result of this development, the seep has been subject to impacts such as infilling, clearing of vegetation and surface compaction.
PES discussion	**PES: Largely Modified (D)** The major driver of the largely modified ecological integrity of the seep was impacts on the vegetation community followed by the altered geohydrological and hydrological regimes. Natural retention and distribution of water within the seep has been impacted by encroachment of informal settlements within the study area which has increased areas of compacted surfaces. Infilling and deposition of soils and foreign material have impacted a portion of this seep and impacts related to clearing of vegetation and the proliferation of alien and invasive species were observed.
Ecoservice provision	**Moderately Low** The encroachment of informal settlements within the seep has resulted in the loss of ecological service provision by the seep. The ecological service provision by the seep was assessed to be moderately low mainly for functions including erosion control and flood attenuation due to the gentle gradient of the slope. In addition, cultivated foods is also considered to be an important ecological service provision of the wetland, largely as a result of

Watercourse drivers:

a) Hydrology

The hydrological regime within the seep has been impacted by the development of informal settlements which increase the extent of compacted surfaces within the wetland. The formation of preferential flow paths as a result of infilling and compaction has resulted in changes in natural water distribution and retention within the HGM unit

b) Water quality

Water quality parameters were not assessed as part of this study, however, since the seep occurs within an urbanised setting, it is likely to be impacted by contaminated runoff (in the form of hydrocarbons and sediment amongst others) from the surrounding catchment activities.

c) Topography: Geomorphology and sediment balance

Impacts such as infilling, surface clearing, vegetation removal and increased compacted surfaces linked to the development of informal settlements within the south-westerly portion of the seep has altered the topography. The loss of vegetation cover increases the runoff potential, thus making the seep more vulnerable to soil erosion.

d) Habitat and biota

The vegetation composition of the seep has been transformed by historical agricultural practices identified from the historical images within the entire study area. Current impacts such as the construction of informal settlements and household landscaping/gardening activities have resulted in loss of wetland habitat.

	the level of poverty in the area and the location of the seep within a slightly rural communal area.	**EIS discussion**	**EIS Category: Low/Marginal** The ecological importance of seep has been significantly modified as a result of the impacts observed within the seep such as the increase in compacted surfaces, as such the seep EIS was assessed to be low / marginal. Given vegetation clearance which has taken place within the study area, it is anticipated that the seep is unlikely to be important for provision of habitat for seep migratory species. The vegetation type (Mesic Highveld Grassland Group 3) within the seep is considered Least Threatened by Mbona et al., (2015 and this further contributes to the low ecological sensitivity of the wetland.
REC Category	**REC Category: D (Largely modified)** **BAS: Category D (Largely modified)** **RMO: D (Maintain)** The recommended management objective (RMO) for the seep based on the PES and EIS scores is to maintain an ecological Category D (Largely modified) of the seep. No further degradation should be permitted and thus, mitigation measures should be implemented during all phases of the proposed development to minimise the risk of further negative impacts on the wetland.		
Possible significant impacts, Business case, Conclusion and Mitigation Requirements: The results of the risk assessment are presented in Section 6 of this report and show that, assuming mitigation measures are strictly enforced, impact significance is of moderate levels during both construction and operational phase. Where feasible, the incorporation of small-scale rehabilitation is considered important and will aid in reinstating the ecological services provided by the seep such as the assimilation of contaminants which are likely to increase with the increase in compacted surfaces.			

5.3.3 Summary of field verification results

The integrity of the wetland delineated within the study area has been impacted as a result of historical agricultural activities, clearing of vegetation, infilling and compaction associated with the development of informal settlements and catchment hardening activities linked to urbanisation. Despite their decreased ecological integrity, these systems can still be considered important for their ecological role particularly from a hydrological and geomorphological perspective (erosion control, flood attenuation, streamflow regulation and assimilation of nutrients and toxicants).

6 LEGISLATIVE REQUIREMENTS

According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however in summary, it is considered to be "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 to be important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on watercourses 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 *et. al,* 2015). 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 *et. al,* 2015).

Legislative requirements were taken into consideration when determining a suitable buffer zone for the delineated wetland within the investigation area associated with the proposed development. The definition and motivation for a regulated zone of activity as well as buffer zone for the protection of the wetland can be summarised as follows (Table 6).

Table 6: Articles of Legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation required	Zone of applicability
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations, 2014 (as amended). ***The Department of Environmental Affairs***	➢ **Activity 12** of Listing Notice 1 (GN 327) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment (EIA) regulations, 2014 (as amended) states that: *The development of:* *(xii) infrastructure or structures with a physical footprint of 100 m² or more;* *Where such development occurs—* *a) Within a watercourse;* *b) In front of a development setback; or* *If no development setback has been adopted, **within 32 m of a watercourse,** measured from the edge of a watercourse.* Excluding – (dd) where such development occurs within an urban area.
Water Use License Application in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA). ***The Department of Water and Sanitation***	**Section 21 of the National Water Act, 1998 (Act No. 36 of 1998)** In accordance with Section 21c & i of the Act water use activities will be triggered should they: • Impeding or diverting the flow of water in a watercourse; or • Altering the bed, banks, course or characteristics of a watercourse. In accordance with GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998), a regulated area of a watercourse for Section 21 (c) and 21 (i) of the National Water Act, 1998 (Act No. 36 of 1998) is defined as: • the outer edge of the 1 in 100 year flood line and/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 from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a **500 m radius from the delineated boundary** (extent) of any wetland or pan in terms of this regulation.
Gauteng Department of Agriculture and Rural Development Requirements for Biodiversity Assessments (2014).	The study area is situated within the urban development zone [EMF Zone 1] and the remaining portion of the study area falls within the high control zone (inside zone 1)[EMF Zone 2] according to the Gauteng Environmental Management Framework (2014). Thus, **a 30 m setback area** is applicable to the wetland.

It was noted during the field assessment that the lower portion of the UCVB has a higher representation of the permanent wetland zone than the upper wetland areas, resulting in a lower water assimilation capacity than the upper wetland areas. For this reason, a larger buffer is required to service the seasonal and temporary wetland areas. A 30 m setback has been recommended in line with the GDARD legislated zone, especially for the upper portions of the wetland, however for the lower portion of the wetland it is considered acceptable that motivation be made for the application of a 15 m specialist variable buffer due to both the current and historical impacts observed. It should be noted that areas indicated as potential development, will still have to be authorised by GDARD, and the possibility exists that these areas might be rejected for development by the authorities.

Figure 20 shows the delineated wetland, specialist variable buffer, GDARD wetland recommended setback area and the applicable Zone of Regulation (ZoR) in terms of GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998). The 32 m buffer as stipulated in GN327 for Activity 12 is not applicable as the proposed development is located within the urban edge (as defined by the Gauteng Environmental Management Framework (2014). As such, the applicable set back area in accordance with the GDARD Minimum Requirements for Biodiversity Assessments (2014) is 30 m.

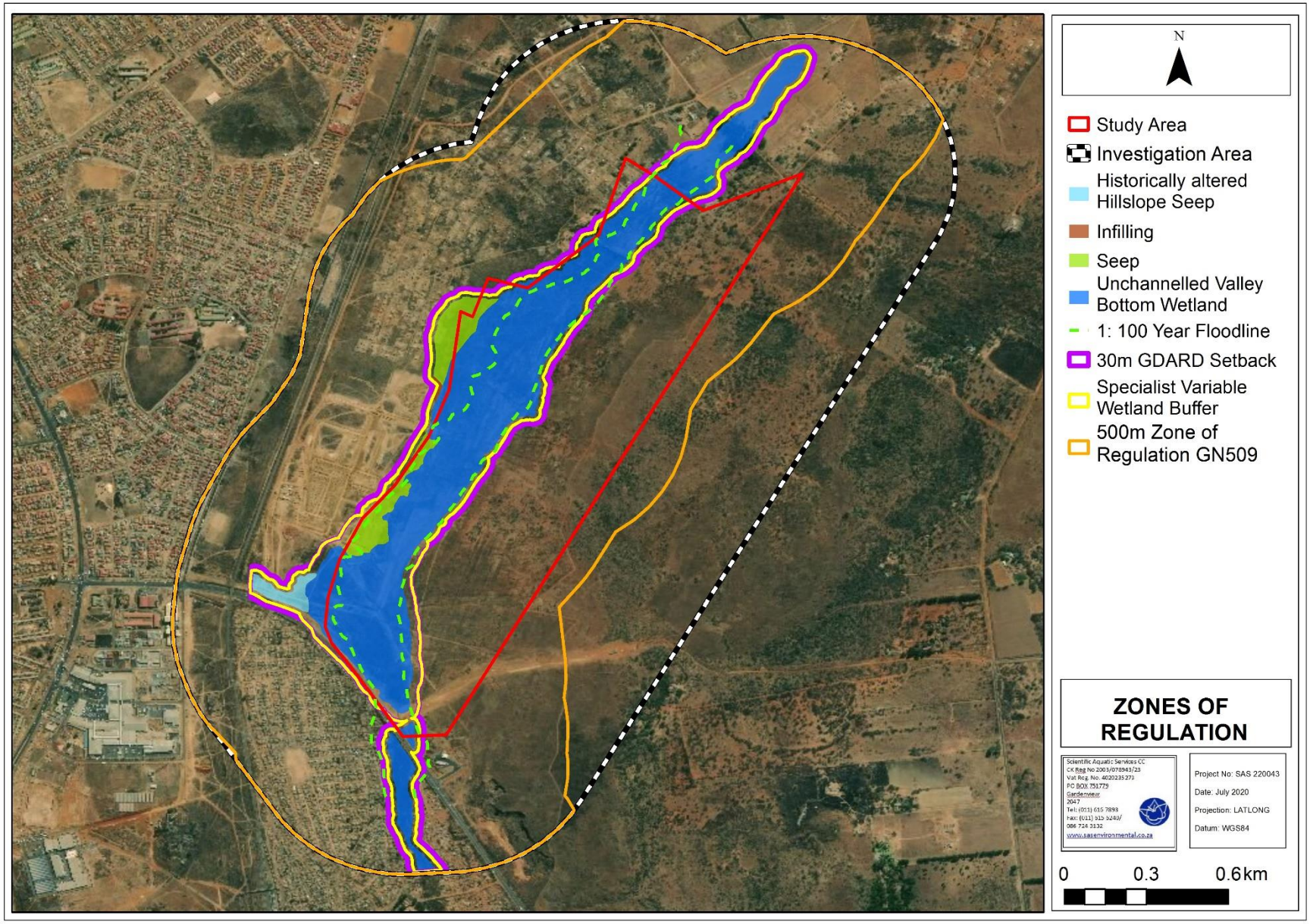


Figure 20: Conceptual presentation of the UCVB and seep, the applicable zone of regulation in terms of GN509 and GDARD setback area.

7 RISK ASSESSMENT

The DWS approved Risk Assessment Matrix (as promulgated in GN509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998)) was applied in order to present the significance of potential impacts on the ecology of the wetland associated with the proposed development (Table 7).

In addition, the risk assessment indicate the required mitigatory measures needed to minimise the perceived impacts associated with the proposed development and the required geotechnical studies, and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented.

7.1 Risk and Impact Analyses

7.1.1 Consideration of impacts and application of mitigation measures

Following the assessment of the UCVB and seeps associated with the proposed development, the DWS approved Risk Assessment Matrix was applied to ascertain the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the wetland associated with the proposed development. These results are summarised in Table 12 of the report.

Following the risk assessment, mitigation measures were compiled to serve as guidance throughout the construction and operational phase of the proposed development. The points below summarise the considerations undertaken when applying the risk assessment matrix:

- The risk assessment was applied assuming that a high level of mitigation is implemented, thus the results of the risk assessment provided in this report present the perceived impact significance post-mitigation;
- In applying the risk assessment, it was assumed that the mitigation hierarchy as advocated by the Department of Environmental Affairs (DEA) *et al*. (2013) would be followed, i.e. the impacts would first be avoided, minimised if avoidance is not feasible, rehabilitated as necessary and offset if required;
- The activities associated with the proposed development are considered to be highly site specific and the spatial extent of any impacts is considered to be limited;
- The construction activities are considered to be temporary, not more than a few years and the operation of the housing development is considered permanent. Impacts associated with the construction phase are envisioned to occur daily;

- Most impacts associated with the construction and operational phases are considered to be easily detectable, with the exception of contamination of surface and groundwater (associated with spillage from construction vehicles, which is likely to be avoidable with implementation of suitable mitigation measures); and
- It is highly recommended that the proponent make provision for small-scale rehabilitation where the wetland has been impacted directly or by edge effects. The area must preferably be rehabilitated to conditions as close as possible to the "natural" state, not the pre-construction state of ecological service provision of the wetland. This will positively improve the ecological integrity of the wetland, aid in protecting the development from potential flood impacts, and enhance the aesthetic value of the property.

7.1.2 Impact discussion and essential mitigation measures

There are four key ecological impacts on the wetland that are anticipated to occur namely,

- Loss of wetland habitat and ecological structure;
- Changes to the wetland ecological service provision;
- Impacts on the hydrology and sediment balance of the wetland; and
- Impacts on water quality.

Various activities and operation aspects may lead to these impacts, however, provided that the mitigation hierarchy is followed, these impacts can be avoided or adequately minimised where avoidance is not feasible. As mentioned above, the risk assessment was compiled on the assumption that no construction activities will take place within the delineated wetland, outside of the GDARD recommended setback area and recommended specialist variable buffer. The mitigation measures provided in this report have been developed with the mitigation hierarchy in mind, and the implementation of and strict adherence to these measures will assist in minimising the significance of impacts on the receiving wetland. The following activities are assessed in the risk assessment"

Pre-construction phase

- Geotechnical studies including drilling of test holes within the wetland and within the regulated area (Figure 23); and
- Movement of heavy vehicles within and/or 500 m of the wetlands.

Construction phase:

- Site clearing prior to construction activities;
- Ground-breaking: excavation of foundations, earthworks and building activities;

- Potential indiscriminate waste disposal and/or spillage from construction vehicles;
- Construction of infrastructure (buildings and roads outside of the delineated wetland);
- Construction of sewer line infrastructure within the delineated wetland; and
- Construction of road crossings within the delineated wetland.

Rehabilitation phase:

- Site establishment – identify area of rehabilitation, establish an on-site nursery;
- Site clearance and alien vegetation control;
- Soil preparation and construction of attenuation ponds; and
- Hydroseeding and panting of vegetation in all disturbed areas.

Operational phase:

- Increased impermeable surfaces within the study area;
- Potential indiscriminate disposal of waste;
- Inadequate capacity and/or maintenance of storm-water and/or sewage systems; and
- Rehabilitation monitoring of affected portions of the wetland.

The conceptual layout for the proposed development is shown in Figure 21 and a summary of the risk assessment is provided in the table below, followed by a discussion of the outcome thereof (Table 12). Figure 22 illustrates the proposed attenuation ponds locations within the unchanneled valley bottom located adjacent to Phase 2-4. Test pits were drilled as part of the geotechnical investigation for the road crossings within the unchanneled valley bottom wetland.

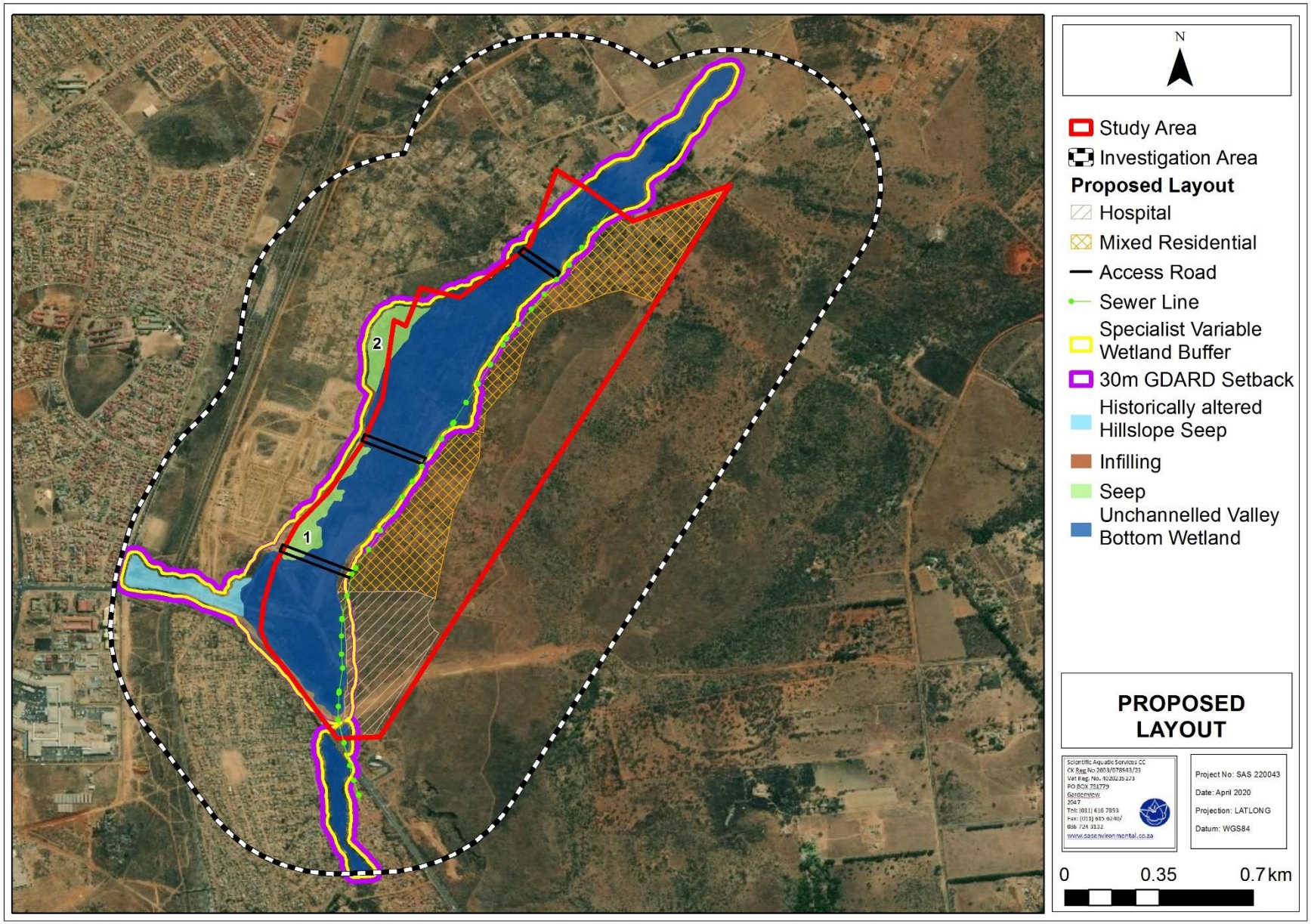


Figure 21: Conceptual presentation of the proposed layout in relation to the delineated wetland.

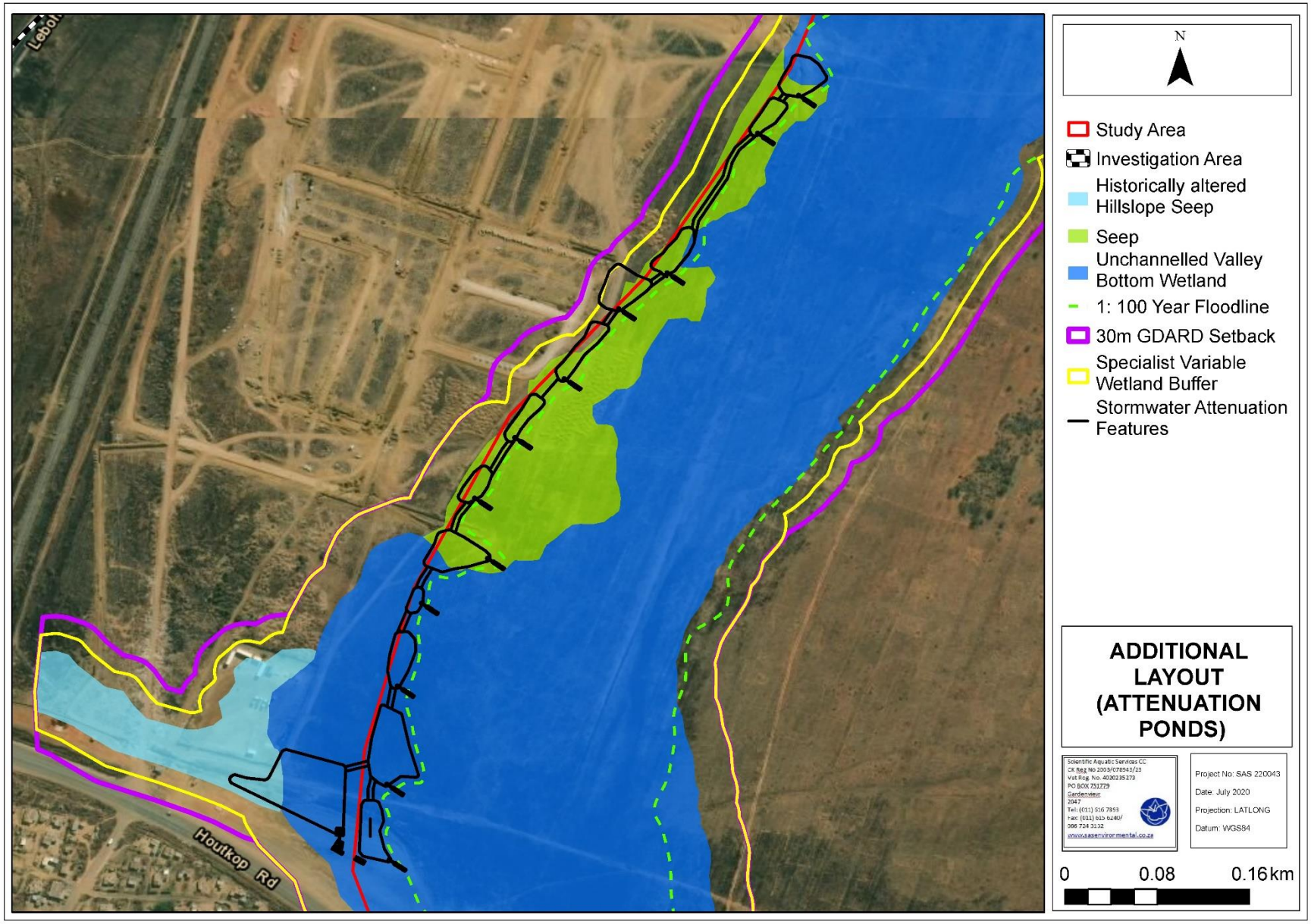


Figure 22: Conceptual presentation of the additional layout (attenuation ponds) in relation to the delineated wetland.

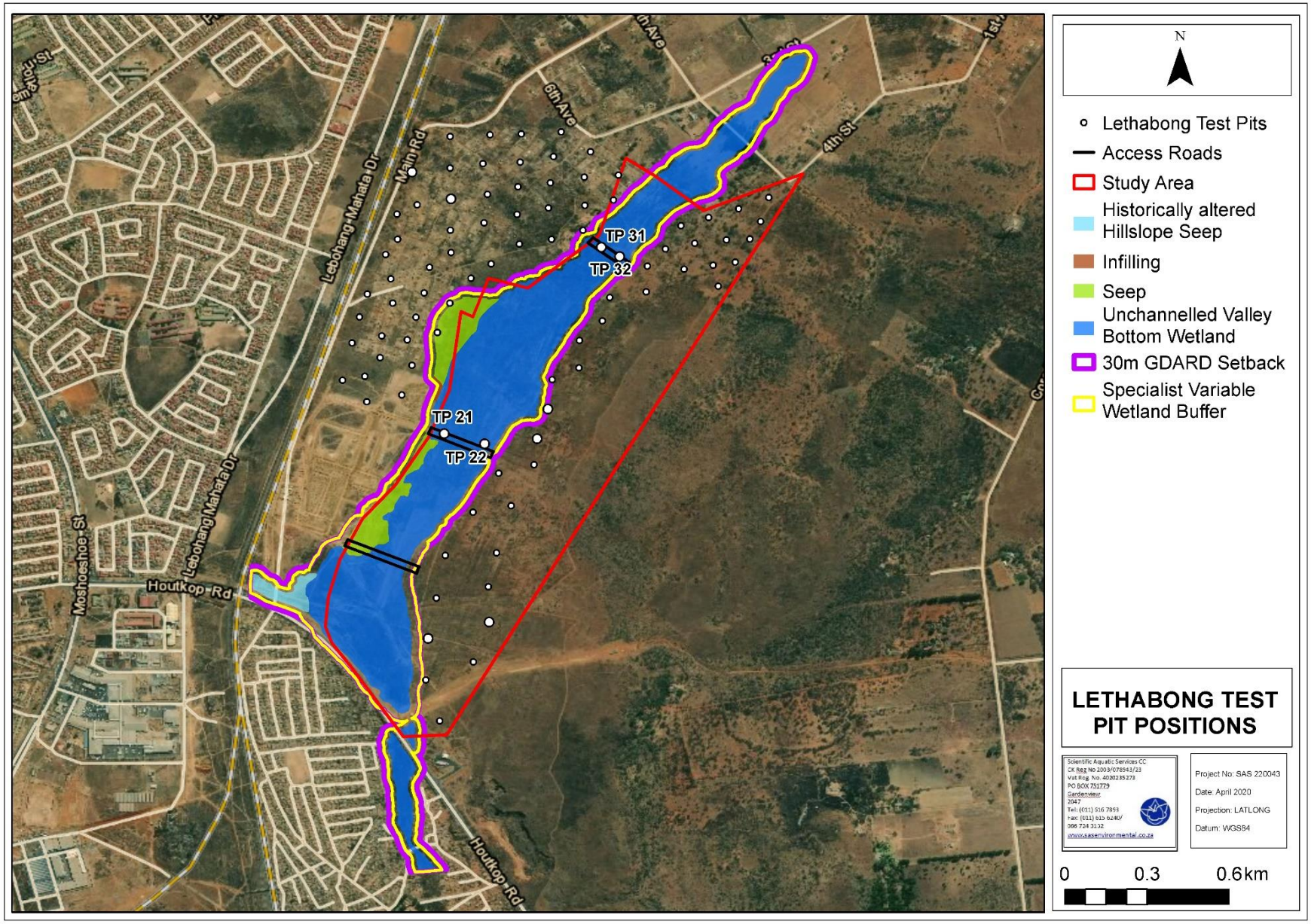


Figure 23: Conceptual representation of test pit locations.

Table 7: Summary of the results of the DWS Risk Assessment applied delineated wetland associated with the proposed development.

Phase	No.	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE Rating Classes	PES /EIS
Pre-construction Phase	1	Geotechnical studies including drilling	*Movement of heavy machinery within wetlands and/or within 500 m of wetlands. *Drilling within wetlands	*Compaction of soils *Disturbance of soils and loss of natural vegetation *Alteration of natural flow paths and the creation of preferential flow paths *Proliferation of alien and invasive vegetation	1	3	16	**48**	**L**	*Ensure movement of machinery within wetland areas is minimised as far as possible. Wherever possible, existing roads should be used. *Any areas of disturbance should be closed, re-profiled and re-seeded if necessary; *Monitoring of all disturbed areas should take place to monitor for erosion or the proliferation of alien and invasive species and if any impacts in this regard are identified, these should be immediately remedied through active prevention of erosion or in the case of alien and invasive species, through manual removal before dense stands can take hold; *No debris associated with the geotechnical drilling should remain behind on completion of the drilling activities; *Ensure geotechnical studies take place in winter when the seasonal and temporary zones are likely to be drier and more resilient to disturbance; *Ensure no movement of machinery takes place through any permanent and if possible seasonal wetland areas; *Only authorised personnel should be authorised to conduct the proposed geotechnical studies; and *A spill prevention and emergency spill response plan should be compiled to guide the construction works; and an emergency response contingency plan should be put in place to address clean-up measures should a spill or leak occur.	N/A	

Phase	No.	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE Rating Classes	PES /EIS
Construction Phase	2	Site clearing prior to commencement of construction activities.	*Removal of vegetation and associated disturbances to soils; and *Possible indiscriminate driving through the wetland by construction vehicles.	*Potential increased runoff and erosion, and thus increased sedimentation; *Proliferation of alien and invasive species due to their rapid establishment following disturbance; and *Decreased ecoservice provision.	3	5	13	**59**	**M**	*Ensure contractor laydown areas, storage facilities and all other non-essential activities are placed outside of the wetland and the approved buffer area to avoid water and soil contamination which would affect the structure and functioning of the wetland. A designated area should be approved by the Environmental Control Officer (ECO) prior to use; *No indiscriminate movement of construction vehicles or personnel is allowed within the wetland. Careful planning of the construction footprint must be undertaken beforehand to ensure that the minimum impact on the wetland occurs; and *Areas which are to be cleared of vegetation, must remain as small as possible to reduce the risk of proliferation of alien vegetation.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; See s (Low)
	3	Ground-breaking: excavation of foundations, earthworks and building activities.	*Excavation of soil and creation of stockpiles; *Compaction of soils as a result of movement of construction vehicles; and *Construction of houses and other infrastructure associated with mixed housing development.	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to altered wetland habitat; *Altered stormwater runoff patterns leading to increased erosion and *Sedimentation of the wetland.	2	6	14	**84**	**M**	*Dust suppression measures must be implemented throughout construction to prevent excessive dust which may smother freshwater vegetation; *Soils must be stockpiled according to their natural sequence in order to ensure that topsoil and subsoils are not mixed during backfilling process; and *Exposed soils, including topsoil, must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geojute or hessian sheeting) in order to prevent erosion and sedimentation of the wetland.	N/A	
	4	Potential indiscriminate waste disposal and/or spillage from construction vehicles.	*Disposal of construction-related waste (such as rubble, hazardous chemicals and litter).	*Potential further loss of scenic beauty of the wetland due to increased rubble and construction debris; *Altered hydrological regime and vegetation structure as a result of disposed rubble; *Creation of preferential flow paths; and *Altered soil / sediment conditions due to chemical waste disposal or spills.	2	4	12	**50**	**L**	*No waste disposal is to be permitted in the delineated wetland and the variable GDARD setback area; *All waste must be removed from the site and disposed at a registered disposal facility; *Vehicles must be regularly inspected for leaks and be refuelled on sealed surfaces to prevent ingress into soils; *All spills are to be immediately cleaned up and must be treated accordingly; and *When not in use, all vehicles must be parked on a non-permeable surface or have drip trays under to prevent any leakage into the nearby wetlands.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; See s (Low)

Phase	No.	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE Rating Classes	PES /EIS
	5	Construction of infrastructure (buildings and roads outside of the delineated wetland).	*Movement of construction equipment adjacent to the delineated wetland; *Stockpiling of construction materials; and *Increased likelihood of dust generation due to exposed soils.	*Loss of freshwater habitat and ecological structure as a result of edge effects associated with the development. *Impacts to the ecoservice provision of the wetland. *Potential impacts on the hydrology and sedimentation of the wetland.	2	4	**14**	**61**	**M**	*Any concrete mixing/temporary storage must be undertaken in bunded areas or on batter boards only. Care must be taken to prevent any spillage within the wetland or surrounding environment; *Dust suppression measures must be implemented throughout construction to prevent excessive dust which may smother freshwater vegetation; and *If feasible, construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities.	N/A	
	6	Construction of sewer line infrastructure within the delineated wetland.	*Movement of construction equipment adjacent to the delineated wetland; *Removal of topsoil and creation of topsoil stockpiles;	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to altered freshwater habitat; *Altered stormwater runoff patterns, leading to increased erosion and sedimentation of the wetland; *Impacts to the ecoservice provision of the wetland; and *Potential impacts to water quality as a result of oil spills/	5	8	**11**	**88**	**M**	*The duration of impacts within the wetland should be minimised as far as possible by ensuring that the duration of time in which sedimentation will take place is minimised. Therefore, the construction period should be kept as short as possible; *Contaminant spillage outside of the demarcated area must be promptly removed and taken to a suitably licensed waste disposal site; *Construction must be scheduled for the drier winter period to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities; and *Excavations associated with the sewer pipeline route must be suitably backfilled and compacted. Any excess soil must be levelled on site or removed.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seep (Low)

Phase	No.	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE Rating Classes	PES /EIS
	7	Construction of three road crossings within the delineated wetland.	*Movement of construction equipment adjacent to the delineated wetland; and *Stockpiling of construction materials.	solid wastes entering the wetland.	5	8	**11**	**88**	**M**	*No indiscriminate movement of vehicles or personnel is allowed within the wetland or associated variable setback. Careful planning of all construction equipment must be undertaken beforehand to ensure that the minimum impact on the wetland occurs; *Any concrete mixing/temporary storage must be undertaken in bunded areas or on batter boards only. Care must be taken to prevent any spillage within the wetland or surrounding environment; *Dust suppression measures must be implemented throughout construction to prevent excessive dust which may smother freshwater vegetation; *Construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities; *It is highly recommended that existing access roads must be used in order to reduce the impacts associated with the creation of new roads within the wetland.	N/A	
	8	Construction of stormwater attenuation features within the wetland.	*Movement of construction equipment adjacent to the delineated wetland; *Removal of topsoil and creation of topsoil stockpiles;	*Altered stormwater runoff patterns, leading to increased erosion and sedimentation of the wetland; *Impacts to the ecoservice provision of the wetland; and *Potential impacts to water quality as a result of oil spills/ solid wastes entering the wetland.	2	4	**14**	**61**	**M**	*Construction must be scheduled for the drier winter period in order to minimise the risk of sediment-laden runoff reaching the wetland as a result of the construction activities; *No indiscriminate movement of vehicles or personnel is allowed within the wetland or associated variable setback. Careful planning of all construction equipment must be undertaken beforehand to ensure that the minimum impact on the wetland occurs; and *The attenuation structures must be suitably constructed in order to ensure rehabilitation and recharge of the wetland. *Mitigation measures and methods as described in the plant species and rehabilitation plan (Habitat Landscape Architects, 2020).	N/A	

Phase	No.	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE Rating Classes	PES /EIS
Operation	9	Increased impermeable surfaces within the study area and the wetland's surrounding catchment areas.	*Potential change in surface runoff patterns due to increased impermeable surfaces.	*Decreased infiltration and increase surface runoff from impervious surfaces; *Increased water inputs to the freshwater environment at unnatural rates; and *Potential change in wetland hydrograph due to modified surrounding landscape.	2	5	**14**	**67**	**M**	*An adequate stormwater management plan should be incorporated into the design of the development; *Release of stormwater into the wetland must not result in further incision or erosion; *Sustainable Drainage Systems (SuDS) must be used to manage stormwater as there will be an increase in hardened surfaces within close proximity to the system. SuDS will assist in preventing significant impacts on the hydrological functioning of the system, reduce the risk of flooding during high flow periods and reduce the risk of increased erosion (Figure A); and *SuDS can include a swale with side walls lined with stones and vegetated with indigenous vegetation in order to reduce the velocity of water within the system and dissipate energy thereby reducing erosion and incision.  **Figure A: Example of SuDS which could be incorporated in the design plan in order to slow down water from compacted surfaces before it reaches the wetland.**	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)

Phase	No.	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE Rating Classes	PES /EIS
	10		Potential risk of contaminated runoff from the increased impermeable surfaces (parking areas and access roads).	*Pollution of freshwater soils, groundwater and surface water.	2	5	**14**	**67**	**M**	*Attenuation facilities for the stormwater management be designed to be as natural as possible (earth) and vegetated to function as a constructed wetland for water quality filtration; *Any spills to be immediately cleaned up and treated accordingly.	N/A	
	11	Operation and associated maintenance of the proposed sewer pipeline.	*Potential leakage of proposed sewer pipeline and discharge of sewage into the wetland; and *Miscellaneous activities by construction personnel associated with maintenance of the proposed sewer pipeline.	*Increased water input into the wetland thus altering the natural hydrological regime of the wetland; *Sedimentation of the wetland resulting from sediment-laden stormwater runoff entering the wetland, and associated disturbances to vegetation; *Potential risk of contaminated runoff and litter entering the wetland thus altering water quality; and *Potential erosion and incision within the wetland as a result of the concentrated flow of water.	5	7	**13**	**91**	**M**	*It is recommended that the managing authority test the integrity of the pipeline at a reasonable frequency; and *Should areas need to be excavated for maintenance purposes, all mitigation measures as stipulated above are deemed applicable; *Only existing roadways should be utilised during maintenance and monitoring activities to avoid indiscriminate movement of vehicles; and *It should be ensured that the wetland is not inundated as a result of leaks or bursting of the proposed sewer pipeline, and that an emergency plan should be compiled to ensure a quick response and attendance to the matter in case of a leakage or bursting of the proposed sewer the pipeline.		
	12	Potential indiscriminate disposal of waste.	*Disposal of solid household waste within the wetland.	*Impacts on the habitats and biota within the receiving environment; and *A reduction in water quality of water and soil.	2	5	**11**	**52**	**L**	*No vehicles are permitted to enter into the wetland. Any maintenance works must be undertaken by foot or the relevant authorisations obtained beforehand; *Litter bins and signages must be placed at various places within the study area particularly within potential wetland crossing areas in order to educate the public about the importance of waste management and wetland systems at large; and *Waste from the litter bins must be collected by the local service provider at the beginning of each week.	N/A	

Phase	No.	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures to be implemented	Borderline LOW MODERATE Rating Classes	PES /EIS
	13	Inadequate capacity and/or maintenance of stormwater and/or sewage systems.	*Failure of the stormwater and/or sewage systems; *Unmanaged stormwater and/or sewage entering the wetland.	*A reduction in water quality, with a subsequent impact on biota; *Impacted soil and water quality condition within the wetland and *Altered hydroperiod of the wetland.	3	6	**11**	**61**	**M**	*Sewage systems must be consistently managed and a response plan must be in place in order to minimise impact in the event of sewer pipe leakage; *Stormwater culverts must be maintained by removing debris which might block culverts or wetland crossings; and *Stormwater from surrounding impervious surfaces must pass through SuDs before entering the delineated wetland.	N/A	
Rehabilitation	14	Rehabilitation of affected portions of the wetland (three road crossings, sewer pipeline).	*Re-vegetate all areas where vegetation removal took place; *Remove any obstructions to flow; and *Alien and invasive plant removal.	*No negative impacts are identified for the proposed rehabilitation actions.	5	7	**8**	**56**	**M**	*A detailed rehabilitation plan was undertaken as part of the proposed development as required by the competent authority; *As much indigenous vegetation growth as possible must be promoted in order to protect soils and to reduce the percentage of impermeable surfaces. All invasive and alien vegetation located within the footprint area should be removed and monitored; *The variable GDARD setback area must be rehabilitated with indigenous vegetation and can be utilised as an open space/recreational area for the development; *Litter bins and signage should be put up along the road crossings to inform staff and the community of the importance of wetland systems to people and biodiversity; and *Monitoring, maintenance and management of the rehabilitated areas must take place after construction, during the operation phase. It is proposed that a **3-month maintenance** period (Growing-in Phase) be included in the contract of the rehabilitation contractor.	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; See s (Low)

8 FRESHWATER MONITORING AND AUDIT PLAN

Prudent monitoring of the UCVB and two seep HGM units to be directly affected by proposed Lethabong mixed-use development is of utmost importance, as this will ensure a continual flow of data, enabling all parties involved to accurately assess and manage water resource related impacts and issues. To ensure the accurate gathering of data, the following techniques and guidelines should be followed:

1) Undertaking monitoring actions as stipulated;
2) Undertake on-site inspection with the lead Contractor to determine compliance with the monitoring checklist;
3) Identification of any non-compliance issues and provision of remediation measures;
4) Regular email correspondence and monitoring with the leading Contractor and Project Manager; and
5) Compilation of a compliance monitoring audit report of all the findings.

The site-specific wetland monitoring plan associated with the proposed mixed-use development will focus on the following aspects, where applicable:

- Long term management of revegetated areas;
- Minimisation of impacts on surface and groundwater quality;
- Stormwater management guidelines;
- Alien and invasive floral management;
- Erosion control and siltation management, including soil management and bank stabilisation;
- Aftercare and maintenance; and
- Monitoring of revegetation and rehabilitation works.

8.1 Monitoring Actions

Monitoring actions were developed for the gathering of data pertaining to the proposed Lethabong mixed-use development situated on the remaining extent of the farm Quaggasfontein Alias Lapdoorn 548 IQ during the construction phase. The monitoring locations, sampling frequency, frequency of reporting, report content and equipment to be used are summarised in Table 8-12.

Table 8: Monitoring actions for the proposed development (stormwater management).

Aspect	**Stormwater management – Erosion, siltation, and soil stabilisation**					
Responsible person	Registered Civil Engineer & Contractor	**Project phase**	Construction	Rehabilitation	Operational	
	Monitoring Location	**Frequency of sampling**	**Frequency of Reporting**	**Report Content**		**Equipment**
	Development footprint associated with the: • UCVB and seep wetlands. • Setback area associated with the wetlands. • Road crossings traversing the UCVB. • Sewer infrastructure within and adjacent to the wetlands. • Stormwater infrastructure and outlets within the buffer area of the wetlands.	1. Monitoring of erosion should occur during the construction phase of the Lethabong mixed-use development where active digging and site clearing takes place. 2. After heavy rainstorms (precipitation of more than 20mm in a 24-hour cycle) and / or floods during construction and operational phases.	1. Internal memorandums after every major rainstorm and / flood during the construction phase. 2. Monthly monitoring report compiled by the appointed ECO during the construction phase.	1. Brief indication of the method of assessment. 2. Assumptions and Limitations must be listed. 3. Photos and GPS point locations taken of existing erosion in the wetland and associated setback areas prior to and post construction and operation must be incorporated into the report. 4. Any erosion observed must be discussed in detail and proposed mitigation measures and corrections must be addressed.		1. GPS 2. Camera 3. Field Form 4. Measuring Tape
	Stormwater management	• Stormwater on the site and surface run-off from cleared areas must be managed to reduce siltation and runoff peaks into the wetland. • As far as possible, all construction activities planned to occur within the delineated wetland must occur within the low flow, or during drier winter months. • Excavations should be limited in extent (only to what is necessary for where open trenches within the wetland are necessary) to ensure that drainage patterns within the wetland return to normal as soon as possible after construction. • Construction of stormwater structure should take place in a phased manner and from an upstream to downstream direction to ensure the recovery process of disturbed areas can commence without any further disturbance from upstream development activities.				
	Sedimentation	• Silt fences should be installed as a temporary barrier to maintain sediment on a construction site in order to prevent soil erosion and pollution through sediment and nutrient loading. Silt fences should be designed and placed to detain sediment from the disturbed construction area and to prevent erosion by decreasing the velocity of the run-off. • The silt fence needs to be installed on all disturbed slopes where sheet erosion as a result of stormwater runoff may take place and should be installed along the contour lines. • The rows of the silt fences should be bowed at the last 2m of each section to prevent erosion and loss of silt on the end of the fence line. • Silt fences needs to be inspected weekly and before forecast of a rainfall event, and all damage must be repaired immediately.				

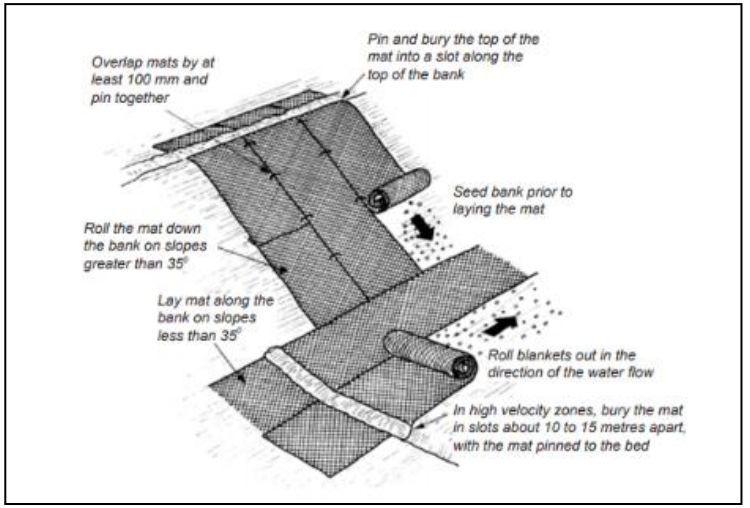
		• Silt deposits must be removed after each rainfall event and the cleared silt must not be placed down slope of the fence. • Figure A (left) below shows an example of silt fences and shown on the left is the current observed situation at the site where silt fences have not been used.   **Figure A: Illustration of a silt fence and placement.**
	Soil stabilisation	• As far as possible, soft excavated material and constructed berms must be removed as quickly as possible from the construction of the road crossings, (areas adjacent to the wetland). • Further erosion and incision within the wetland must be prevented during the construction and operational phases, particularly for the infrastructure planned within the wetland. • Where areas within the wetland are at risk of such erosion and incision, immediate measures such as strategic placement of hessian sheeting (Figure B) or stabilisation with sandbags must be taken in order to prevent erosion from occurring. • Compacted soils during the construction phase must be ripped and loosened to a depth suitable for establishment of vegetation (approximately 300m). • It must be ensured that topsoil used is clear of any alien and invasive species before being reinstated on re-profiled areas. • During this process all slopes shall be worked off to the same gradient as the surrounding slopes but limited to a maximum of 1:3 unless indicated otherwise. The top and bottom intersection of the diagonal slope line shall be worked off concave and convex respectively to ensure that contour lines knit and create even slopes.  **Figure B: Use of hessian sheeting as a stabilisation method.**

Table 9: Monitoring actions for the proposed development (alien vegetation control).

Aspect	**Alien Vegetation Control**				
Responsible person	Contractor	**Project phase**	Construction	Rehabilitation	Operational
	Monitoring Location	**Frequency of sampling**	**Frequency of Reporting**	**Report Content**	**Equipment**
	Development footprint associated with the: • UCVB and seep wetlands. • Setback area associated with the wetlands. • Stockpile areas associated with construction activities.	1. Monitoring must be done during and after growing season during the construction phase. 2. Regrowth of alien vegetation should be monitored monthly during the first three year after the construction phase.	1. Monthly monitoring report must be compiled by the appointed ECO during the construction phase. 2. Bi-annual follow up reports on the regrowth of alien vegetation during the operational phase (at least three years after construction).	1. Provide a list of species occurring within the affected areas. 2. Discuss the density of species. 3. Provide method of eradication. 4. Fixed point photo (Taking photo at specific point within priority area to show effect of alien vegetation control). 5. Map indicating where alien vegetation is present.	1. GPS 2. Camera 3. Field Form
	Alien Invasive Species	• Proliferation of alien invasive plant species is expected within any disturbed area and, as there is already an extensive proliferation of alien invasive species, particularly within the western boundary of the study area. These species should be eradicated and controlled to prevent their spread beyond the proposed development footprint. • Such species include *Tagetes minuta* (Not listed), *Ipomoea purpurea* (1b)[2], *Datura stramonium* (1b), *Mirabilis jalapa (1b), Xanthium strumarium (1b), Verbena bonariensis (1b)* and *Flaveria bidentis* (1b) which were widely distributed along the western portion of the study area and within the watercourse habitat. • This is in line with the requirements as stipulated by the National Biodiversity Act, 1998 (Act No. 10 of 2004) and Alien and Invasive Species List, 2016 wherein the landowner is responsible for managing alien proliferation. • It is advised that an AIP control plan be compiled and implemented in order to avoid any negative latent effects caused by the inappropriate removal of alien vegetation. • AIP management during the operational phase should be focused on limiting AIP spread, e.g. roadsides to and from the proposed residential development as well as fence lines should be monitored, as they serve as common corridors along which AIP species are introduced and dispersed, and disturbed areas should be regularly monitored for AIP recruitment. • Alien vegetation that is removed must not be allowed to lay on unprotected ground as seeds might disperse upon it. All cleared plant material to be placed in waste disposal containers and be disposed of at a licensed waste facility, which comply with legal standards.			
	Revegetation	• All re-vegetation work must be undertaken by a specialist contractor familiar with such works and with a proven track record. This will be in in accordance with the Working for Wetlands Program: Best Management Practice Manual (See Russel et al. 2009: 291-303). • All proposed seeding areas shall be ripped by machine or manually to a depth of 150 mm. The ripped surface shall be lightly and evenly firmed and reduced to a fine tilth. • A 150 mm layer of topsoil shall be evenly spread across the surface areas as indicated on site.			

[2] **Category 1b** Listed Invasive Species are those species listed as species which must be controlled.

		• The time between the completion of the site clearance, soil preparation and the hydroseeding of the grass seed shall be kept to a minimum. • The specified seed mix and necessary fertilizer shall be added to the required amount of water and applied using an approved hydroseeding machine. • All rehabilitated areas shall be maintained during the Establishment Period by adequate watering at frequent and regular intervals in order to ensure proper germination of seeds and growth of grass until an acceptable grass cover has been established and thereafter until the end of the Period of Maintaining of the grassed areas.

Table 10: Monitoring actions for the proposed development (waste management and spills).

Aspect	**Waste management and spillages**				
Responsible person	Contractor	**Project phase**	Construction	Rehabilitation	
	Monitoring Location	**Frequency of sampling**	**Frequency of Reporting**	**Report Content**	**Equipment**
	All construction areas, especially construction of services and infrastructure within the wetland and wetland setback area.	1. Monitoring of any spillage events should occur daily during the construction phase, or directly after a spill event, and for the operational phase, during maintenance activities. 2. Monitoring of waste or litter problems should occur daily where construction is taking place.	1. Monthly monitoring report compiled by the appointed ECO during the construction phase	1. Discuss type and extent of spill. 2. Photos and GPS point locations taken of the spills in the wetland. 3. Recommended mitigation should be presented. 4. Photos of construction sites where litter and waste are present.	1. GPS 2. Camera 3. Field Form
	Waste management	• All wet and dry material should be stored within the construction camp, which is located outside of the delineated wetland and associated with the 30m GDARD setback area. These materials should be covered and contained to prevent contact with rainfall or runoff. • Concrete and cement-related mortars can be toxic to aquatic life downstream of the wetland. Proper handling and disposal should minimize or eliminate discharges into the wetland. High alkalinity associated with cement, which can dramatically affect and contaminate both soil and ground water. The following recommendations must be adhered to: o Fresh concrete and cement mortar should not be mixed near the wetland. Mixing of cement may be done within the construction camp, may not be mixed on bare soil, and must be within a lined, bound or bunded portable mixer. Consideration must be taken to use ready mix concrete. o No mixed concrete shall be deposited directly onto the ground within the wetland. A batter board or other suitable platform/mixing tray is to be provided onto which any mixed concrete can be deposited whilst it awaits placing. o A washout area should be designated outside of the 30m GDARD setback area, and wash water should be treated on-site or discharged to a suitable sanitation system (USEPA. 2005). o Cement bags must be disposed of in the demarcated hazardous waste receptacles and disposed of through the hazardous substance waste stream. o Spilled or excess concrete must be disposed of at a suitable landfill site.			

Table 11: Monitoring actions for the proposed development (wetland integrity).

Aspect	**Monitoring wetland integrity**				
Responsible person	Contractor	**Project phase**		Rehabilitation	Operational
	Monitoring Location	**Frequency of sampling**	**Frequency of Reporting**	**Report Content**	**Equipment**
	The entire wetland system and within the 30m GDARD setback area.	1. Monitoring of the wetland ecological integrity determining the present ecological state (PES) before and after construction activities, this must be based on the hydrological, vegetation and geomorphology aspects. 2. Monitoring change in wetland ecological service provision and ecological importance and sensitivity before and after the construction activities.	Annual monitoring - Assessment and monitoring of the rehabilitation progress of the freshwater environment.	1. The report must discuss in detail the impacts observed on site. 2. The report must include assessment of the PES of the HGM units associated with the proposed development; 3. The wetland ecological importance and sensitivity must be assessed according to the defined method (Rountree & Kotze, 2013); and 4. Photos of impacts present on the site must be taken and included in the report.	1. GPS 2. Camera 3. Field Form
	Wetland rehabilitation measures	• It is recommended that the GDARD setback area be utilised as a conservation buffer from the delineated wetland. This area should be demarcated a no-go area and no unauthorised activities are allowed within the delineated extent of the wetland; • All areas exposed and disturbed as a result of the construction of the sewer line and proposed road within the wetland must be further stabilised through re-vegetation with indigenous grasses and flora as soon as possible to prevent erosion. Although the primary goal is erosion control, the vegetation can also provide nesting cover for birds and small faunal species; • Due to loss of alien invasive vegetation soils will be exposed and replanting/ reseeding should, therefore, take place immediately to prevent soil loss. • Hand seeding is recommended in order to avoid further impacts from machinery; • Methods of rehabilitation as described in the plant species and rehabilitation plan (Habitat landscape Architects, 2020) must be adhere to; • The contractor shall allow for the planting of plugs at a rate of 25 per square meter in the areas as indicated in the detailed drawings: - Schoenoplectus muriculatus - Schoenoplectus paludicola - Imperata cylindrica - Cyperus alterifolius - Cyperus profiler - Cyperus textilus - Echinochloa colona - Juncus effesus - Setaria spp. - Sorobolus africana • All plant material must be inspected and approved by the Landscape Architect prior to the commencement of planting; and • It is proposed that a **3-month maintenance** period (Growing-in Phase) be included in the contract of the rehabilitation contractor.			

9 CONCLUSION

During the field assessment undertaken on the 26th March 2020, a large unchannelled valley bottom (UCVB) and two seep HGM units were identified within the study area associated with the proposed mixed housing development. During the assessment the UCVB and seep 2 were assessed to be largely modified while seep 1 was seriously modified.

The delineated wetland associated with the proposed development has been impacted by historical agricultural activities, indiscriminate disposal of foreign soil material, encroachment of informal settlements within the study area and by urbanisation within the greater catchment which has increased compaction of surfaces and as a result altered runoff patterns. The results summary of the assessment of the delineated wetland as provided in Section 5 and summarised in Table 12 below.

Table 12: Summary of the results of the field assessments as discussed in Section 5.

Watercourse	Present Ecological State (PES)	Ecological Importance and Sensitivity	Ecoservices	Recommended Ecological Category (REC) / Best Attainable State (BAS) / Recommended Management Objective (RMO)
Unchannelled valley bottom	Category D: (Largely Modified)	Moderate	Intermediate	REC Category: D BAS Category: D RMO: Maintain
Seep 1	Category E: (Seriously Modified)	Low / Marginal	Moderately Low	REC Category: D* BAS Category: D RMO: Maintain
Seep 2	Category D: (Largely Modified)			REC Category: D BAS Category: D RMO: Maintain

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

Based on the findings of the watercourse ecological assessment and the risk assessment findings, it is the opinion of the freshwater ecologist that the proposed development poses a moderate risk to the freshwater systems present. Impacts associated with ground-breaking activities, installation of sewer lines and construction of access roads within the wetland are anticipated to pose the highest risk to the ecological integrity and functional extent of the wetland although it is acknowledged that the sensitivity of the wetland has been reduced to a degree. Adherence to cogent, well-conceived and ecologically sensitive site development plans, the mitigation measures provided in this report, as well as general good construction practice and ongoing management, maintenance and monitoring, are essential if the

significance of the perceived impacts are to be reduced to limit further degradation to the freshwater environment.

It is the opinion of the specialist that the proposed development can be considered acceptable on the proviso that strict adherence to mitigation measures is enforced to ensure that the ecological integrity of the freshwater environment is not further compromised. In addition, it is highly recommended that where possible, new roads which are proposed to be constructed within the wetland must be minimised as far as possible, ideally, no new roads be constructed within the wetland. Should this be unavoidable, careful planning and consideration of the design should take place to ensure free flow of water and to ensure that no upstream inundation, downstream desiccation, and the creation of preferential flow paths takes place. The appropriate design of the access roads and rehabilitation of the areas associated with the roads and stormwater infrastrcuture are likely to not only avoid impacts on the wetland but assist in enhancing the functionality of the wetland. Similarly, given that the sewer line needs to tie into the existing municipal infrastructure, it is considered inevitable that this infrastructure will encroach within the boundaries of the wetland, but it is considered critical that this is done in an ecologically sensitive manner which does not further compromise the already impacted integrity of the wetland.

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APPENDIX A - Terms of Use and Indemnity

INDEMNITY AND TERMS OF USE OF THIS REPORT

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 CC and its staff reserve the right 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 REQUIREMENTS

The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 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 (NEMA) (Act No. 107 of 1998)	The National Environmental Management Act (NEMA) (Act No. 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 Water Act (NWA) (Act No. 36 of 1998)	The National Water Act (NWA) (Act No. 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 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA (Act No. 36 of 1998)	In accordance with Regulation GN509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: 1. The outer edge of the 1 in 100 year flood line and/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; 2. In the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or 3. A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: ➢ Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ➢ Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; ➢ Do maintenance with their 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; ➢ Conduct river and stormwater management activities as contained in a river management plan; ➢ Conduct rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix; and ➢ Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. 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.
GDARD Requirements for Biodiversity Assessments Version 3 (GDARD, 2014).	The biodiversity assessment must comply with the minimum requirements as stipulated by GDARD Version 3 of 2014 and must contain the following information: ➢ The wetland delineation procedure must identify the outer edge of the temporary zone of the wetland, which marks the boundary between the wetland and adjacent terrestrial areas; ➢ The delineation must be undertaken according to the DWAF guidelines; ➢ The wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive in a sensitivity map. Rules for buffer zone widths are as follows: ➢ 30m for wetlands occurring inside urban areas; ➢ 50m for wetlands occurring outside urban areas; and ➢ 50m for priority pans.

APPENDIX C - Method of Assessment

WATERCOURSE 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 watercourses 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 watercourses 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[3] (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 a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. DWA Ecoregions have

[3] 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.

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*., 2009).

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. Wetland Functional 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".[4] The assessment of the ecosystem services supplied by the identified watercourses was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

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

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the watercourses. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the watercourses.

Table C5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

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

The purposed of assessing importance and sensitivity of the watercourses 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 C6) of the wetland system being assessed.

Table C6: 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 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.	>1 and <=2	C
Low/marginal	>0 and <=1	D

EIS Category	Range of Mean	Recommended Ecological Management Class
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.		

6. 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 watercourses (sections above), with the objective of either maintaining, or improving the ecological integrity of the watercourses in order to ensure continued ecological functionality.

A watercourse may receive the same class for the REC as the PES if the watercourse 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 C7: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
PES	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 unnacceptable (Malan and Day, 2012) and therefore, should a watercourse resource fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

Table C8: Description of Recommended Ecological Category (REC) classes.

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

7. Wetland and Riparian Delineation

The watercourse delineation took place according to the method presented in the "Updated manual for the identification and delineation of wetland and riparian resources" published by DWAF in 2008. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

According to the DWA (2005) like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands. The delineation process requires that the following be taken into account:

- topography associated with the watercourse;
- vegetation; and
- alluvial soils and deposited material.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005).

APPENDIX D - 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 method to be used for assessing risks/impacts is outlined in the sections below.

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 is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[5]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects 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 freshwater features, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** 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 extent** refers to the geographical scale of the impact.
- **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 severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. 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[6].

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

[5] The definition has been aligned with that used in the ISO 14001 Standard.
[6] Some risks/impacts that have low significance will however still require mitigation

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.

"RISK ASSESSMENT KEY" (Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol)

Table D1: Severity (How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Table D2: Spatial Scale (How big is the area that the aspect is impacting on)

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Table D3: Duration (How long does the aspect impact on the resource quality)

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
PES and EIS (sensitivity) must be considered.	

Table D4: Frequency of the activity (How often do you do the specific activity)

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Table D5: The frequency of the incident or impact (How often does the activity impact on the resource quality)

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table D6: Legal issues (How is the activity governed by legislation)

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

Table D7: Detection (How quickly or easily can the impacts/risks of the activity be observed on the resource quality, people and resource)

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table D8: Rating Classes

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

A low risk class must be obtained for all activities to be considered for a GA

Table D9: Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence X Likelihood

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.

i) Risks/Impacts were assessed for construction phase and operational phase; and
  - Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Control Measure Development

The following points presents the key concepts considered in the development of mitigation measures for the proposed construction:

- Mitigation and performance improvement measures and actions that address the risks and impacts[7] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and

[7] Mitigation measures should address both positive and negative impacts

- Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the freshwater ecology of the resources traversed by or in close proximity of the proposed infrastructure.

APPENDIX E - Results of Field Investigation

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

Table E1: Presentation of the results of the PES assessment (WET-Health) applied to the unchannelled valley bottom and two seep HGM units.

Wetland	Hydrology		Geomorphology		Vegetation		Overall Score	Overall PES Category
	Impact Score & (PES Category)	Trajectory of Change	Impact Score & (PES Category)	Trajectory of Change	Impact Score & (PES Category)	Trajectory of Change		
UCVB	6.5	-1	0.6	0	5.8	-1	4.68	D
Seep 2	6.0	-2	1.0	0	8.4	-2	5.25	D
Seep 1	9.0	-2	1.7	-1	8.2	-2	6.67	E

Table E2: Presentation of the results of the Ecoservices applied to the unchannelled valley bottom and two seep HGM units.

Ecosystem service	UCVB	Seep 2	Seep 1
Flood attenuation	2,2	1,8	2,0
Streamflow regulation	1,8	1,4	1,6
Sediment trapping	1,0	1,6	1,7
Phosphate assimilation	1,3	1,7	1,4
Nitrate assimilation	1,5	1,7	1,5
Toxicant assimilation	1,4	1,4	1,6
Erosion control	1,7	1,7	1,6
Carbon Storage	0,8	0,3	0,5
Biodiversity maintenance	2,1	1,2	1,2
Water Supply	0,6	0,6	0,6
Harvestable resources	1,2	1,2	1,2
Cultivated foods	1,4	2,0	1,2
Cultural value	1,0	1,0	1,0
Tourism and recreation	0,3	0,1	0,1
Education and research	0,8	0,5	0,5
SUM	**18,8**	**18,2**	**17,7**
Average score	**1,3**	**1,2**	**1,2**

Table E3: Presentation of the results of the EIS applied to the unchannelled valley bottom and two seep HGM units.

FRESHWATER FEATURE:			UCVB	Seep 1	Seep 2
Ecological Importance and Sensitivity			Score (0-4)	Score (0-4)	Score (0-4)
Biodiversity support			A (average)	A (average)	A (average)
			0.00	0.00	0.00
Presence of Red Data species			0	0	0
Populations of unique species			0	0	0
Migration/breeding/feeding sites			0	0	0
Landscape scale			B (average)	B (average)	B (average)
			1.00	0.40	0.40
Protection status of the wetland			0	0	0
Protection status of the vegetation type			2	2	2
Regional context of the ecological integrity			1	0	0
Size and rarity of the wetland type/s present			2	0	0
Diversity of habitat types			0	0	0
Sensitivity of the wetland			C (average)	C (average)	C (average)
			2.00	0.00	0.67
Sensitivity to changes in floods			2	0	1
Sensitivity to changes in low flows/dry season			3	0	0
Sensitivity to changes in water quality			1	0	1
ECOLOGICAL IMPORTANCE & SENSITIVITY (max of A,B or C)			B	B	C
Hydro-Functional Importance			Score (0-4)	Score (0-4)	Score (0-4)
Regulating & supporting benefits	Flood attenuation		2	2	2
	Streamflow regulation		2	1	2
	Water Quality Enhancement	*Sediment trapping*	1	1	1
		Phosphate assimilation	1	1	1
		Nitrate assimilation	1	1	1
		Toxicant assimilation	1	1	1
		Erosion control	1	1	1
	Carbon storage		0	0	0
HYDRO-FUNCTIONAL IMPORTANCE (average score)			1	1	1
Direct Human Benefits			Score (0-4)	Score (0-4)	Score (0-4)
Subsistence benefits	*Water for human use*		0	0	0
	Harvestable resources		0	0	0
	Cultivated foods		1	0	0
Cultural benefits	*Cultural heritage*		0	1	1
	Tourism and recreation		0	0	0
	Education and research		0	0	0
DIRECT HUMAN BENEFITS (average score)			0,17	0,17	0.17

Table E4: List of species identified within the delineated wetlands.

Species	Habitat and distribution
Andropogon eucomus	Grows in wet areas within disturbed soils.
Aristida congensta subsp congesta	Grows in disturbed areas such as old cultivated lands and overgrazed patches.
Asparagus sp	Grows in most soils and is fairly drought tolerant, but can also be found growing in soil which is rich in organic matter and periodically wet.
Berkheya radula	Widely distributed and occurs within moist grasslands].
Bidens pilosa	Widely distributed weed within disturbed areas.
Chloris virgata	Grows in disturbed areas, particularly within ponds or standing water and mostly in clay soils.
Conyza bonariensis	Widely distributed weed within disturbed areas.
Cosmos bippinatus	Grows within disturbed areas such as abandoned fields, roadsides and areas along railroads.
Cymbopogon caecius	Grows in most soils types (sandy / gravelly), within disturbed and undisturbed veld.
Datura ferox	Weed widely distributed within disturbed and cultivated areas
Eucalyptus globulus	Commonly found in areas associated with high rainfall and well-drained soil..
Helichrysum aureonitens	Occurs within grassland habitats.
Hibiscus trionum	Commonly found in grasslands disturbed areas.
Hyparrhenia hirta	Grows within well drained soils in disturbed areas and often within riversides.
Imperata cylindrica	Grows within poorly drained and damp soils.
Ipomoea purpurea	Widely distributed weed within disturbed areas.
Mirabilis jalapa	Grows within disturbed and often moist areas.
Persicaria attenuata	Grows within wet areas.
Pogonarthria squarrosa	Grows within disturbed and undisturbed soils, within sandy and well drained soils.
Salix babylonica	Alien tree commonly growing in wet areas usually next to a lake or river.
Schoenoplectus paludicola	Grows in edge of rivers, seasonal ponds and muddy areas.
Schoenoplectus muriculatus	Grows within permanent pools.
Seriphium plumosum	Commonly found in disturbed or overgrazed areas.
Sporobolus africanus	Grows in disturbed areas, near streams and damp places.
Tagetes minuta	Widely distributed weed within disturbed and cultivated areas.
Tricholaena monachne	Grows in disturbed areas such as road-side and old cultivated areas.
Urochloa mosambicensis	Grows in disturbed places such as road-side and overgrazed areas.

APPENDIX F - Impact Assessment and 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 freshwater system identified in this report:

Development footprint

- All development footprint areas should remain as small as possible and should 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, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes should avoid freshwater areas 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 should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage;
- No fires should 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 and equipment must be regularly inspected for leaks. Re-fuelling must take place outside of the stipulated setback area, 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 the recollection of spillage should be practiced 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.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed areas. Alien invasive species are opportunistic, and where disturbances do occur, they will propagate; therefore, these species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Removal of the alien and weed species encountered within the study area and particularly any identified within the watercourse must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) and Section 28 of the National Environmental Management Act, 1998 (Act No. 107 of 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 should be kept as small as possible when removing alien plant species; and

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

Soils

- Sheet runoff from impermeable surfaces such as access roads and the walkways within close proximity to the watercourse should be slowed down by the strategic placement of berms;
- As far as possible, all construction activities should 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 soils;
- No stockpiling of topsoil is to take place within close proximity to the watercourse, and all stockpiles must be protected with a suitable geotextile to prevent sedimentation of the w watercourse;
- All soils compacted as a result of construction activities as well as ongoing operational activities falling outside of project footprint areas should be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence should be implemented to prevent erosion and incision.

Rehabilitation

- Construction rubble must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed development should be removed. Alien vegetation control should take place for a minimum period of two growing seasons after rehabilitation is completed.

Risk Assessment Matrix in terms of GN509 of 2016					Reviewed by: Stephen van Staden SACNASP number: 400134/05 Signature																	
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Borderline LOW MODERATE Rating Classes	PES / ESI
1	Pre-construction Phase	Geotechnical studies including drilling	*Movement of heavy machinery within wetlands and/or within 500 m of wetlands. *Drilling within wetlands	*Compaction of soils *Disturbance of soils and loss of natural vegetation *Alteration of natural flow paths and the creation of preferential flow paths *Proliferation of alien and invasive vegetation	1	1	1	1	1	1	1	3	5	5	5	1	16	48	L	80	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ;
	Construction Phase	Site clearing prior to commencement of construction activities.	*Removal of vegetation and associated disturbances to soils; and *Possible indiscriminate driving through the wetland by construction vehicles.	*Potential increased runoff and erosion, and thus increased sedimentation; *Proliferation of alien and invasive species due to their rapid establishment following disturbance; and *Decreased ecoservice provision.	3	2	3	2	2,5	1	1	4,5	5	1	5	2	13	58,5	M	80	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps

2		Ground-breaking: excavation of foundations, earthworks and building activities.	*Excavation of soil and creation of stockpiles; *Compaction of soils as a result of movement of construction vehicles; and *Construction of houses and other infrastructure associated with mixed housing development.	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to altered wetland habitat; *Altered stormwater runoff patterns leading to increased erosion and *Sedimentation of the wetland.	2	2	2	2	2	2	2	6	5	2	5	2	14	84	M	80	N/A	
3		Potential indiscriminate waste disposal and/or spillage from construction vehicles.	*Disposal of construction-related waste (such as rubble, hazardous chemicals and litter).	*Potential further loss of scenic beauty of the wetland due to increased rubble and construction debris; *Altered hydrological regime and vegetation structure as a result of disposed rubble; *Creation of preferential flow paths; and *Altered soil / sediment conditions due to chemical waste disposal or spills.	1,5	1	1	1	1,1	1	2	4,13	3	2	5	2	12	49,5	L	80	N/A	
4		Construction of infrastructure (buildings and roads outside of the delineated wetland).	*Movement of construction equipment adjacent to the delineated wetland; *Stockpiling of construction materials; and *Increased likelihood of dust generation due to exposed soils.	*Loss of freshwater habitat and ecological structure as a result of edge effects associated with the development. *Impacts to the ecoservice provision of the wetland. *Potential impacts on the hydrology and sedimentation of the wetland.	2	1,5	3	3	2,4	1	1	4,38	5	2	5	2	14	61,25	M	80	N/A	
5		Construction of sewer line infrastructure within the delineated wetland.	*Movement of construction equipment adjacent to the delineated wetland; *Removal of topsoil and creation of topsoil stockpiles;	*Disturbances of soils leading to increased alien vegetation proliferation, and in turn to altered freshwater habitat; *Altered stormwater runoff patterns, leading to increased erosion and sedimentation of the wetland;	5	5	5	5	5	2	1	8	3	2	5	1	11	88	M	80	N/A	

6		Construction of road three crossings within the delineated wetland.	*Movement of construction equipment adjacent to the delineated wetland; and *Stockpiling of construction materials.	*Impacts to the ecoservice provision of the wetland; and *Potential impacts to water quality as a result of oil spills/ solid wastes entering the wetland.	5	5	5	5	5	2	1	8	3	2	5	1	11	88	M	80		
7	Operational phase	Increased impermeable surfaces within the study area and the wetland's surrounding catchment areas.	*Potential change in surface runoff patterns due to increased impermeable surfaces.	*Decreased infiltration and increase surface runoff from impervious surfaces; *Increased water inputs to the freshwater environment at unnatural rates; and *Potential change in wetland hydrograph due to modified surrounding landscape.	3	2	1	1	1,8	2	1	4,75	5	2	5	2	14	66,5	M	80	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)
8			Potential risk of contaminated runoff from the increased impermeable surfaces (parking areas and access roads).	*Pollution of freshwater soils, groundwater and surface water.	3	2	1	1	1,8	2	1	4,75	5	2	5	2	14	66,5	M	80	N/A	

9		Operation and associated maintenance of the proposed sewer pipeline.	*Potential leakage of proposed sewer pipeline and discharge of sewage into the wetland; and *Miscellaneous activities by construction personnel associated with maintenance of the proposed sewer pipeline.	*Increased water input into the wetland thus altering the natural hydrological regime of the wetland; *Sedimentation of the wetland resulting from sediment-laden stormwater runoff entering the wetland, and associated disturbances to vegetation; *Potential risk of contaminated runoff and litter entering the wetland thus altering water quality; and *Potential erosion and incision within the wetland as a result of the concentrated flow of water.	5	5	5	5	5	1	1	7	5	2	5	1	13	91	M	80	N/A	
10		Potential indiscriminate disposal of waste.	*Disposal of solid household waste within the wetland.	*Impacts on the habitats and biota within the receiving environment; and *A reduction in water quality of water and soil.	2	1	2	2	1,8	2	1	4,75	3	2	5	1	11	52,25	L	80	N/A	
11		Inadequate capacity and/or maintenance of storm-water and/or sewage systems.	*Failure of the storm-water and/or sewage systems; *Unmanaged storm-water and/or sewage entering the wetland.	*A reduction in water quality, with a subsequent impact on biota; *Impacted soil and water quality condition within the wetland and *Altered hydroperiod of the wetland.	3	3	2	2	2,5	1	2	5,5	3	1	5	2	11	60,5	M			
																					N/A	

12	**Rehabilitation**	Rehabilitation of affected portions of the wetland (three road crossings, sewer pipeline).	*Re-vegetate all areas where vegetation removal took place; *Remove any obstructions to flow; and *Alien and invasive plant removal.	*No negative impacts are identified for the proposed rehabilitation actions.	5	5	5	5	5	1	1	7	1	1	5	1	8	56	M	80	N/A	PES: UCVB (D) ; Seep 1 (F) ; Seep 2 (D) EIS: UCVB (Moderate) ; Seeps (Low)

APPENDIX G - Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

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

Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)
Kieren Bremner	MSc (Aquatic Ecology) (University of Johannesburg)
Nqobile Lushozi	MSc (Geoinformatics) (Stellenbosch University)

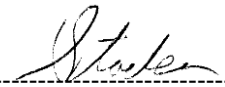
1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Natural 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		

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 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 KIEREN JAYNE BREMNER

PERSONAL DETAILS

Position in Company	Senior Aquatic and Wetland Ecologist
Joined SAS Environmental Group of Companies	2020

MEMBERSHIP IN PROFESSIONAL SOCIETIES

SACNASP – Aquatic Science – Registration number 119341 (Active)
Accredited SASS5 Practitioner
Gauteng Wetlands Forum
South African Wetland Society
South African Society for Aquatic Scientists

EDUCATION

Qualifications

MSc (Aquatic Ecology) (University of Johannesburg)	2011
BSc (Hons) Natural Sciences (Aquatic Ecology) (University of Johannesburg)	2005
BSc (Zoology and Biochemistry) (Rand Afrikaans University)	2004

Short Courses

Additional Training

Wetland Rehabilitation Course – presented by Piet-Loius Grundling (DEA) and	(2019)
Cilliers Blaauw (Aurecon)	(2019)
Grammar for Writers – South African Writers College	(2018)
Wetland Soils Course – University of the Free State	(2018)
Fish Identification Course – SAIAB	(2018)
Tools for Wetland Assessment – Rhodes University	(2017)
VEGRAI training – presented by James MacKenzie	(2017)
SASS5 Accreditation – Department of Water and Sanitation	(2011)
First Aid – Level 1 refresher	(2008)
Wetland Plants Taxonomy – Workshop – SANBI	(2018)
First Aid for Children and Family – Lifestyle Projects	(2005)

Public Participation – Golder Associates
First Aid Certificate – Level 1 – Sharpminds
Environmental Auditing Workshop – University of Johannesburg (UJ)
Advanced 4x4 driving course – Driving School

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Botswana, Malawi
West Africa – Ghana, Senegal, Mali
Central Africa – Democratic Republic of the Congo, Uganda
East Africa – Tanzania

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- 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

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

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

SAS ENVIRONMENTAL GROUP OF COMPANIES –
SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

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
Tools for wetland assessment short course Rhodes University	2016
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013

Short Courses

Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS OF WORK EXPERIENCE

South Africa – All Provinces

Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia

Eastern Africa – Tanzania Mauritius

West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona

Central Africa – Democratic Republic of the Congo

SELECTED PROJECT EXAMPLES OUT OF OVER 2000 PROJECTS WORKED ON

1 Mining: Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2 Linear developments
3 Energy Transmission, telecommunication, pipelines, roads
4 Minerals beneficiation
5 Renewable energy (wind and solar)
6 Commercial development
7 Residential development
8 Agriculture
9 Industrial/chemical

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Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF NQOBILE LUSHOZI

PERSONAL DETAILS

Position in Company	Junior Field Ecologist Wetland and Aquatic Ecology
Joined SAS Environmental Group of Companies	2019

MEMBERSHIP IN PROFESSIONAL SOCIETIES

National Executive Committee (NEC) member of the International Affiliation for Impact Assessments (IAIAsa) South Africa group

EDUCATION

Qualifications

MSc Geoinformatics (Cum laude) (Stellenbosch University)	2019
BSc (Hons) Environmental Sciences (University of KwaZulu-Natal)	2015
BSc Environmental Sciences (University of KwaZulu-Natal)	2014

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Northern Cape, Free State

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
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