FRESHWATER ASSESSMENT

WATERCOURSE DELINEATION AND IMPACT ASSESSMENT OF THE PROPOSED REHABILITATION OF THE EXISTING BENMORE DAM WITHIN BENMORE GARDENS, GAUTENG PROVINCE

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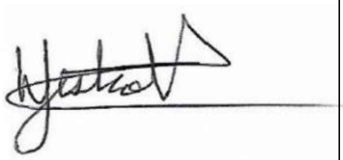
Signature			
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SPECIALIST DECLARATION:

I Wayne Westcott, declare that:

- I acted as an independent specialist;
- The assessment results were interpreted in an objective manner, even if the conclusions were not favourable to the client;
- I have the relevant expertise required to conduct a specialist report of this nature in terms of the National Environmental Management Act (NEMA) (Act no. 107 of 1998) and the National Environmental Management; Biodiversity Act (Act no. 10 of 2004);
- The contents of this report comply with the relevant legislative requirements, specifically Appendix 6 of the NEMA: EIA Regulations (2014, as amended in 2017);
- I understand that any false information published in this document is an offence in terms of Regulation 71 and is punishable in terms of Section 24(f) of the Act; and
- I am a professionally registered scientist with the South African Council for Natural Scientific Professions (SACNASP) (no. 117334).

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EXECUTIVE SUMMARY

Environmental Assurance (Pty) Ltd. (hereafter referred to as "ENVASS") was appointed by GA Environment (Pty) Ltd. (hereafter referred to as "the client"), on behalf of the Johannesburg Road Agency, to undertake a watercourse delineation and impact assessment of the proposed rehabilitation of the existing Benmore Dam, which was situated within Benmore Gardens of the province of Gauteng. The direct footprint of the proposed rehabilitation of the Benmore Dam, as supplied by the design engineer, will hereafter be referred to as the proposed development, and the proposed development inclusive of a 500 metre (m) assessment radius (buffer) around it will constitute as the study area within this report.

Based on discussion with the client and following a site visit with the design engineer, it was evident that the need for the proposed development stemmed from the current Benmore Dam not being fit for purpose as a conservational pond and stormwater attenuation facility. During the initial site visit with the project team it was recorded that the entire extent of the Benmore Dam had been silted up, which caused the eventual collapse of the dam wall to occur. In addition to this, it was visually observed that severe undercutting and donga formation had taken place within and upstream of the Benmore Dam site. This was attributed to severe flood events and the significantly altered baselevel of the stream, which was caused by the dam wall and several other artificial impeding features situated within the watercourse. The proposed development will therefore entail the rehabilitation of the current degraded dam site to a stormwater attenuation facility, which will essentially consist of an old farm dam as a silt trap with a gravity fed weir that will be used as cattle drinking area, and the primary dam site which will be reshaped and the banks stabilised before formalisation.

The field survey relevant to this combined watercourse impact assessment report was conducted on the 5th of June 2020 within the South African National Biodiversity Institution (SANBI) dry season for the region. The timing of this study did present a limitation, specifically with the identification of hydrophytic vegetation, however soil samples were used as the primary means to confirm the outer boundaries of the watercourses. The aim of his study and the accompanying data is to provide specialist input into the relevant authorisation processes, which in the case of the proposed development will be a Water Use License Application (WULA) and Environmental Authorisation (EA) from the relevant Competent Authorities (CAs). This study will focus on the Section 21(c) and (i) water uses, which will apply to the proposed development.

At-risk Watercourses (wetlands and rivers)

All the at-risk watercourses (wetland and riverine systems) present within the study area were delineated using the Department of Water Affairs and Forestry`s (DWAF) (now the Department of Water and Sanitation (DWS)) (2008) 'a practical field procedure for the identification and delineation of wetlands and riparian areas' and subsequently classified according to the 'classification systems for wetlands and other aquatic ecosystems in South Africa' (Ollis *et al*., 2013). Subsequent to conducting an initial desktop study and undergoing a field survey of the study area, it was determined that out of the total four (4) watercourses within the study area, three (3) may be at-risk of being impacted on by the proposed development.

Table ES01 and **ES02** below present the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) scores and Recommended Management Objectives (RMO's) that were calculated for the at-risk wetland and riverine systems, respectively.

Table ES01: Summary table presenting the Present Ecological State (PES), Ecological Sensitivity and Importance (EIS) scores and Recommended Management Objectives (RMO's) of the at-risk wetland systems.

WETLAND SYSTEMS						
HGM UNIT CODE	WET-HEALTH MODULES			OVERALL PES	EIS	RMO
	HYDROLOGY	GEOMORPHOLOGY	VEGETATION			
Seep01	4.0 (D) ↓	3.1 (C) ↓	5.7 (D) ↓	**4.2 (D)**	High	Improve PES to Class C/D
Seep02	6.0 (E) ↓	4.6 (D) ↓	5.7 (D) ↓	**5.5 (D)**	High	

KEY: ↓- Deteriorate Slightly over the next five years. PES Categories: C (Moderately modified), D (Largely modified) and E (Seriously modified) (Macfarlane *et al*., 2009).

Table ES02: Summary table presenting the Present Ecological State (PES), Ecological Sensitivity and Importance (EIS) scores and Recommended Management Objectives (RMO's) of the at-risk riverine systems.

RIVERINE SYSTEMS				
HGM UNIT	INSTREAM IHI	RIPARIAN IHI	EIS	RMO
Rip01	57.56 % (Class D)	49.40 % (Class D)	**Moderate**	Maintain PES Class at D

KEY: PES Category- Class C (Moderately modified) & Class D (Largely modified) (Kleynhans, 2008).

Table ES03 below presents the water quality and SASS5 scores that were obtained at two (2) sites on the at-risk Rip01 riverine system. These sites were situated upstream and downstream of the proposed development and were used to provide input into the current macroinvertebrate health within the system.

Table ES03: Summary table presenting the water quality and SASS5 aquatic biomonitoring results for two sites on the at-risk Rip01 system.

SITE	pH	EC (uS/cm)	TDS (mg/l)	IHAS (%)	NO. OF TAXA	SASS5 SCORE	ASPT	ECOSTATUS
Upstream	6.85	948	616	47	6	16	2.67	E/F
Downstream	7.15	443	287	46	6	21	3.50	E/F

KEY: EC- Electrical Conductivity, TDS- Total Dissolved Solids, IHAS- Integrated Habitat Assessment System, ASPT- Average Species per Taxa.

Wetland Ecosystem Services

The effectiveness and opportunity of the at-risk wetland systems to provide direct and indirect Ecosystem Services (ESS) to the surrounding anthropogenic and natural environmental were assessed using the WET-EcoServices tool (Kotze *et al*., 2007). The following ESS were calculated to have been provided to the receiving environmental at a moderately high level from the at-risk Seep01 and Seep02 wetland systems: Flood attenuation, phosphate trapping, nitrate and toxicant removal and erosion control.

Buffer Zone Determination

Using the Buffer Zone Guideline Tool by Macfarlane & Bredin (2016), the buffer zones were determined for the watercourses within the study area. **Table ES04** below presents the calculated buffer zones that must be applied to all at-risk riverine and wetland systems within the study area. Although the proposed development will occur directly within Rip01, the calculated buffer zones should be applied to all associated equipment and temporary infrastructure. It must however be noted that although the below presented and illustrated buffer zones were calculated based on on-site analyses, applicable legislation must be consulted to determine the exact buffer zone requirements. The furthest buffer must be applied to each at-risk watercourse.

Table ES04: Presentation of the calculated buffer zones that should be implemented during the construction and operational phases associated with the proposed development.

SYSTEMS	CONSTRUCTION PHASE (m)	OPERATIONAL PHASE (m)
Seep01, Seep02 & Seep03	24	15
Rip01	30	15

Impact Statement

Based on the calculated PES, ESS, EIS and overall integrity scores, and the presumed construction method that will be applied on site, a Risk Assessment Matrix (RAM) (DWS, 2016) was undertaken for the proposed development. It was determined that the following aspects could not be mitigated down to a low significance score post-mitigation: 1) The excavation, infill and subsequent formalisation of un-inundated portions of Rip01, Seep01 and Seep02; and 2) the Construction of a permanent flow barrier within Rip01, which will consequently alter the sediment capacity and quantity of flow to downstream aquatic habitats. In line with Department of Water and Sanitation (DWS) General Notice (GN) No. 506, published within Government Gazette (GG) no. 40229 of 2016, the proposed development will therefore need to be subject to a full Water Use License Application (WULA) process.

Conclusion

Considering the project as a whole, it is the specialist's substantive opinion that the proposed development continues, provided that the following take place and/or be implemented:

- All buffer zones, mitigation and/or rehabilitation measures presented within this report and the site-specific Environmental Management Programme (EMPr) are strictly implemented and subsequently monitored through a formal monitoring programme approved by the competent authority (DWS).

The following should be considered as conditions within the relevant WULA:

- A detailed Rehabilitation and Landscaping Programme should be drafted for the project to guide the post-construction landscape and ensure that the area exhibits the required level of biodiversity. An IAPS Control and Management Plan should be incorporated into this programme.
- Biannual aquatic biomonitoring should be conducted by an accredited SASS5 practitioner at the sites presented within this report on a biannual basis to monitor the overall integrity of the stream and potential impacts that the proposed development may have on the system. This will guide any remediation actions that may be required

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LIST OF ABBREVIATIONS AND ACRONYMS

TERM	EXPANSION
BA	Biodiversity Area
CBA	Critical Biodiversity Area
CR	Critically Endangered
CVB	Channelled Valley-bottom
DAFF	Department of Agriculture, Forestry and Fisheries
D'MOSS	Durban Metropolitan Open Space System
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
EN	Endangered
ESS	Ecosystem Services
FEPA	Freshwater Ecosystem Priority Area
FHIA	Freshwater Habitat Impact Assessment
GG	Government Gazette
GIS	Geographic Information System
GN	General Notice
GPS	Geographic Positioning System
HGM	Hydrogeomorphic
IAPS	Invasive Alien Plant Species
IHI	Index of Habitat Integrity
LT	Least Threatened
MAMSL	Meters Above Mean Sea Level
MAP	Mean Annual Precipitation
MASR	Mean Annual Surface Runoff
MAT	Mean Annual Temperature

TERM	EXPANSION
NEMA	National Environmental Management Act (Act no. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Area
NWA	National Water Act (Act no. 36 of 1998)
PES	Present Ecological State
PU	Planning Unit
REC	Recommended Ecological Category
RAM	Risk Assessment Matrix (DWS, 2016)
RMO	Recommended Management Objective
RWQO	Resource Water Quality Objectives
SANBI	South African National Biodiversity Institute
SCC	Species of Conservation Concern
TOPS	Threatened and/or Protected Species
TWQR	Target Water Quality Range
VIA	Vegetation Impact Assessment
VU	Vulnerable
WMA	Water Management Area
WULA	Water Use Licence Application
WUL	Water Use Licence

1 INTRODUCTION

1.1 Background

Environmental Assurance (Pty) Ltd. (hereafter referred to as "ENVASS") was appointed by GA Environment (Pty) Ltd. (hereafter referred to as "the client"), on behalf of the Johannesburg Road Agency, to undertake a watercourse delineation and impact assessment of the proposed rehabilitation of the existing Benmore Dam, which was situated within Benmore Gardens of the province of Gauteng. The direct footprint of the proposed rehabilitation of the Benmore Dam, as supplied by the design engineer, will hereafter be referred to as the proposed development, and the proposed development inclusive of a 500 metre (m) assessment radius (buffer) around it will constitute as the study areas within this report.

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1.2 Locality

The proposed development will be situated within Benmore Gardens Extension 3, as part of Sandton. The site falls within the City of Johannesburg District Municipality (JHB) and City of Johannesburg Metropolitan Municipality, within the Gauteng Province of South Africa. **Figure 1** overleaf presents the proposed development in relation to the surrounding towns within the relevant municipal boundaries.

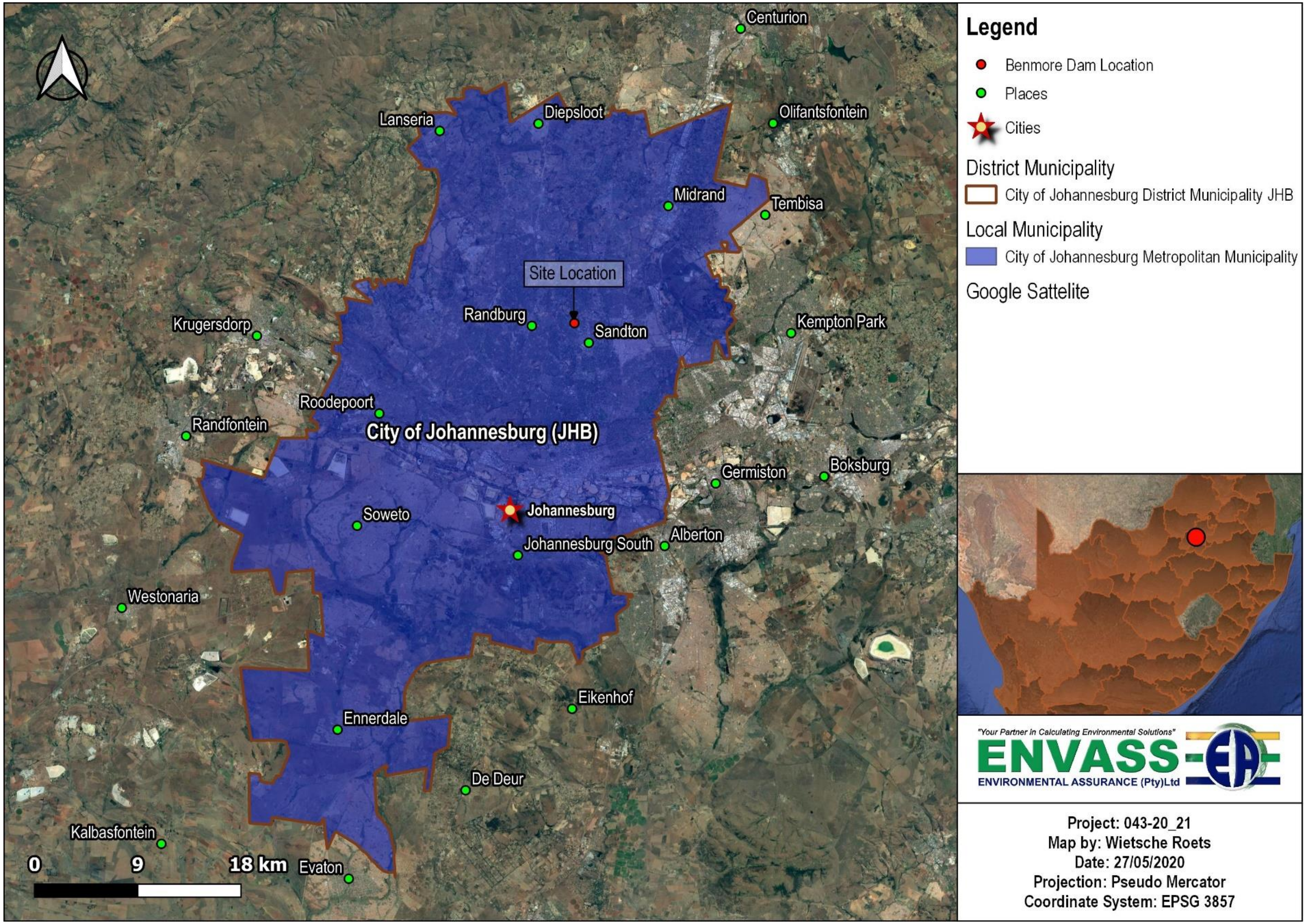

Figure 1: Locality map of the proposed development in relation to surrounding cities and municipal boundaries within the KZN Province, South Africa.

1.3 Applicable Legislation

This study was conducted and the relevant data and/or information obtained in accordance, or with consideration to, the following legislation (**Table 1**).

Table 1: Description of the legislation that was considered when drafting this watercourse impact assessment.

LEGISLATION	DESCRIPTION
South African Constitution (Act no. 108 of 1996)	The constitution is the overarching framework of South African law. It provides a legal foundation for the existence of the republic, outlines the rights and responsibilities of South African citizens and it defines the structure of government. Chapter 2- Bill of rights (Section 24) Everyone has a right to an environment that is not harmful to their health or wellbeing and is protected through reasonable legislative or other measures. (Section 27) National government is the custodian of all the country's water resources.
Conservation of Agricultural Resource Act (CARA) No. 43 of 1983	This act deals with control of the over-utilization of South Africa's natural agricultural resources, and to promote the conservation of soil and water resources and natural vegetation. This includes wetland systems and requires authorizations to be obtained for a range of impacts associated with cultivation of wetland areas.
DWS General Notice 509 Government Gazette no. 40229 (2016)	This GA replaces the need for a water user to apply for a license in terms of the NWA provided that the water use is within the ambit of the aforementioned GA. Although this GA is legislated throughout South Africa, it only applies to water use in terms of Section 21 (c) and (i) of the NWA within the regulated area of a watercourse. In order to understand and interpret GN 509 (2016) the following definitions must be presented and expanded upon (GN509, 2016): Characteristics of a watercourse: the resource quality of a watercourse within the extent of a watercourse; Diverting: To, in any manner, cause the instream flow of water to be rerouted temporarily or permanently; Extent of a watercourse: (a) The outer boundary of the 1:100year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse; and (b) Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan. Flow-altering: To, in any manner, alter the instream flow route, speed or quantity of water temporarily or permanently. Impeding: to, in any manner, hinder or obstruct the instream flow of water temporarily, or permanently, but excludes the damming of flow so as to cause storage of water. Regulated area of a watercourse: For Section 21 (c) and (i) of the NWA water uses in terms of GN509 means:

LEGISLATION	DESCRIPTION
	(a) The outer boundary of the 1:100year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse; (b) In the absence of a determined 1:100year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse if the first identifiable annual bank fill flood bench; or (c) A 500m radius from the delineated boundary of any wetland or pan. Rehabilitation: The process of reinstating natural ecological driving forces within part or the whole of a degraded watercourse to recover former or desired ecosystem structure, function, biotic composition and associated Ecosystem Services (ESS). Watercourse: (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. Wetland: Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil. According to GN509 (2016), a water use in terms of Section 21 (c) and (i) of the NWA may be granted under a GA as oppose to a full water use license if all activities within the regulated area of a watercourse is calculated to be low risk utilising the DWS adopted Risk Assessment Matrix.
DWS Regulation No. R. 267, Government Gazette no. 40713 (2017)	The purpose of this regulation is to prescribe the procedure and requirements for Water Use License Applications (WULAs) as contemplated in Section 41, as well as an appeal in terms of Section 41(6) of the NWA. Within Section 6 of Regulations No. R. 267 the content required within a Wetland Delineation Report (including watercourses) are stipulated, and thus were considered by the author when drafting this report. Additionally, the standardised and DWS accepted methods that must be used for determining the various aspects of assessments during the WULA process related to wetlands are presented and their sources referenced.
National Environmental Management Act (NEMA): EIA Regulations (2014, as amended in 2017)	As the primary purpose of this assessment is to provide specialist input into the environmental management process, including the water use license application, associated with the proposed development the author has drafted this specialist report in accordance with the requirements listed under Appendix 6 of the NEMA: EIA Regulations (2014, as amended).
National Water Act (NWA) (Act no. 36 of 1998)	The purpose of the NWA is to ensure that the national water resources are protected, used, developed, conserved, managed and controlled in ways which take into account amongst other factors: (g) protecting aquatic and associated ecosystems and their biological diversity:

LEGISLATION	DESCRIPTION
	(h) reducing and preventing pollution and degradation of water resources; In terms of the NWA, water use is broadly defined as, and includes taking and storing water, activities which reduce stream flow, waste discharges and disposals, controlled activities (activities which impact detrimentally on a water resource), altering a watercourse, removing water found underground for certain purposes, and recreation. In general, a water use must be licensed unless it is listed in Schedule I, is an existing lawful use, is permissible under a General Authorisation (GA), or if a responsible authority waives the need for a license. The water uses, as listed under Section 21 of the NWA, that are applicable to this project are: (c) impeding and diverting the flow of water in a watercourse; and (i) altering the bed, banks, course or characteristics of a watercourse.
National Environmental Management Act: Biodiversity Act (NEM:BA) (Act No. 10 of 2004)	The objectives of the NEM:BA are (within the framework of NEMA) to provide for: (i) the management and conservation of biological diversity within the Republic and of the components of such biological diversity; (ii) the use of indigenous biological resources in a sustainable manner; and (iii) the fair and equitable sharing among stakeholders of benefits arising from bioprospecting involving indigenous biological resources.
City of Johannesburg Municipal bylaws	These legislated documents must be reviewed by the design team to ensure that all requirements regarding conservation targets and land-use zonation/planning is met and the proposed development is in-line with the overall purpose of the area. All construction activities must also adhere to the requirements stipulated within these bylaws.

2 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are relevant to this study:

- The direct footprint of the proposed development and associated infrastructure (i.e. site camp, access roads etc.) were not provided to ENVASS. Instead, a KML file representing the "general impact area" was provided to ENVASS by the design engineer. This limited the accuracy of the direct impact of the proposed development on the receiving environment.
- The conceptual idea of the proposed development was communicated to ENVASS during the initial site visit with the project team. This included the construction of two (2) dams within the existing disturbance footprint that will be formally connected. If this concept changes, ENVASS will be notified and this study altered if required.
- The field survey relevant to this study was a once-off assessment that was conducted in June 2020, and therefore does not cover seasonal variations in freshwater habitat characteristics. Ecosystems vary both temporally and spatially. Once-off assessments such as this may potentially miss certain ecological information, specifically trends and floral species that do not flower within the field survey season.
- Only those wetland/riverine habitats which will be significantly impacted by the proposed development were accurately delineated in the field. The remaining freshwater resources within a 500m assessment radius were delineated at a desktop level.
- Wetland and/or riparian boundaries are essentially based on GPS coordinate waypoints taken on-site of soil sampling points and of important morphological features. The variations experienced in GPS precision will ultimately affect the accuracy of the GPS waypoints and consequently will affect the accuracy of the recorded freshwater resource boundaries. All sampling waypoints were recorded using a Garmin Montana 650 GPS and captured, analysed and geoprocessed utilising a GIS (i.e. QGIS and ArcGIS).
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological issues identified during the field survey and based on the assessor's working knowledge and experience with similar activity projects. No construction method statement, layout plan or civil designs were submitted to ENVASS.
- Evaluation of the significance of impacts with mitigation takes into account mitigation measures provided in this report and standard mitigation measures included in the project-specific Environmental Management Programme report (EMPr).

3 OBJECTIVES

The primary objective of this watercourse impact assessment was to delineate all watercourses (wetlands and riverine ecosystems) within the study area and identify those watercourses that may be at-risk of being impacted on by the proposed development. The Present Ecological State (PES), Ecological Importance and Sensitivity (EIS), as well as the opportunity/effectiveness of the at-risk systems to supply valuable Ecosystem Services (ESS) to the surrounding catchment area needed to be determined using best-practice and legislated methodologies and techniques. Based on the calculated integrity of the watercourses and the impacts recorded (if any), mitigation and/or rehabilitation measures were identified if required to maintain the Recommended Management Objectives (RMOs), as determined using the Department of Water Affairs and Forestry (DWAF) (now the Department of Water and Sanitation (DWS)) management hierarchy (DWAF, 2007). To determine the significance of the proposed activities on the at-risk watercourses, a Risk Assessment Matrix (RAM) was conducted to ascertain whether the proposed development may be subject to authorisation through a General Authorisation (GA) process, or full Water Use License Application (WULA) for the applicable water uses. As a result of RAM being considered more detailed than the standard DEA (2013) impact assessment methodology, it was used as the impact assessment within this study.

The content and structure of this watercourse impact assessment report was formulated in accordance with the requirements stipulated within the DWS Regulation no. 267, which was published within Government Gazette ((GG) no. 40713 of 2017, as well as Appendix 6 of the National Environmental Management Act (NEMA) Act no. 107 of 1998).

4 METHODOLOGY

This section details the different techniques and methods used to obtain the data for this report in order to finally assess the overall ecological integrity of the at-risk watercourses and identify appropriate mitigation and/or rehabilitation measures to implement in an effort to reduce the potential impact (if any) on the receiving aquatic environment.

4.1 Freshwater Habitat Assessment

Assessment of the freshwater ecosystem entail the characterisation of the aquatic environment, aquatic habitat and associated biota. In order to enable an adequate description of the aquatic environment and determination of the PES, the following stressor, habitat and response indicators were evaluated:

- Current and potential threats to water quality and watercourse condition;
- Information regarding upstream and downstream conditions, point and non-point pollution sources, water usage etc. and translate it into information that may be used to develop WUL conditions and determine the integrity of the watercourses;
- Baseline data with regard to PES, resources water quality objectives and the desired future system condition;
- Isolate point source impacts and assess the nature and significance of these impacts;

- Implement the most up-to-date best practice methodologies and techniques (e.g. WET-Health (Macfarlane *et al.,* 2009)) to accurately assess the current and change in condition within each reach; and
- Provide specialist recommendations that may be implemented to mitigation and/or rehabilitated the identified and quantified impacts;
- Develop a comprehensive report containing result analyses and specialist recommendations that will assist with decisions and the development of management objectives.

4.2 Desktop Assessment

A desktop assessment was undertaken, in which all the available data (e.g. government records and previous studies) pertaining to the proposed study area was sourced and subsequently utilised to determine the theoretical importance and sensitivity of the freshwater ecosystems involved. Additionally, the study area was digitally illustrated and mapped utilising Geographical Information Systems (GIS) (e.g. QGIS and/or ArcGIS) to better understand the layout and structure of the surrounding environment and study area.

During this process, all the relevant GIS shapefiles were overlain onto Google Earth Satellite imagery to provide the reader with a holistic view of the study area. **Table 2** below presents the datasets that were utilised, their references and date of publication.

Table 2: Presentation of the datasets and available information that was utilised during the desktop study associated with this assessment.

DATASET/TOOL	SOURCE	RELEVANCE
Catchment data	DWS (2012)	Determine the regional hydrological characteristics of the site (e.g. Mean Annual Precipitation (MAP), Mean Annual Simulated Runoff (MASR), Mean Annual Temperature (MAT) and the general flow direction into, through and out of the study area.
Google Earth Pro™ Imagery	Google Earth Pro™ (2019)	Survey the current and historical imagery of the study area to determine the change in land-use practices, and thus identify potential impacts.
DWS Ecoregions (Geographic Information System (GIS) data)	DWS (2005)	Determine the characteristics of the freshwater resources within the study area.
National Freshwater Ecosystem Priority Areas (NFEPA) river and wetland inventories (GIS coverage)	Council for Scientific and Industrial Research (CSIR) (2011)	Ascertain which freshwater resources have been categorised as important and/or sensitive habitats at a national scale, and thus those that will require conservation.

DATASET/TOOL	SOURCE	RELEVANCE
National Wetland Inventory (NWI) Version 5.	SANBI (2018)	National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. This dataset was therefore used as a guideline to the location and extent of the wetlands within the study area.
Gauteng Conservation Plan Version 3.3	Gauteng Department of Agriculture and Rural Development (GDARD) (2011)	Ascertain which planning units have been categorised as critically important to maintaining, or achieving the conservation targets at a national and regional scale, and thus those that will require conservation.
South African Geological Map (GIS coverage)	Geological Survey (1988)	Determine the underlying lithostratigraphic units to extrapolate the sub-surface flow movements and the parent material of the hydric soils.
South African national land-cover (GIS coverage)	GeoTerraImage (2015)	To conduct a comparison of what is presented in the dataset against what is currently observed on-site, and thus identify potential disturbance/impacts.
Wetland Vegetation dataset of South Africa	SANBI (2011)	Determine the presumed natural hydrophilic vegetation communities within the study area to ascertain the degree to which the natural cover has been altered by change in land-use practices.

4.3 Visual Inspection

During the fieldwork, a visual investigation of the study area was conducted to identify any on site and upstream impacts, from both the surrounding land-use activities and environmental processes which may have influenced the overall health and functionality of the impacted watercourses. The impacts observed and condition of the study area were photographed, documented and related to professional experience. This essentially provided a baseline for further studies and justify the PES of the impacted watercourses.

4.4 Field Survey

A field assessment of the watercourses situated within the study area associated with the proposed development was conducted on the 5th June 2020. The primary objectives of the field survey were to; 1) verify and accurately delineate the watercourses that were deemed to be at high or medium risk of being impacted on by the proposed development, 2) record the current ecological integrity of the surrounding catchment areas by identifying disturbances and areas of degradation in relation to the reference, or natural state, 3) conduct an in-depth analysis of the PES of the at-risk watercourses and determine the potential of, and level to which, the systems supply valuable ESS to the surrounding natural and anthropogenic environments.

The watercourses were delineated in detail during the field assessment utilising the methodology and techniques outlined within the wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2008). The permanent, seasonal and temporary (outer boundary) zones of wetness were determined by infield investigation of the wetness indicators, namely (**Figure 2**):

1. The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
2. The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991-2018), which are associated with prolonged and frequent saturation.
3. The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
4. The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

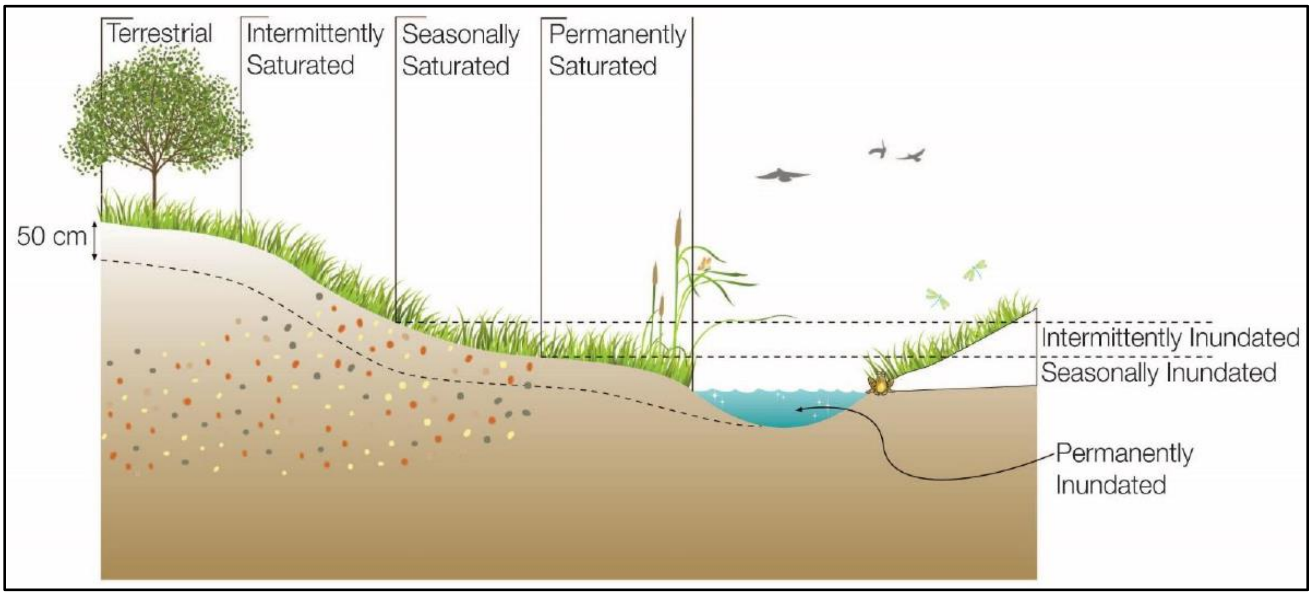

Figure 2: Illustration of the wetness zones typically present through a wetland system (Ollis *et al.*, 2013).

According to the wetland definition used in the NWA (Act no. 36 of 1998), vegetation is the primary indicator of wetness, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained. The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display.

4.5 Wetland Integrity: WET-Health Assessment

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation modules. The technique compares the presumed natural state of a wetland to the current condition observed on-site to ascertain what impacts/disturbances may have occurred within and surrounding the wetland, and thus determine the PES of the system by evaluating this in terms of the three aforementioned modules. Subsequent to determining the impacts that were recorded to have acted, or are acting, on the wetland, specific mitigation and/or rehabilitation measures can be formulated and implemented to reduce the impact with the end-goal of obtained the Recommended Management Objective (RMO) of each wetland.

There are two levels of complexity, namely: Level 1 that is used for assessment at a broad catchment level, and Level 2 which provides detailed and confident analyses of individual wetlands based on in-field survey of the three WET-Health modules. Level 1 was utilised for the assessment of the wetlands that may be impacted on by the proposed development. The following will briefly describe the three modules, followed by a presentation of the overall PES score categorisation that is used to represent the overall integrity/health of an assessed wetland.

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

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

Vegetation is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic on-site transformation and/or disturbance in comparison to the presumed natural state, or reference condition. 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 PES score.

The WET-Health tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (**Table 3**).

Table 3: Guideline for interpreting the magnitude of impacts on wetland integrity (Macfarlane *et al.*, 2009).

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9

IMPACT CATEGORY	DESCRIPTION	SCORE
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in **Table 4** below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table 4: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*., 2009).

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

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

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

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

4.6 Wetland Functionality: WET-Ecoservice Assessment

WET-EcoServices is used to assess the potential and effectiveness of a wetland at providing Ecosystem Services (ESS) (regulatory and supporting, and cultural and provisional benefits) to the surrounding anthropogenic and natural environment, thereby quantifying the value of the wetland and thus aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ESS (e.g. flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydrogeomorphic setting (e.g. floodplain or unchannelled valley-bottom wetland). ESS delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on an in-field assessment of key descriptors (e.g. flow pattern through the wetland). The tool assists the practitioner to determine what ESS are currently being supplied, and to what degree/level, and thereafter identify any threats are acting on the benefits and if/what opportunities are available for enhancing the benefits.

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ESS that they supply. This allows for more informed planning and decision making. **Table 5** overleaf presents the ESS/benefits that are utilised within the WET-Ecoservice assessment, followed by **Table 6** overleaf which illustrates the categories used to rank the ability of a wetland to provide each ESS.

Table 5: Ecosystem Services that are used in the WET-Ecoservices assessment.

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

Table 6: The classes for determining the likely extent to which a benefit is being supplied based on the overall score for that benefit (Kotze *et al.*, 2007).

SCORE RANGE (0-4)	< 0.5	0.5-1.2	1.3-2.0	2.1-2.8	> 2.8
RATING OF THE LIKELY EXTENT TO WHICH A BENEFIT IS BEING SUPPLIED	Low	Moderately Low	Intermediate	Moderately High	High

4.7 Wetland: Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) of the watercourses was determined by utilising a rapid scoring system that was developed by Rowntree (2013), which incorporates aspects of the WET-Ecoservices tool (Kotze *et al.*, 2007) and earlier DWS EIS assessment tools. The purpose of assessing the EIS of a watercourse is to identify those watercourses that are of high conservation concern, primarily as a result of their ability to provide ESS at an above average level, biodiversity function or are specifically susceptible to impacts/disturbances within the catchment area.

Water resources with a higher ecological importance may require managing such systems in a better condition than the present to ensure the continued provision of ESS in the long-term (Rowntree, 2013).

Three proposed suites of criteria for assessing the EIS of wetlands form the basis of this tool, namely (**Table 7**):

- EIS, 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 score out of the three abovementioned suites is then used to determine the overall EIS category of the wetland system (**Table 8**).

Table 7: Template used to calculate the overall Ecological Importance and Sensitivity of a wetland (Rowntree, 2013).

ECOLOGICAL IMPORTANCE AND SENSITIVITY			
Ecological Importance	**Score (0-4)**	**Confidence (1-5)**	**Motivation for site**
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rarity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			
HYDROLOGICAL/FUNCTIONAL IMPORTANCE			
IMPORTANCE OF DIRECT HUMAN BENEFITS			

ECOLOGICAL IMPORTANCE AND SENSITIVITY			
Ecological Importance	**Score (0-4)**	**Confidence (1-5)**	**Motivation for site**
OVERALL IMPORTANCE			

Table 8: Presentation of the categories used to rank the EIS of each wetland system (Rowntree, 2013).

ECOLOGICAL IMPORTANCE AND SENSITIVTIY CATEGORY	RANGE OF EIS SCORE
Very High: Wetlands that are considered ecologically important and sensitive on a **national or even international scale**. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and ≤4
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and ≤3
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and ≤2
Low/Marginal: Wetlands that are not ecologically important or sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1

4.8 Delineation of Riparian Areas

Riparian zones are described as “the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas” , Riparian zones can be thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas (**Figure 3**).

Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel. Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are: - **Landscape position**; - Alluvial soils and recently deposited material; - **Topography** associated with riparian areas; and - **Vegetation** associated with riparian areas.

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

The NWA's (Act no 36 of 1998) definition of riparian zones refers to the structure of the banks and likely presence of alluvium. A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised macro-channels, which are typical of many of Southern Africa's eastern seaboard rivers. Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area, and thus the likely presence of wetlands. Vegetation associated with riparian areas unlike the delineation of wetland areas, where redoxymorphic features in the soil are the primary indicator, the identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs: - in species composition relative to the adjacent terrestrial area; and - in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

Additional verification can be obtained by examining for any recently alluvial deposited material to indicate the extent of flooding and thus obtain at least a minimum riparian zone width. The following procedure should be used for delineation of riparian zones: A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. The macro-channel is an incised feature, created by uplift of the subcontinent which caused many rivers to cut down to the underlying geology and creating a sort of "restrictive floodplain" within which one or more active channels flow.

Floods seldom have any known influence outside of this incised feature. Within the macro-channel, flood benches may exist between the active channel and the top of the macro channel bank. These depositional features are often covered by alluvial deposits and may have riparian vegetation on them. Going (vertically) up the macro channel bank often represents a dramatic decrease in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

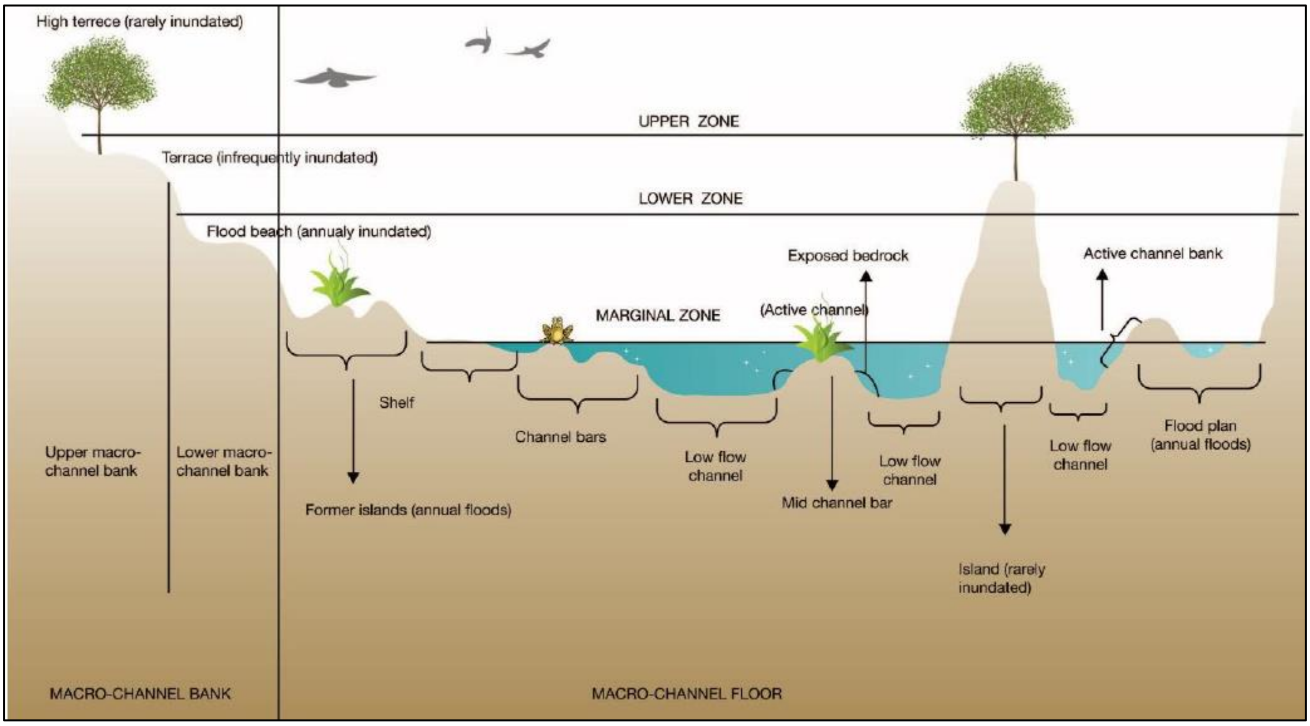

Figure 3: A schematic diagram illustrating the typical dissection of a river system (Kleynhans *et al.*, 2007).

4.9 Present Ecological State (PES) – Riverine Systems

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

The Index of Habitat Integrity, 1996, version 2 (Kleynhans, 2012) was used to obtain a habitat integrity class for the instream habitat and riparian zone. This tool compares the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state (in the absence of anthropogenic impacts). This involved the assessment and rating of a range of criteria for instream and riparian habitat scored individually (from 0-25) using **Table 9** as a guide.

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

Table 9: Category of score for the Present Ecological State (PES).

RATING SCORE	IMPACT SCORE	DESCRIPTION
0	A: Natural	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
1-5	B: Good	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.
6-10	C: Fair	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.
11-15	D: Poor	The modification is generally present with a clearly detrimental impact on habitat quality, diversity size and variability. Large areas are, however, not influenced.
16-20	E: Seriously Modified	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.
21-25	F: Critically Modified	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.

4.9.1 Ecological Importance & Sensitivity – Riverine Systems

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh, *et. al*., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (**Table 10**).

Table 10: Components considered for the assessment of the ecological importance and sensitivity of a riverine system. An example of the scoring has also been provided.

ECOLOGICAL IMPORTANCE AND SENSITIVITY ASSESSMENT (RIVERS)		
DETERMINANTS		SCORE (0-4)
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	0,0
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	2
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	1,0
	Refugia (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.0

ECOLOGICAL IMPORTANCE AND SENSITIVITY ASSESSMENT (RIVERS)		
DETERMINANTS		SCORE (0-4)
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	1,0
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	2
MEDIAN OF DETERMINANTS		1,00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		**LOW, EC=D**

The scores assigned to the criteria in **Table 10** were used to rate the overall EIS of each mapped unit according to **Table 11** below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane *et al*., 2009).

Table 11: The ratings associated with the assessment of the EIA for riparian areas.

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

4.10 Impacts and Risk Assessment Matrix (RAM) Methodology (DWS, 2016)

The following tables present and explain the scoring within the DWS required RAM for all watercourses within the 500m regulated area around a Section 21(c) and (i) water use.

Table 12a: Severity - How severe does the aspects impact on the environment and resource quality characteristics (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 the activity is located within the boundary (the temporary, seasonal or permanent zone) of the watercourse	

Table 12b: 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 12c: Duration - How long does the aspect impact on the environment and 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

Table 12d: Frequency of activity - How often do you do the specific activity?

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

Table 12e: Frequency of incident/impact - How often does the activity impact on the environment?

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 12f: 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 (within the outer edge of the 1:100yr flood line, or delineated riparian area as measured from the middle of the watercourse measured on both banks, or within a 500m radius from the outer boundary of any wetland).	

Table 12g: Detection - How quickly can the impacts/risks of the activity be observed on the environment (water resource quality characteristics), people and property?

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

Table 12h: Calculations

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

Table 12i: 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. Wetlands may be excluded.
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. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.
A low risk class must be obtained for all activities to be considered for a GA (GN509, 2016)		

5 DESKTOP ASSESSMENT

The following sections consist of information obtained during the desktop study of with the proposed development site and the surrounding terrestrial and aquatic environment. The information obtained at a desktop level was ground-truthed and used to provide input into the perceived changes that may have occurred to the presumed natural state of the at-risk watercourses.

5.1 Hydrological Setting

The study area was observed to fall within the quaternary catchment area A21C, that is within the Crocodile (West) and Marico Water Management Area (WMA) (**Figure 4**). The proposed development was recorded to traverse the Sub-Quaternary Reach (SQR) A21C-1262 (Braamfonteinspruit), which was calculated to have a Present Ecological State (PES) score falling within Class E (Seriously modified) and be of a low Ecological Importance and moderate Ecological Sensitivity within the broader catchment area (DWS, 2012). The low PES and overall ecological value of the watercourses within the SQR was attributed to the highly urbanised environment and consequent addition of stormwater and suspended and diluted pollutants that are presumably present in flow.

5.2 Ecoregion

According to the delineation provided by Dallas (2005), the level 1 ecoregion in which the study area is recorded was the Highveld ecoregion (**Figure 5**). **Table 13** below presents the primary characteristics and data that have been collected for the relevant ecoregion.

Table 13: Highveld Ecoregion attributes (Kleynhans *et al.*, 2005) (Bold indicates the most dominant attribute/s).

MAIN ATTRIBUTES	HIGHVELD
Terrain Morphology: Broad division (dominant types in bold) (Primary)	**Plains; Low Relief;** **Plains; Moderate Relief;** Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to high Relief Closed Hills. Mountains; Moderate and High Relief
Vegetation types (dominant types in bold) (Primary)	Mixed Bushveld (limited); Rocky Highveld Grassland; **Dry Sandy Highveld Grassland**; Dry Clay Highveld Grassland; **Moist Cool Highveld Grassland**; Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited)
Altitude (m a.m.s.l) (secondary)	1100-2100, 2100-2300 (very limited)
MAP (mm) (modifying)	400 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 35
Rainfall concentration index	45 to 65
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	12 to 20
Mean daily max. temp. (°C): February	20 to 32
Mean daily max. temp. (°C): July	14 to 22
Mean daily min. temp. (°C): February	10 to 18
Mean daily min temp. (°C): July	-2 to 4
Median annual simulated runoff (mm) for quaternary catchment	5 to >250

5.3 Land Use

The dominant land cover associated with the study area were recorded to be; 1) Urban residential buildings, 2) Urban school and sports ground, 3) Urban commercial buildings that is surrounded by thicket or dense bush (**Figure 6**). Subsequent to conducting a field survey it was recorded that the majority of the desktop modelled land cover classes were correct, however the extent of historic Thicket area within the Assessment radius of the study area was over presented. The remaining land cover classes delineated within SANBI (2013/14) were observed to have been an accurate representation of the broad land cover within the study area. These classes were used to guide the development of habitat classes within this study.

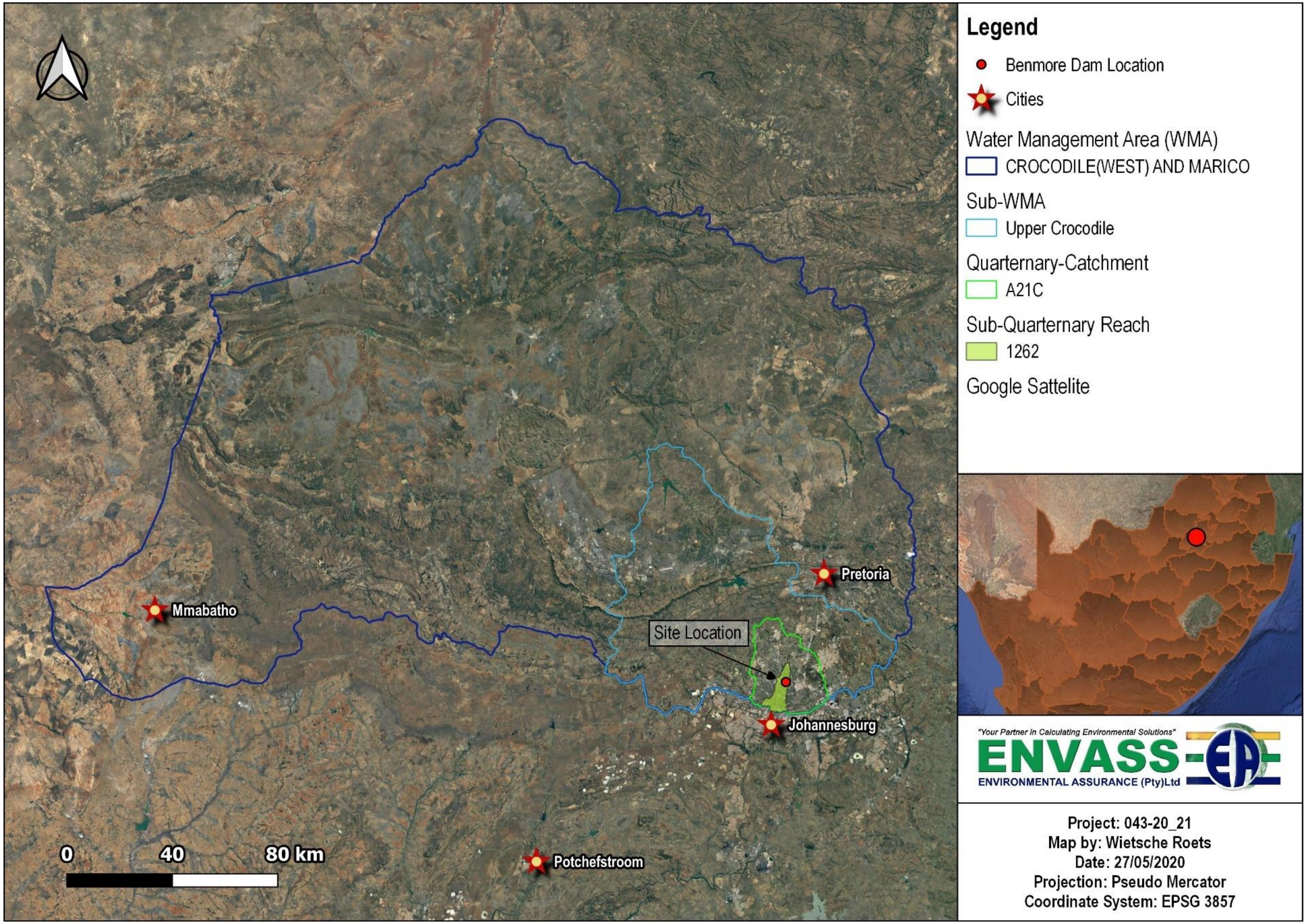

Figure 4: Illustration of the Water management Areas (WMAs) that were associated with the proposed development site (Kleynhans, 2005).

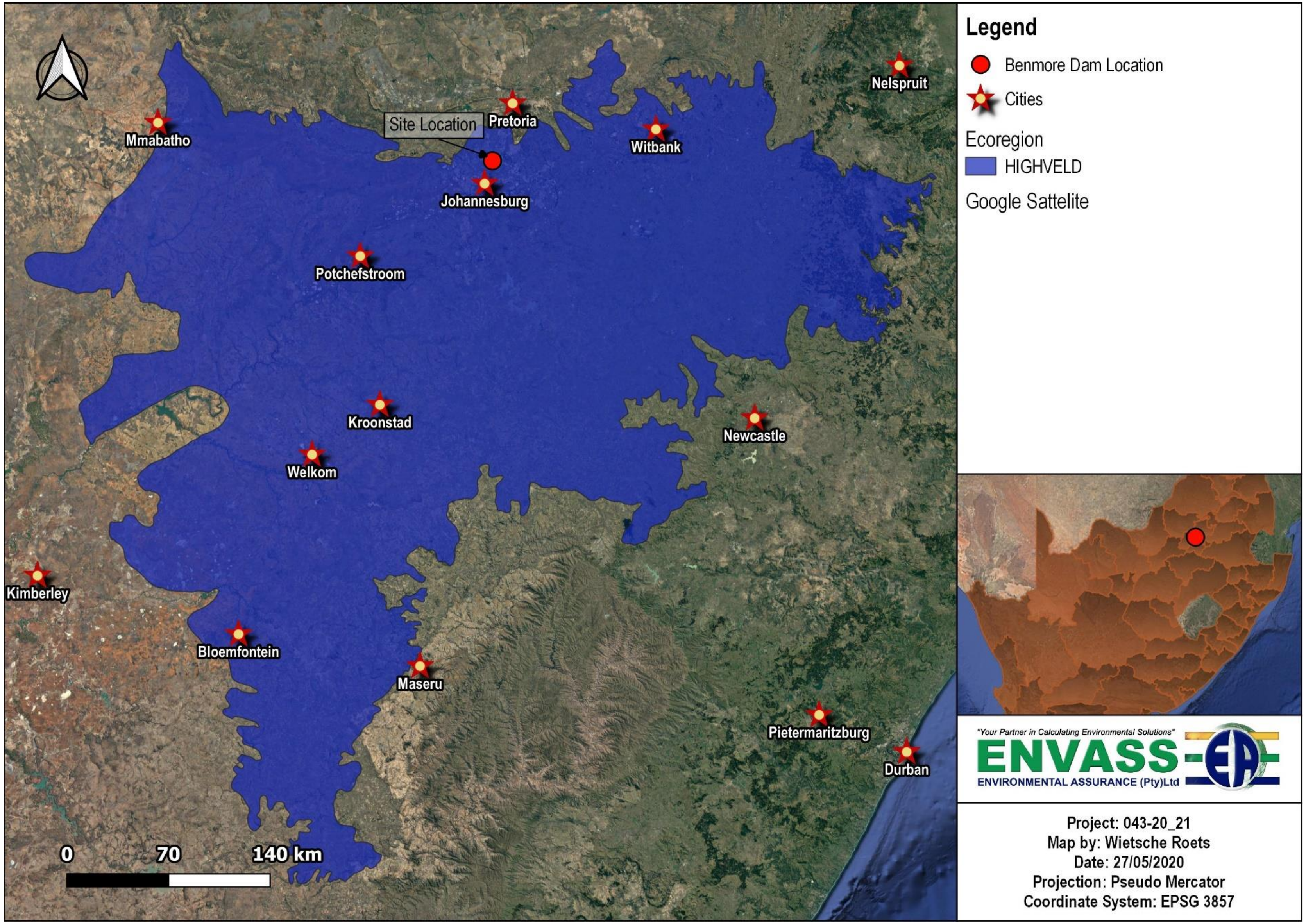

Figure 5: Ecoregion associated with the proposed development (Kleynhans, 2005).

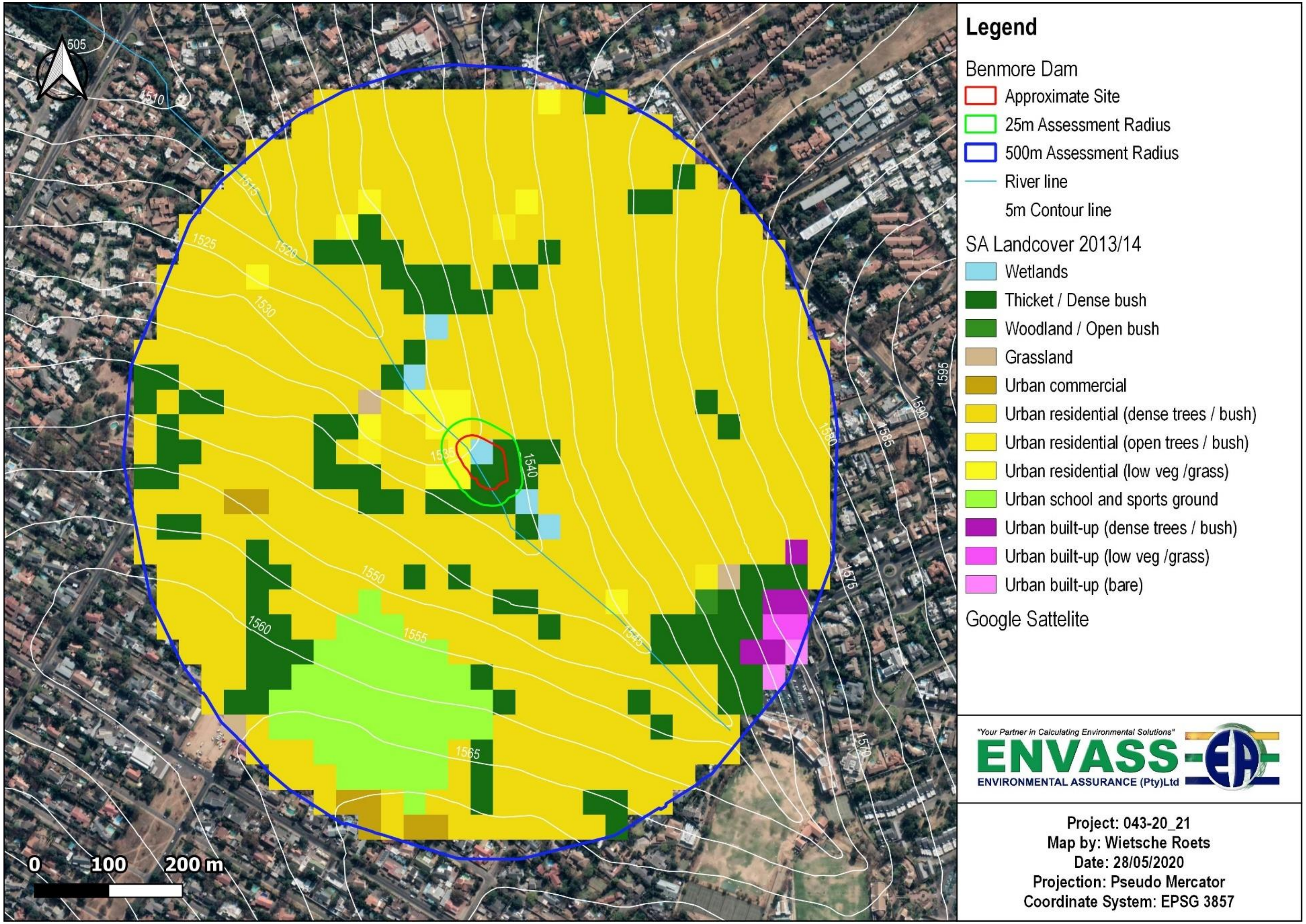

Figure 6: Land cover associated with the proposed development study area (SANBI, 2013/14).

5.4 Vegetation

Vegetation types were identified and delineated on a national scale by Mucina and Rutherford (2006), and this terrestrial vegetation delineation has since been continually modified at five (5) year intervals to account for changes in land cover. The most recent version of the dataset at the time of this study was from 2018. As this delineation was at a national scale, the vegetation dataset was used as a broad baseline against which the on-site land-cover and vegetation condition was compared to in order to determine whether changes had occurred on-site.

According to the most recent SANBI (2006-2018) delineation, the study area was recorded to extend into the Egoli Granite Grassland vegetation type (Gm10) (**Figure 7**). This vegetation type forms part of the Grassland Biome within the Mesic Highveld Grassland Bioregion and is considered to be hardly protected. The vegetation has a conservation status of endangered with only 3 % already protected on a national scale and an estimated 31.8 % of its natural extent is still remaining within SA (SANBI, 2006-18). It must however be noted that the condition of the aforementioned vegetation type was highly impacted on and degraded as the developments surrounding the study area had encroached on the overall delineated habitat boundaries, and thus this has altered the desktop delineated vegetation units.

Figure 8 below also presents the wetland vegetation (WetVeg) types that were delineated within the study area, at a national scale (Driver *et al*., 2011). The WetVeg type that was observed in the study area was the Mesic Highveld Grassland (Group 3) unit, which was categorised as critically endangered at a national scale (Driver *et al*., 2011). Remnant of this WetVeg unit was recorded on-site, however the majority of the watercourses had been invaded by Invasive and Alien Plant Species (IAPS) and pioneer species within disturbance footprints.

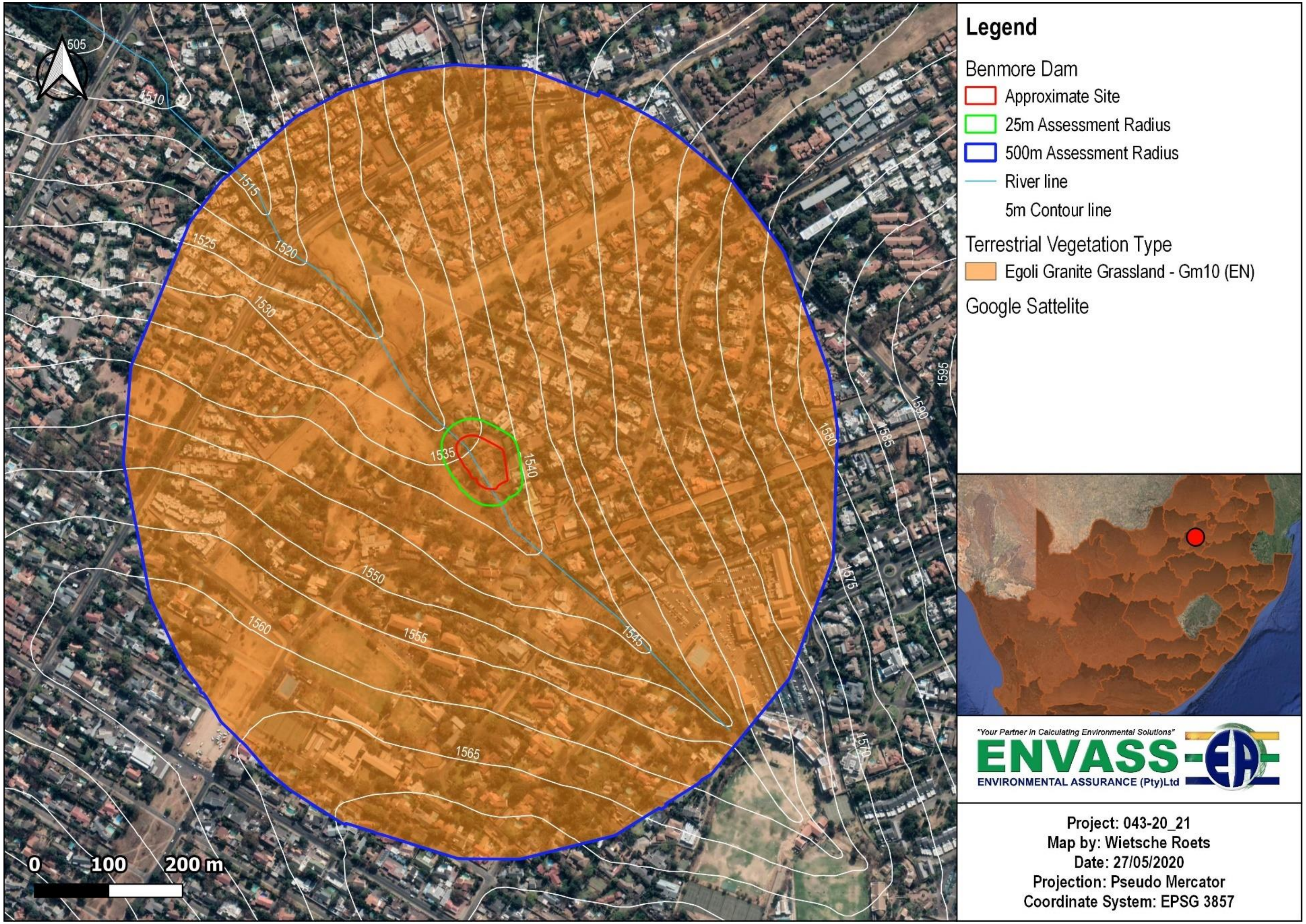

Figure 7: Terrestrial vegetation type associated with the proposed development study area (SANBI, 2006-2018).

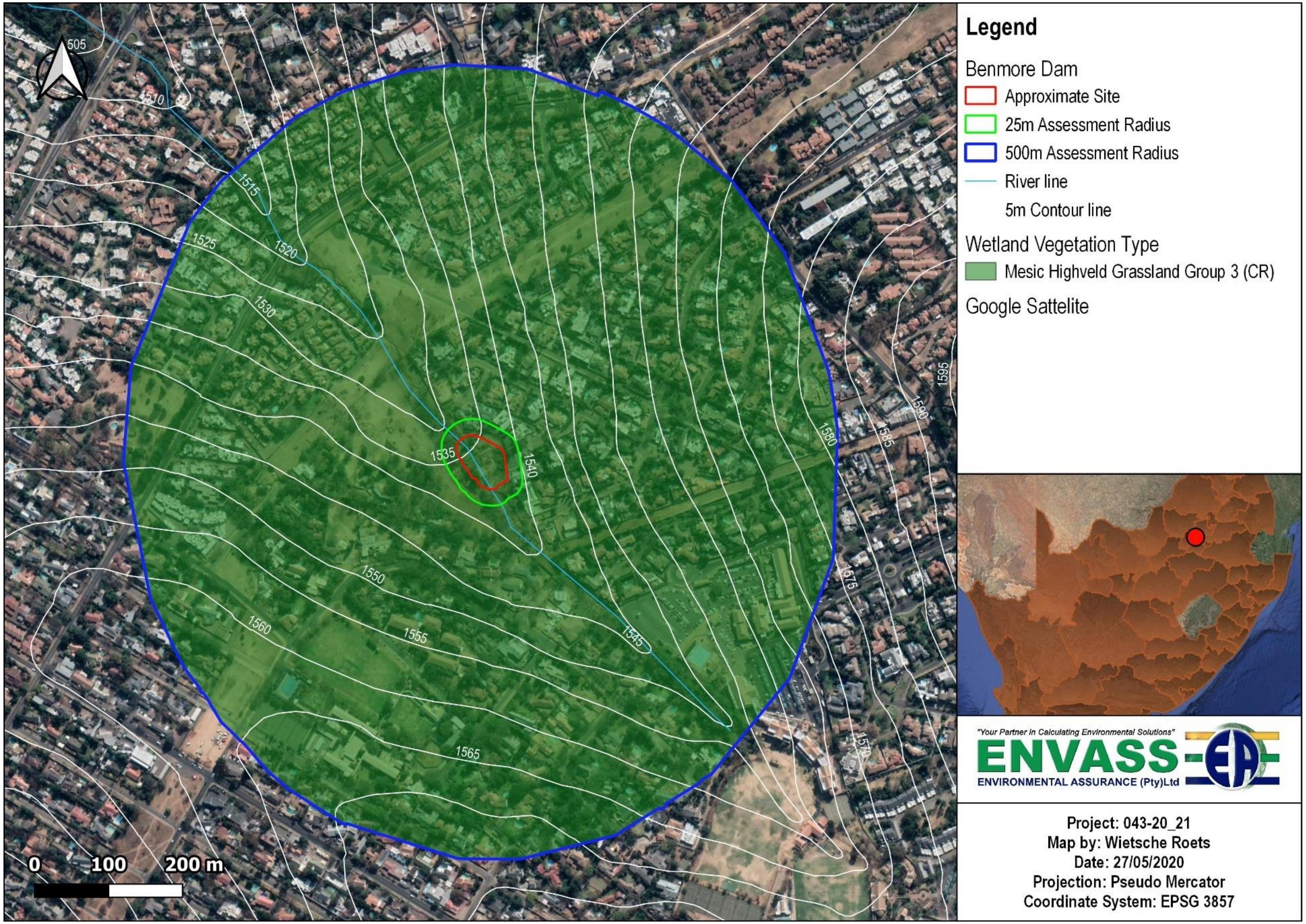

Figure 8: Wetland vegetation types relevant to the study area (Driver *et al.*, 2011) (Category= Critically Endangered).

5.5 Conservation Plan: Gauteng Province

The component of Gauteng Department of Agriculture and Rural Development (GDARD), namely Gauteng Nature Conservation, produced the Gauteng Conservation Plan Version 3.3 that was released in October 2011 (hereafter referred to as the "C-Plan"). The C-Plan was developed to provide spatial planners with knowledge of an area through a simplified guide to systematic conservation assessments. Critical Biodiversity Areas (CBA) and Ecological Support Areas (ESA) planning units were delineated to outline areas of conservation concern. CBAs are areas which are irreplaceable often providing essential habitat for particular species (GDARD, 2011). A buffer of 100 m is recommended for any proposed activities in relation to CBA. ESAs are areas which provide ecological support to CBA, offering forage or often act as movement corridors for sensitive species, these include fish sanctuaries and registered freshwater and Wetland National Freshwater Ecosystem Priority Areas (NFEPAs) (GDARD, 2011; Driver *et al*., 2011). A buffer of 30 m is often recommended for ESAs (GDARD, 2011).

It was noted that the proposed development fell within a valuable ecological corridor within a surrounding urbanised area. This corridor was recorded to have fallen within a planning unit categorised as an Important Area with sections of Ecological Support Area (ESA) surrounding it (GDARD, 2011) (**Figure 10**). This classification was recorded to accurately represent that onsite condition, and it is the specialist's recommendation that this area remain as an ecological corridor.

5.6 National Wetland Inventory (NWI) and Freshwater Ecosystem Priority Areas (NFEPAs)

The NFEPA database provides strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. NFEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (Driver *et al.,* 2011). The National Wetland Inventory (NWI) map 5 was developed to provide input into the 2018 National Biodiversity Assessment, as well as to improve the overall land-use planning and decision mapping surrounding wetland ecosystems at a national scale. Subsequent to an analysis of the NFEPA river and wetland datasets, as well as the NWI, at a desktop level and during a field assessment, it was determined that one (1) artificial NFEPA wetland was delineated within the site area, namely the Benmore Dam (**Figure 11**). According to the NWI map, a Channelled Valley-bottom (CVB) wetland and Hillslope Seep (HS) wetland were delineated within the 500 m assessment radius around the proposed development (**Figure 11**). The CVB wetland was however determined to have been a riverine environment with additional HS wetlands flowing into the primary channel. These systems are considered of high conservation importance and ecosystem service supply to the region at a national scale.

5.7 Geology and Soils

Figure 12 below illustrates the geological units that were recorded to be underlying the study area, and consequently providing the parent material from which the overlying soils were created. It was evident that the study area was underlain by a single lithostratigraphic unit, namely the Halfway House granite, which is an igneous rock formation. The aforementioned lithology forms part of the fundamental basement framework upon which the stratigraphic successions, ranging in age from the earliest Precambrian to the Phanerozoic times were laid down (Council for Geoscience, 2008).

The unit consists of granodiorite (porphyritic in places), gneiss and migmatite (Council for Geoscience, 2008). The abovementioned lithostratigraphic unit can be described as a moderate-to-highly impermeable underlying sequence, which was observed to have been very shallow in the north western portion of the study area where sections of the dome are exposed (**Figure 9**). This geological formation is paramount to the subsurface seepage that was evident on either valley flowing into the central riverine system present within the study area. Precipitation presumably flows down the exposed sections of the dome into the B soil horizon, creating redoximorphic characteristics as the moisture precipitates the iron and manganese particles out of the soil prior to reaching the impermeable underlying sequence. The subsurface flow then flows downgradient and into the stream situated at the valley bottom, which was recorded to have been underlain by a sedimentary sequence (observed in the erosion donga formed).

Subsequent to a review of the hydrologic soil properties within the study area, it is evident that Class B soil formed the material overlying the abovementioned lithostratigraphic unit. Hydrological soil Class B generally demonstrates a moderate infiltration rate with rapid permeability and excessive to well-drained drainage (Schultze, 2010). These characteristics result in a moderate inherent surface runoff potential being exhibited by the soil profile. In terms of the slope characteristics, the well-drained, recharge, soils situated at the crest of the slope will result in plentiful flow entering the downstream watercourse via the soil/bedrock interflow toward the valley bottoms.

Figure 9: Evidence of exposed Halfway House Granite in the north western corner of the study area.

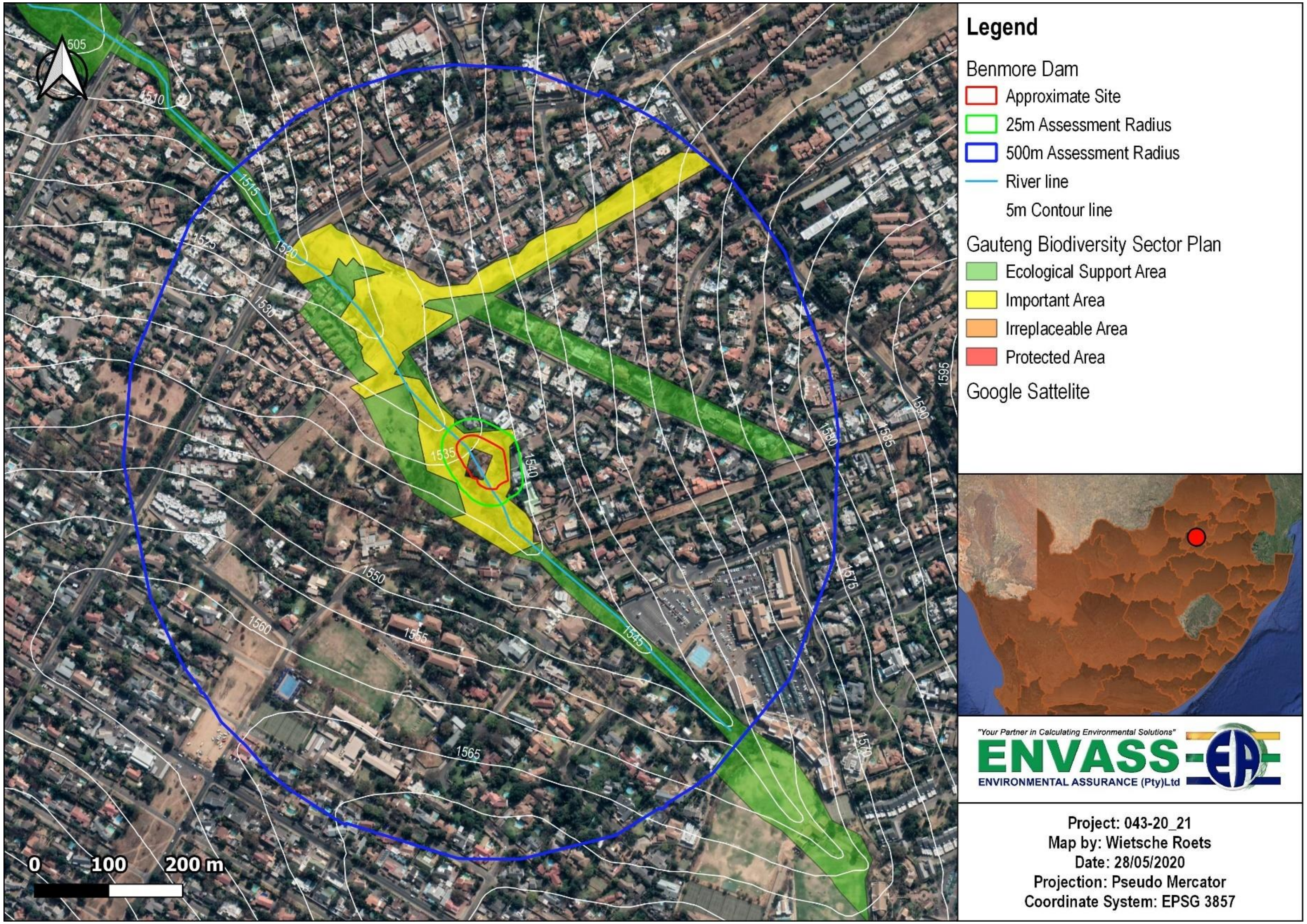

Figure 10: Systematic Conservation Planning units that were determined to be situated within the study area (GDARD, 2011).

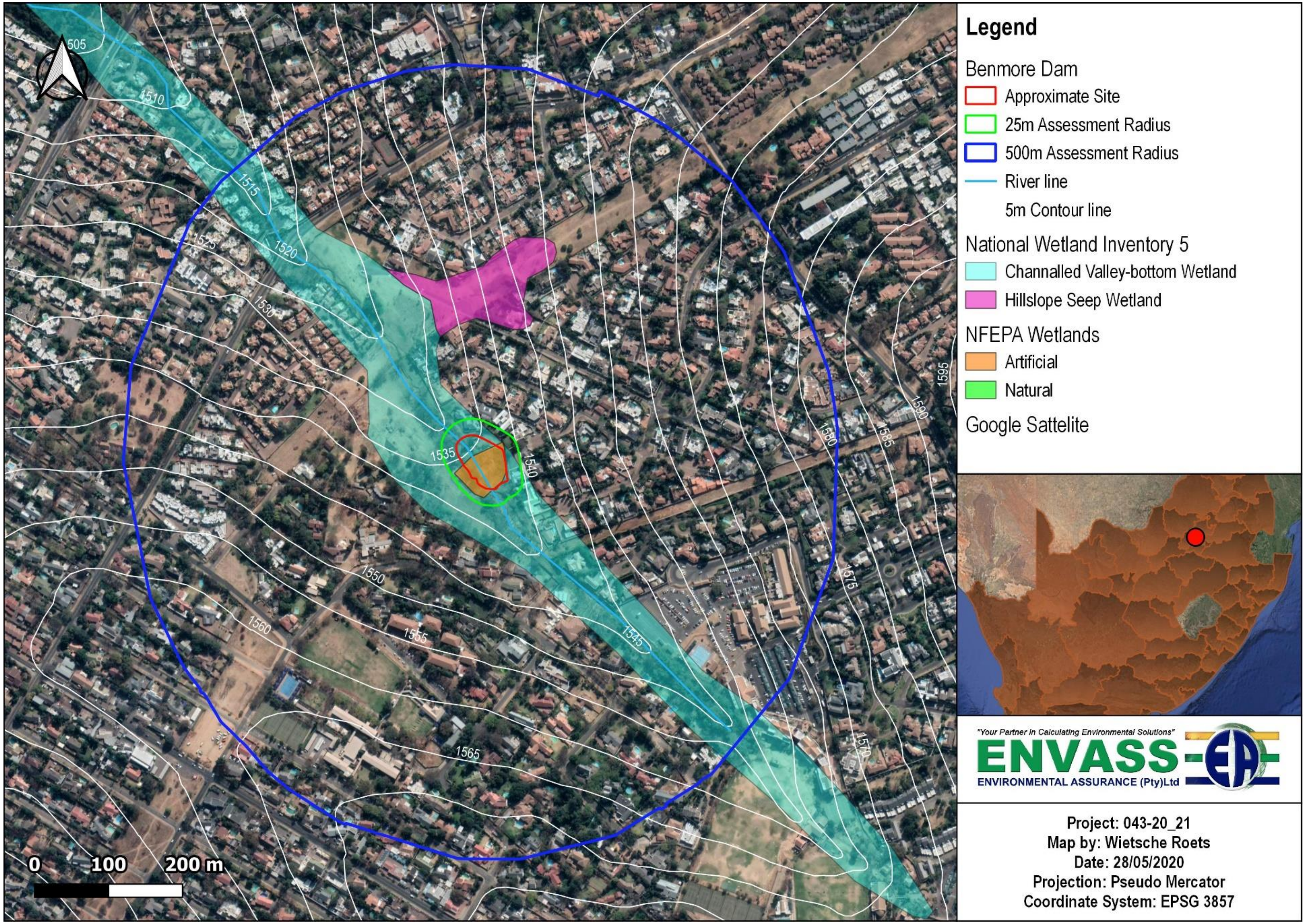

Figure 11: Illustration of the NFEPA and NWI systems that were recorded within and around the proposed development study area (Driver *et al*., 2011).

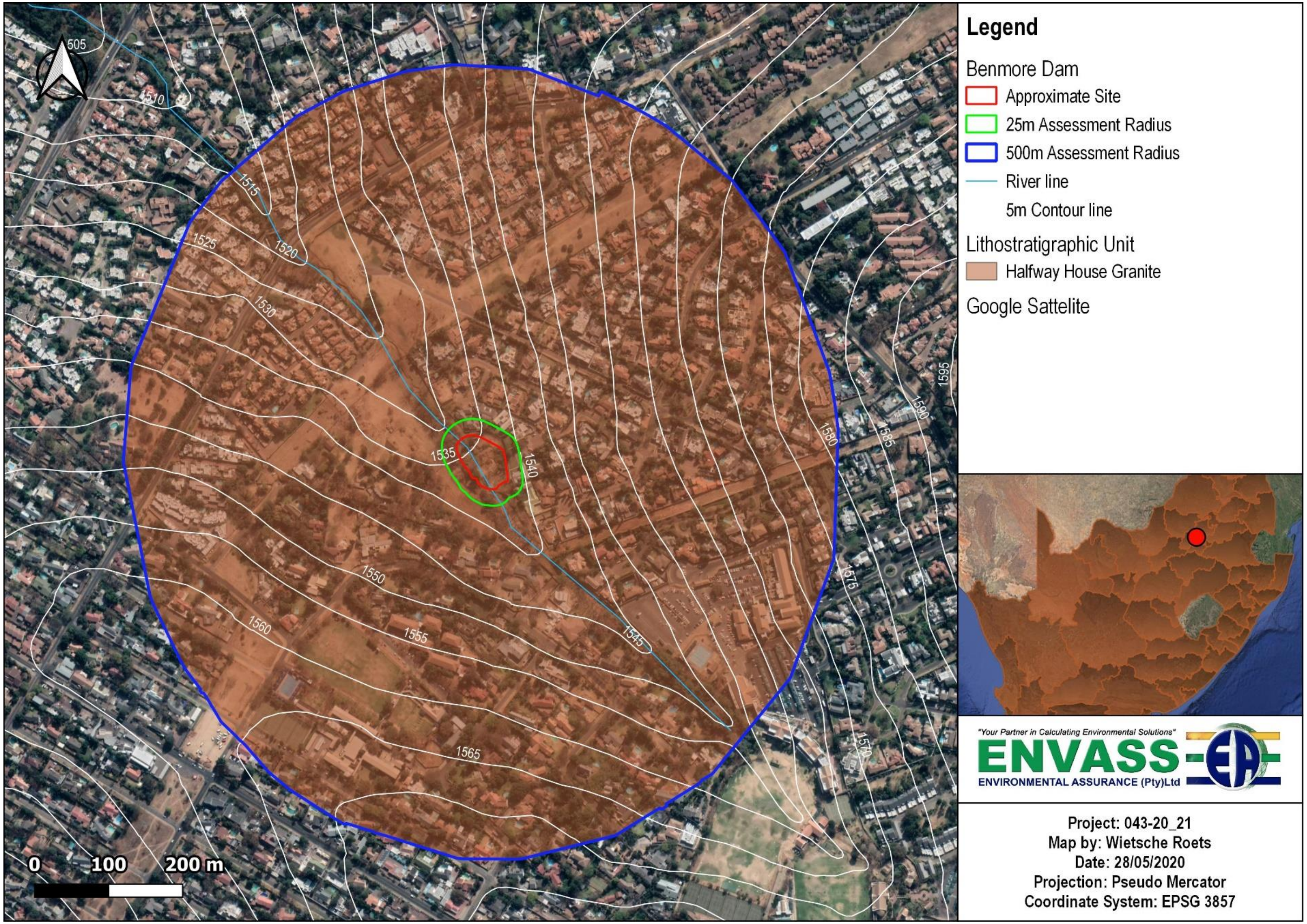

Figure 12: Geology recorded in the proposed development study area (Council for Geoscience, 2008).

6 RESULTS

The field survey associated with this study took place on the 5th of June 2020. This section provides the findings subsequent to the implementation of the various methodologies/tools utilised during this assessment.

6.1 Delineation of Watercourses

All at-risk watercourses within the study area were delineated on-site utilising the wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2008). The following sections provide descriptions of the wetness indictors that were recorded during the field survey associated with the proposed development.

6.1.1 Terrain Unit Indicator

Figure 13 below illustrates the topographic profile across two transects, namely south east to north west and south west to north east, applicable to the proposed development which is represented by the yellow polygon. The topographic profile down the stream was calculated to have an average gradient of -3.7 %, and the cross-section across the proposed development site illustrates that the site is situated within a prominent trough within the landscape, with moderately steep slopes leading into it. The south western slope into the trough was where the Halfway Granite dome was exposed within the study area. This topographic environment presents optimum conditions for subsurface seepage to slow downslope, through moderately well-drained soils, into a riverine environment at the valley-bottom.

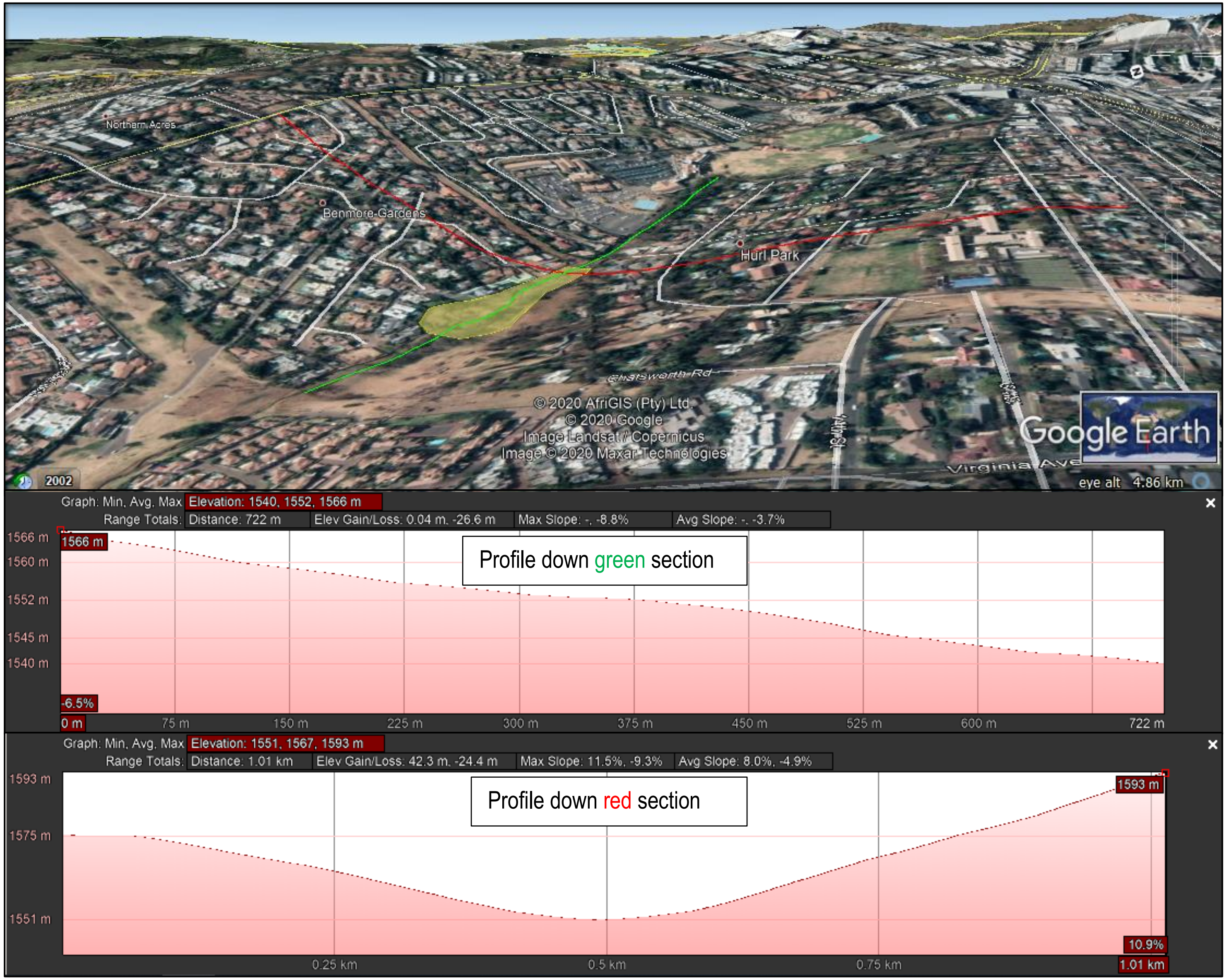

Figure 13: Topographic profiles down the two longitudinal profile applicable to the proposed development.

6.1.1.1 Soil Wetness Indicator

In practice, the soil wetness indicator is used as the primary indicator of the presence of hydric soils, and thus a wetland (DWAF, 2008). Various colour components of the soil profile provide evidence of hydric soils, which can be defined as soils that undergo repeated and prolonged period of saturation (DWAF, 2008). These components include the presence of mottling (i.e. brightly coloured streaky, or specks of iron compounds), a gleyed soil matrix (i.e. grey coloured soil) and iron or manganese concretions. It must be noted that the hydromorphic soils must exhibit signs of wetness within the top 50 centimetres (cm) of the soil profile to be classified as a wetland. These soil wetness indicators were utilised on-site to determine whether they may have been wetlands within the study area. **Table 14** below presents the various soil wetness indicators, as well as the Munsell Soil Chart values recorded within the three wetness zones of the watercourses surveyed, as well as a terrestrial sample that was collected within the study area.

Table 14: Presentation of the soil wetness indicators recorded within each zone of wetness of the watercourses delineated within the study area, as well as an image and Munsell Colour Chart description of example soil samples.

WETNESS ZONE	WETNESS INDICATORS	SOIL TEXTURE	MATRIX MUNSELL COLOUR CHART VALUES		IMAGE
			0-10CM	40-50CM	
Permanent	No permanently saturated soils were present within the study area. Alluvium was however sampled within the perennial stream channel.				
Seasonal	- >10% of matrix gleyed - High abundance of mottles - Frequently saturated	Sandy clay loam	Hue: 10YR Value: 2 Chroma: 1-2	Hue: 10YR Value: 2 Chroma: 1-2	
Temporary	- <10% of matrix gleyed - Moderate to low abundance of mottles - Saturated less then 3months per annum	Sandy Loam	Hue: 10YR Value: 4 Chroma: 1-3	Hue: 10YR Value: 4 Chroma: 1-2	

WETNESS ZONE	WETNESS INDICATORS	SOIL TEXTURE	MATRIX MUNSELL COLOUR CHART VALUES		IMAGE
			0-10CM	40-50CM	
Terrestrial	Does not exhibit any signs of wetness	Sandy loam	Hue: 10YR Value: 4 Chroma: >4	Hue: 10YR Value: 4 Chroma: >4	

6.1.1.2 Vegetation Indicator

Although the majority of vegetation encountered during the site survey was observed to have been moderately-to-highly degraded in comparison to the natural state, the floral species composition observed provided a useful guide to finding the outer boundary of the watercourses. As the zone of wetness within a watercourse changes, so does the species composition of the floral community. This provides a very helpful guide to distinguishing the potential wetness zone boundaries. It must be noted that the riverine systems within the study area contained few hydrophytes[1], and thus these delineations were primarily based on alluvial soil and deposited material. **Tables 15** and **16** below present the definitions of the various vegetation classifications used for hydrophilic plant species and the wetness zones these species are typically recorded in.

Table 15: Relationship between wetness zones and vegetation types (Adapted from DWAF, 2008).

VEGETATION CLASS	WETNESS ZONE		
	TEMPORARY	SEASONAL	PERMANENT
Herbaceous	Predominantly grass species. A mixture of species, which occur extensively in the terrestrial zone, as well as hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic sedge and grass species, which are restricted to wetland areas.	Dominated by: 1) Emergent plants, including reeds, a mixture of sedges and bulrushes that are usually >1 m tall, or 2) Floating or submerged aquatic plants.

[1] Hydrophyte: Plant species that are adapted to living in soils that are either periodically, or permanently saturated/inundated and hence are adapted to anoxic conditions.

VEGETATION CLASS	WETNESS ZONE		
	TEMPORARY	SEASONAL	PERMANENT
Woody	Mixture of woody species, which occur extensively in the terrestrial zone, as well as hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species, which are restricted to wetland areas.	Hydrophilic woody species, which hare restricted to wetland areas. Morphological adaptions to prolonged wetness (e.g. prop roots).

Table 16: Classification of plant species according to occurrence in wetland systems (Adapted from DWAF, 2008).

PLANT SPECIES TYPE	DESCRIPTION
Obligate wetland (ow) species	Almost always grow in wetlands (>99% occurrence).
Facultative wetland (fw) species	Usually grow in wetlands (67 – 99% occurrence), but occasionally found in non-wetland areas.
Facultative (f) species	Are equally likely to grow in wetlands and non-wetland areas (34 – 66% occurrence).
Facultative dry-land (fd) species	Usually grow in non-wetland areas, but sometimes grow in wetlands (1 – 34% occurrence).

Table 17 below presents the plant species that were recorded within the different wetness zones that were delineated within the study area relative to this project. These species were observed to be dominant, and thus were considered strong indicators of hydric conditions within the at-risk watercourses.

Table 17: Various plant hydrophilic plant species that were identified within the wetness zones delineated within the study area.

WETNESS ZONE	PLANT SPECIES	PLANT SPECIES TYPE
Seasonal	1. *Stenotaphrum secundatum* 2. *Pycreus polystachyos* 3. *Cynodon dactylon* 4. *Cyperus papyrus* 5. *Typha capensis*	1. Poaceae, fw 2. Herbaceous, ow 3. Poaceae, fw 4. Herbaceous, ow 5. Herbaceous, ow
Temporary	1. *Cynodon dactylon* 2. *Leersia hexandra*	1. Poaceae, fw 2. Poaceae, fw
Riparian	1. *Acacia mearnsii* 2. *Populus deltoides* 3. *Salix babylonica*	1. Woody (Alien) 2. Woody (Alien) 3. Woody (Alien)

6.1.2 Watercourse Delineation Map

The watercourses within the study area were identified on a desktop level, classified and delineated in-field and subsequently mapped utilising GIS (QGIS 2.18 and Google™ Earth Pro) and available spatial data (**Figure 14**). It must be noted that the urbanisation of the study area drastically limited the accessibility to properties for sampling and analysis, and thus although the delineation was based on soil samples and analysis in field it is assumed that the actual extent of the flood line and hillslope seepage wetlands delineated along the north eastern and south western banks of the riverine environment are in fact mush greater. Evidence of the subsurface seepage was visually observed within the yards of the properties situated adjacent to the proposed development site. In addition to this, interviews with the local residence confirmed that issues with subsurface flow have been evident in the area, which have caused cement wall collapse at properties directly adjacent to the proposed development site. Although this evidence was presented, the delineated depicted in **Figure 14** was based on evidence gathered using the various wetness indicators, in accordance with DWAF (2008).

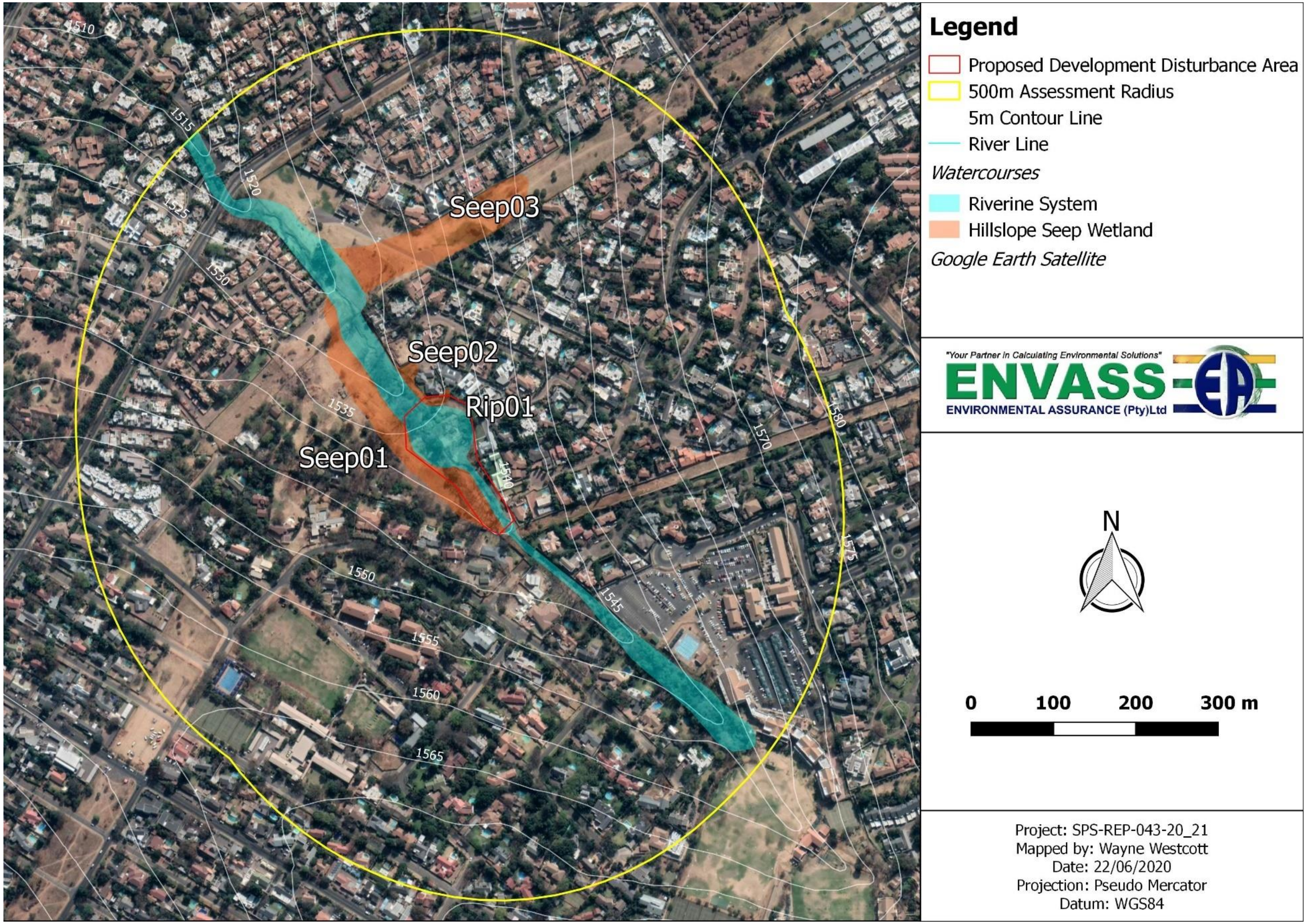

Figure 14: Map illustrating the watercourses delineated within the study area associated with the proposed development.

6.1.3 Watercourse Classification

To allow for in-depth system-specific analysis to occur within this study, the various watercourses that were delineated within the study area were classified in accordance with the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*., 2013). The classification system uses six tiers to differentiate between each system at a fine scale, namely: level 1- broadest spatial scale (marine, estuarine or inland systems), level 2- regional setting (i.e. NFEPA WetVeg unit), level 3- landscape unit, level 4- Hydrogeomorphic (HGM) unit, level 5- hydrological regime and level 6- descriptors (Ollis *et al*., 2013). For the purpose of this study the watercourses were classified to level 5, however descriptions of their hydrological regimes and other characteristics are elaborated on in the sections to follow. It must be noted that as a result of all the systems within the study area being classified as inland at level 1, **Table 18** below begins at level 2.

Table 18: Presentation of the classification of each watercourse to level 5 of Ollis *et al.* (2013).

<table>
<tr><th rowspan="2">No</th><th rowspan="2">LEVEL 2: REGIONAL SETTING</th><th rowspan="2">LEVEL 3: LANDSCAPE UNIT</th><th colspan="3">LEVEL 4: HGM UNIT</th><th colspan="2">LEVEL 5: HYDROLOGICAL REGIME</th></tr>
<tr><th>A- HGM Unit</th><th>B- Longitudinal Zonation/Landform</th><th>C- Landform/ Inflow Drainage</th><th>A- Perenniality /Inundation</th><th>B- Non-perennial subgroups /Saturation</th></tr>
<tr><td>A</td><td rowspan="2">WetVeg: Mesic Highveld Grassland Group 3 (CR)</td><td>Slope</td><td>RIV</td><td>Transitional Zone</td><td>Active and Riparian Zones</td><td>Perennial</td><td>N/A</td></tr>
<tr><td>B</td><td>Slope</td><td>HS</td><td>Without channelled outflow</td><td>N/A</td><td>Unknown</td><td>Seasonally</td></tr>
</table>

KEY: CR- Critically Endangered, HS- Hillslope Seep and RIV- River/Stream.

Based on the classification system described in **Table 18** and the delineation map (**Figures 14**) above, **Table 19** below present the watercourses that were delineated within the study area and subsequently classified according to Ollis *et al.* (2013).

Table 19: Classification of the delineated watercourses according to Table 18 and their extent within the study area.

CLASSIFICATION	HGM UNIT CODE	EXTENT IN STUDY AREA (ha)
A	Rip01	2.69
B	Seep01, Seep02 and Seep03	0.99 + 0.10 + 1.10 = 2.19
TOTAL EXTENT OF WATERCOURSES IN THE STUDY AREA (ha)		**4.88 ha / 76 ha (6.4 %)**

6.1.4 At-risk Watercourses

Based on the in-field watercourse delineation and the activities associated with, as well as the location of the watercourses in relation to, the proposed development the risk categories were determined for each HGM unit. There are several factors that must be considered in determining whether and to what degree a watercourse may be impacted on by activities associated with a specific proposed development. These factors, among others, include: 1) type of watercourse, 2) position of the watercourse within the landscape in comparison to the proposed development and associated infrastructure, 3) surface and sub-surface hydrological flow regime and 4) other land-use practices within the minor catchment area. **Table 21** below presents the risk category that was determined for each HGM unit based on the criteria described in **Table 20**, and the total extent of watercourse that may be directly impacted on as a result of the proposed development. This extent was calculated using the disturbance KML file that was provided by the design engineer as an overlay onto the delineated watercourses. Only the watercourses that were determined to be of medium-to-high risk of being impacted on by the proposed development were assessed further during this study using the legislated tools.

Table 20: Presentation of the risk categories used to analyse the delineated watercourses within the study area.

RISK CATEGORY	CRITERIA
High	The watercourse is situated directly within or in close proximity to the proposed development footprint. Therefore, the aquatic habitat, biota present within, water quality of and/or the hydrological regime through the watercourse are highly likely to be impacted on by aspects of the proposed development.
Medium	The watercourse is situated directly upstream, or within a medium distance (32m to 50m) downstream of the proposed development within the same minor catchment area. This may result in the aquatic habitat, biota present within, water quality of and/or the hydrological regime through the watercourse being indirectly impacted on by aspects pertaining to the proposed development (e.g. sedimentation, pollution and/or a change in the hydrological characteristics of the system).
Low	The watercourse/wetland is situated a significant distance (>50m) upstream or downstream of the proposed development, or within a landscape that prevents any direct/indirect impacts that have been determined to originate from the activity from reaching it, and thus is not likely to be impacted on by the proposed development.

Table 21 below presents the risk screening results of this study. Only those watercourses determined to be of medium or high risk of being impacted on by the proposed development will be assessed further within this assessment.

Table 21: The risk categories of each HGM unit and the extent (ha) of watercourse within the proposed development footprint.

HGM UNIT CODE	RISK RATING	COMMENT
Rip01, Seep01 and Seep02	**High**	All three watercourses were situated within the disturbance footprint polygon.
None	**Medium**	No Systems of Medium Risk.
Seep03	**Low**	This system was situated approximately 0.19 km downstream, and upslope, of the proposed development.

6.2 Current Impacts within the Minor Catchment Area

The following were land uses and anthropogenic pressures that were observed to have impacted on the watercourses associated with the proposed development:

- Point-source and sheet stormwater flow;
- Overgrazing by livestock;
- Dam construction as well as other impeding features (e.g. pathways and roads);
- Urban developments; and
- Existing servitudes (i.e. fencing, powerlines and pipelines).

6.3 Wetland Systems: Present Ecological State

The assessment of the condition or PES of the HGM units that were delineated within the study area is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and the structure and composition of hydrophilic floral species. WET-Health works by comparing a wetland in its current state with a natural/reference condition (Macfarlane *et al*., 2009). The following section provides a discussion of the PES scores determined for the at-risk watercourses.

6.3.1 Hillslope Seepage Wetland

Definition: A wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material downslope (Ollis *et al*., 2013). These wetlands are usually driven by subsurface flow inputs and interflow through-flow, which are characterised by their association with the underlying geological lithologies and topographic position. **Figure 15** illustrates a diagram of a typical Seepage wetland system within the greater stream network.

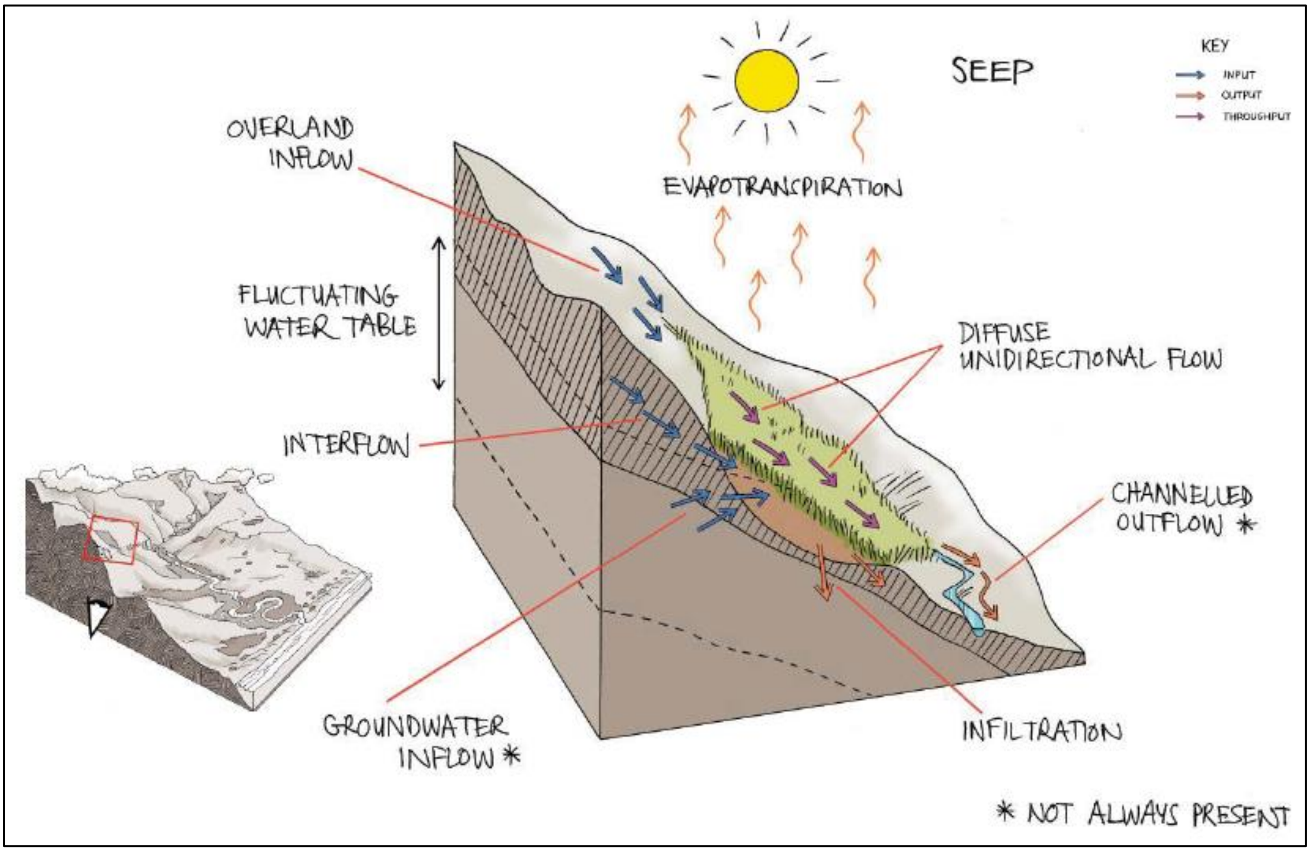

Figure 15: A typical Seepage Wetland System (Ollis *et al.*, 2013)

6.3.1.1 Natural vs Current State

As the WET-Health assessment technique was based on a comparison between the wetland systems natural and current state it was imperative to define both in terms of the three different WET-Health modules (i.e. hydrology, geomorphology and vegetation). **Table 22** below presents the presumed natural and recorded current state of the Seepage wetlands that were delineated within the study area. **Figure 16** overleaf illustrates the condition of the Seepage wetland systems assessed during the field survey.

Table 22: Description of the natural and current state of the three WET-Health assessment modules relevant to the Depression wetlands within the study area.

SEEPAGE WETLANDS		
MODULE	**NATURAL STATE**	**CURRENT STATE**
Hydrology	System dominated by subsurface diffuse flow with inputs from lateral surface flow and a fluctuating water table atop an impermeable igneous rock layer. The presence of wetness zones depends on the systems position on the slope.	Systems dominated by subsurface seepage, however various excavation and infill events has created a drawdown/abstraction effect in pits and hardened surfaces causing altered surface runoff in areas of infill. The excessive hardened surfaces and vegetation

		clearing/cutting within the upstream catchment area has also already the hydrological regime into the systems.
Geomorphology	Moderate gradient down slope with no erosion within the system. Cohesion of soil particles assisted by good groundcover and soils with a moderately high organic content.	Moderate to high gradient slopes with areas of slight erosion and hillslope slumping evident. Degradational systems with reduced soil particle cohesion. Infill events in sections impeding the flow of sediment downstream.
Vegetation	100 % native vegetation dominated by a mixture of obligate wetland plants, hydrophilic poaceae species and sparsely distributed woody vegetation.	Changes in land-use practices within the catchment areas (i.e. natural grassland to urban and gardens) have resulted in the encroachment of several IAPS (e.g. *Acacia mearnsii*, *Bidens pilosa* and *Solanum mauritianum*). Overgrazing directly within Seep01 and Seep02 has resulted in the systems being dominated by pioneer and ruderal weeds.

6.3.1.2 Current PES Score

The overall PES scores of the at-risk Seepage wetland systems, namely; Seep01 and Seep02, were both calculated to fall within health Class D (Largely modified), which indicated that the systems had undergo moderate to large changes in ecosystem processes and loss of natural habitat and biota (**Table 23**).

Table 23: Presentation of the current Present Ecological Scores (PES) that were calculated for the at-risk seepage wetland systems.

WET-HEALTH SCORES				
HGM UNIT	**HYDROLOGY**	**GEOMORPHOLOGY**	**VEGETATION**	**OVERALL SCORE**
Seep01	4.0 (D) ↓	3.1 (C) ↓	5.7 (D) ↓	**4.2 (D) Largely Modified**
Seep02	6.0 (E) ↓	4.6 (D) ↓	5.7 (D) ↓	**5.5 (D) Largely Modified**

KEY: ↓: State is likely to deteriorate slightly over the next five (5) years (Macfarlane *et al*., 2009).

Figure 16: Illustrations of the onsite condition of the Hillslope Seepage wetland and evidence of their presence.

6.4 Wetlands Systems: Ecosystem Service Delivery and Functionality

The at-risk Seepage wetland systems were calculated to have the potential to supply the following ESS to the surrounding anthropogenic and natural environments at a moderately high level; flood attenuation, phosphate trapping, nitrate and toxicant removal, with Seep01 providing erosion control to a moderately high degree (**Table 24**). As a result of the largely degraded state of the systems, their ability to provided several ESS that would've been provided to a high degree in their perceived natural states has diminished. These would've included *inter alia*; stream flow regulation, further erosion control, maintenance of biodiversity and carbon sequestration. The primary disturbances that have hindered the at-risk systems from providing these services has been the degradation of the floral composition and overall hydrological regime shift that has occurred in the upstream catchment, predominantly as a result of the hardened surfaces and channelled stormwater flow throughout the area. Although this is the case, the systems, specifically Seep01, were determined to have a moderately high opportunity to be rehabilitated to near natural state provided that the land uses within the systems are governed and maintained as open conservation space.

Table 24: Presentation of the ecosystem services that the at-risk wetland systems were calculated to supply, or have the potential to supply, the surrounding environments.

WET-ECOSERVICES				
ECOSYSTEM GOODS AND SERVICES	**Seep 01**	**CLASS**	**Seep 02**	**CLASS**
Flood attenuation	2.1	**MH**	2.1	**MH**
Streamflow regulation	1.5	**I**	1.5	**I**
Sediment trapping	1.1	**ML**	0.8	**ML**
Phosphate trapping	2.5	**MH**	2.2	**MH**
Nitrate removal	2.8	**MH**	2.7	**MH**
Toxicant removal	2.3	**MH**	2.1	**MH**
Erosion control	2.1	**MH**	1.8	**I**
Carbon sequestration	0.7	**ML**	0.7	**ML**
Maintenance of biodiversity	1.9	**I**	1.4	**I**
Water supply for human use	0.9	**ML**	0.4	**L**
Natural resources	0.8	**ML**	0.0	**L**
Cultivated foods	0.0	**L**	0.0	**L**
Cultural significance	0.0	**L**	0.0	**L**
Tourism and recreation	0.4	**L**	0.1	**L**
Education and research	1.0	**ML**	0.8	**ML**

KEY: MH- Moderately High, I- Intermediate, ML- Moderately Low, L- Low (Kotze *et al*., 2007).

6.5 Wetland Systems: Ecological Importance and Sensitivity

The at-risk Seepage wetland systems that were assessed within the study area were calculated to be ecologically important and sensitive at a national and regional scale (**Table 25**). This can be attributed to the presence of remnant floral species of the critically endangered WetVeg type, Mesic Highveld Grassland (Group 4), and the HS wetland within this WetVeg group also being classified as critically endangered. The systems were also recorded to be acting as significant ecological corridors within the surrounding urban area and providing refugia to faunal species within the hydrophytic vegetation species. **Table 25** below that the at-risk systems were calculated to be of moderate importance in terms of their ability to provide ecological and functional/hydrological ESS, however all were calculated to be of a low importance at supplying direct ESS to the surrounding anthropogenic environment. This was as a result of their degraded state, which has the potential to be rehabilitated to a state more conducive to a highly level of ESS provision.

Table 25: Presentation of the ecological importance and sensitivity that was calculated for the at-risk wetland systems within the study area.

SUMMARY	SEEP01		SEEP02	
	Score	Rating	Score	Rating
Ecological Importance	2.60	High	2.40	High
Functional/Hydrological Importance	1.89	Moderate	1.74	Moderate
Direct Benefits to Society	0.52	Low	0.22	Low
Overall Importance and Sensitivity	**2.60**	**High**	**2.40**	**High**

RANGE: Very High- >3<4, High- >2<3, Moderate- >1<2 and Low: >0<1 (Rowntree, 2013).

6.6 Riverine Systems: Present Ecological State

According to the analysis conducted using the Ollis *et al.,* (2013) classification system, the at-risk riverine system that was categorised as being of high risk of being impacted on by the proposed development fell within the Transitional longitudinal zonation, as well as within the Highveld ecoregion. This longitudinal zonation is characteristic of a system that is of moderate gradient, which in the case of Rip01 was calculated to have been 3.7 %, within a semi-confined valley with a low diverse habitat availability. However, it must be noted that the natural channel of Rip01 was observed to have been formalised (concreted) in the reach upstream of the proposed development, presumably to reduce the erosion within the system. This however altered the natural base level of the stream and consequently created niched points for undercutting and lateral displacement of energy to occur, as well as channel incision downslope which was exasperated by the increased flow velocity created by the concreted surface. The section to follow will present the riverine system PES score calculated using the Index of Habitat Integrity (IHI) tool (Kleynhans *et al.,* 2012), as well as the aquatic biota scoring that was determined for two (2) sites along the assessed reach, one upstream and the other downstream of the proposed development, using SASS5 (Dickens & Graham, 2002). **Table 26** below provide the general system characteristics that fed into the aforementioned assessments.

Table 26: Presentation of the characteristics associated with the Rip01 system.

ATTRIBUTE	DESCRIPTION
Longitudinal Zone	**Transitional Zone**
At-risk HGM Unit	Rip01
Flow Type	Perennial 'C' Channel Stream (predominantly as a result of stormwater input)
Hydrological Setting	Sub-WMA: Upper Crocodile Sub-Quaternary Reach: A21C- 1262
Channel Dimensions	Macro channel: 1.5 – 3.5 m; Active channel: 1.0 – 2.0 m; Estimated depth in flow: 0.1-1.0 m
Wetland Vegetation Type	Mesic Highveld Grassland Group 4 (Critically Endangered)
Instream Habitat	Dominated by a coarse sand substrate presumably eroded and transported from the upstream catchment area, as well as from within the historic Benmore Dam basin as a result of the dam wall breach allowing excess sediment to enter the downstream system. The assessed reach upstream of the proposed development was recorded to have been formalised into a concrete channel. Very little floral species were evident, aside from poaceae and cyperus species recorded to have proliferated along the fringe of the channel.
Riparian Habitat	The riparian zone of the Rip01 system was dominated by IAPS, namely; *Poplar deltoides, Salix babylonica and Acacia mearnsii*, that were presumably planted there for aesthetic purposes. Other IAPS that were recorded to have encroached into the zone were *Solanum mauritianum, Lantana camara and Canna indica*. A total of six (6) indigenous woody species were identified within the zone (ENVASS, 2020). The flood extent was recorded to be extensive towards the south of the site where the gradient levels, indicated by debris and alluvial deposits. These areas were included into the riparian zone, as per the DWAF (2008) delineation guideline. A small amount of fringe vegetation was available to be sampled using the SASS5 methodology, however these species were limited to cyperus and poaceae.

Figure 17 overleaf illustrates the general condition of the at-risk Rip01 riverine habitat that was assessed in-field during this study.

Figure 17: Illustration of the current condition of the Rip01 riverine system.

6.6.1 At-risk Rip01 Riverine System

Table 27 below presents the PES results calculated for the Rip01 riverine system, which was calculated using the IHI tool (Kleynhans *et al*., 2012). The instream and riparian zone PES scores were calculated to be 57.56 % and 49.40 %, respectively, which both fall within PES Class D (Largely modified). The primary factors that were recorded to have influenced the natural state of these systems were the alteration of the catchment hydrological flow regime, which consequently impacted on the flow, bed and bank characteristics, removal of indigenous vegetation and significant encroachment by several IAPS, specifically *Acacia mearnsii* and *Solanum mauritianum*.

Table 27: Presentation of the Index of Habitat Integrity (IHI) Assessment scores that were calculated for the Rip01 stream.

PRESENT ECOLOGICAL STATE SCORE: RIP01			
CRITERION	**WEIGHTING**	**AVERAGE**	**SCORE**
INSTREAM ZONE			
Water abstraction	14	9	5.04
Flow modification	13	18	9.36
Bed modification	13	16	8.32
Channel modification	13	16	8.32
Water quality	14	11	6.16
Inundation	10	9	3.60
Exotic macrophytes	9	1	0.36
Exotic fauna	8	1	0.32
Solid waste disposal	6	4	0.96
		TOTAL INSTREAM IHI	**57.56 % (Class D)**
RIPARIAN ZONE			
Indigenous vegetation removal	13	10	5.20
Exotic vegetation encroachment	12	16	7.68
Bank erosion	14	16	8.96
Channel modification	12	12	5.76
Water abstraction	13	9	4.68
Inundation	11	9	3.96
Flow modification	12	18	8.64
Water quality	13	11	5.72
		TOTAL RIPARIAN IHI	**49.40 % (Class D)**

6.6.2 SASS5 Ecological State

To gauge the baseline aquatic macroinvertebrate population present within the at-risk Rip01 system, single upstream and downstream sites along the assessed reach were sampled using the SASS5 aquatic biomonitoring methodology (Dickens & Graham, 2002). To guide the aquatic macroinvertebrate discussion, the aquatic habitat availability within each assessed reach was calculated using the Integrated Habitat Assessment System (IHAS) (McMillan, 1998) and several water quality variables were measured at each site. The SASS5 results of the assessment were interpreted using the Highveld (upper) ecoregion percentiles, as calculated and presented in Dallas (2007). **Table 28** below presents the upstream and downstream results applicable to this study.

The following observation were made when comparing the upstream to downstream site:

- The water quality at the upstream site was recorded to have been considerably worse than the downstream site, with EC and TDS both being 53 % higher at the downstream site in comparison to upstream. The pH at the upstream site was also observed to have been slightly more acidic than the upstream site, which can presumably be attributed to a higher concentration of salts and decreased carbonates in solution. The improved water quality at the downstream site was presumed to be as a result of the silt within the historic Benmore Dam basin acting as a filtration mechanism. Evidence of iron precipitation (filtered) was visually observed on the surface of the dam.
- The habitat availability at each site was very similar, with the upstream site having slightly more fringe vegetation and diversity in depth class available for sampling in comparison to downstream, which was dominated by shallow sand instream.
- The same number of species were identified at each site, however slightly more sensitive species in the Coleoptera family were collected from the downstream site. This was attributed to the improved water quality, as well as no formalised channel being situated, within the downstream reach. The more pollution sensitive species present downstream resulted in the ASPT being 24 % higher downstream, however this did not change the EcoStatus which was determined to fall within a Class E/F (Seriously modified) at both sites.

Table 28: Presentation of IHAS, SASS5 and overall Ecostatus of the upstream and downstream sites.

SITE	pH	EC (uS/cm)	TDS (mg/l)	IHAS (%)	NO. OF TAXA	SASS5 SCORE	ASPT	ECOSTATUS
Upstream	6.85	948	616	47	6	16	2.67	E/F
Downstream	7.15	443	287	46	6	21	3.50	E/F

KEY: EC- Electrical Conductivity, TDS- Total Dissolved Solids, IHAS- Integrated Habitat Assessment System, ASPT- Average Species per Taxa.

6.6.3 Riverine System: Ecological Importance and Sensitivity

The EIS of freshwater habitats is an expression of the importance of the water resource for the maintenance of biological diversity and ecological functioning on local and wider scales, whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). **Tables 29** below present the EIS scores that were calculated for the at-risk riverine system, namely: Rip01.

The Rip01 system was calculated to be of moderate EIS in the surrounding anthropogenic environment. Although the diversity of biota within the system was recorded to have been low the ecological corridor and buffer zone the riverine environment provides within the urban area was considered of importance on a regional scale. This was mirrored by the value that was placed on the system by GDARD, whom delineated it as an Important Area in terms of conservation planning units. This watercourse formed an integral component of the broader catchment network within a severely altered anthropogenic environment, and should thus be conserved. According to Kleynhans (2007) streams with a moderate EIS are observed to have a relatively high number of aspects which can be influenced by alterations to the hydrological regime, or changes to water quality.

Table 29: Presentation of the Ecological Importance and Sensitivity (EIS) results obtained for the at-risk non-perennial riverine systems situated within the Transitional longitudinal zonation.

RIP01	
DETERMINANTS	**SCORE 0-4**
BIOTA (RIPARIAN & INSTREAM)	
Rare & endangered (range: 4=very high - 0 = none)	0.0
Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	0.0
Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	0.0
Species/taxon richness (range: 4=very high - 1=low/marginal)	1.0
RIPARIAN & INSTREAM HABITATS	
Diversity of types (4=Very high - 1=marginal/low)	2.0
Refugia (4=Very high - 1=marginal/low)	2.0
Sensitivity to flow changes (4=Very high - 1=marginal/low)	1.0
Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	2.0
Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	4.0
Importance of conservation & natural areas (range: 4=very high - 0=very low)	4.0
MEDIAN OF DETERMINANTS	**1.50 (Moderate EIS)**

6.7 Recommended Management Objectives

Utilising the overall PES and EIS scores that were calculated for the at-risk wetland and riverine systems and interpreting them using **Table 30**, the Recommended Management Objectives (RMO), or Recommended Ecological Category (REC), were determined.

The relevant RMOs are presented in **Table 30** using the HGM codes, as per the labels presented in **Figure 14**. The relevant RMOs can be achieved by implementing the mitigation and/or rehabilitation measures presented within this report and the project-specific Environmental Management Programme (EMPr).

Table 30: Interpretation of the recommended management objectives for wetland and river systems (DWAF, 2007).

			ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)			
			Very High	**High**	**Moderate**	**Low**
PRESENT ECOLOGICAL STATE (PES)	**A**	**Pristine**	A Maintain	A Maintain	A Maintain	A Maintain
	B	**Natural**	A Improve	A/B Improve	B Maintain	B Maintain
	C	**Good**	B Improve	B/C Improve	C Maintain	C Maintain
	D	**Fair**	C Improve	C/D Improve **Seep01 & Seep02**	D Maintain **Rip01**	D Maintain
	E/F	**Poor**	D Improve	E/F Improve	E/F Maintain	E/F Maintain

6.8 Buffer Zone Determination

Buffer zones are defined as a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another (DWA, 2005). Due to the increasing stress from anthropogenic pressures impacting on the ecological condition of freshwater resources throughout South Africa it is vital that measures to prevent further degradation be implemented. Thus, buffer zones can play a meaningful role in reducing impacts to aquatic resources and, in doing so, protect the ecosystem services they provide the communities and ecosystems which surround them. The following points summarise the essential importance of the implementation of relevant buffer zones, these include;

- Maintaining basic ecosystem services and aquatic processes.
- Reducing impacts on water resources from adjacent land-use practices and upstream activities.
- Providing habitats for fauna and flora, including rare and endangered, species.
- Meeting life need requirements for aquatic and semi-aquatic species.
- Providing several ancillary societal benefits.

Buffer zones for all the at-risk riverine and wetland systems within the study area were determined using the Buffer Zone Guideline Tool by Macfarlane & Bredin (2016), which was drafted for the Water Research Commission and the national DWS. **Table 31** below presents the calculated buffer zones that must be applied to all at-risk riverine and wetland systems within the study area.

It must however be noted that although the below presented and illustrated buffer zones were calculated based on on-site analyses, applicable legislation must be consulted to determine the exact buffer zone requirements. The furthest buffer must be applied to each at-risk watercourse.

As a result of the proposed development being constructed directly within Rip01 and a portion of Seep01, the buffer zones will not apply to direct construction. However, it is strongly recommended that these be applied to all associated infrastructure, stockpiling etc. No ablution facilities, washing of vehicles, stockpiling, waste dumping (organic or artificial), site camps and any other activities which may be detrimental to the health and functionality of the freshwater resources are to take place within the buffer zones. Any unauthorised, or potentially detrimental activities, which occur in the direct vicinity, or upstream, of the freshwater resources should be rehabilitated according to the site EMPr and preventative or mitigation strategies. As a precautionary measure, the buffer zones that were calculated for the at-risk HGM units were also applied to the remaining watercourses within the study area.

Table 31: Presentation of the calculated buffer zones that should be implemented during the construction and operational phases associated with the proposed development.

SYSTEMS	CONSTRUCTION PHASE (m)	OPERATIONAL PHASE (m)
Seep01, Seep02 & Seep03	24	15
Rip01	30	15

Figures 18 overleaf illustrates the proposed construction phase buffer zones that must be implemented for all freshwater resources within the study area.

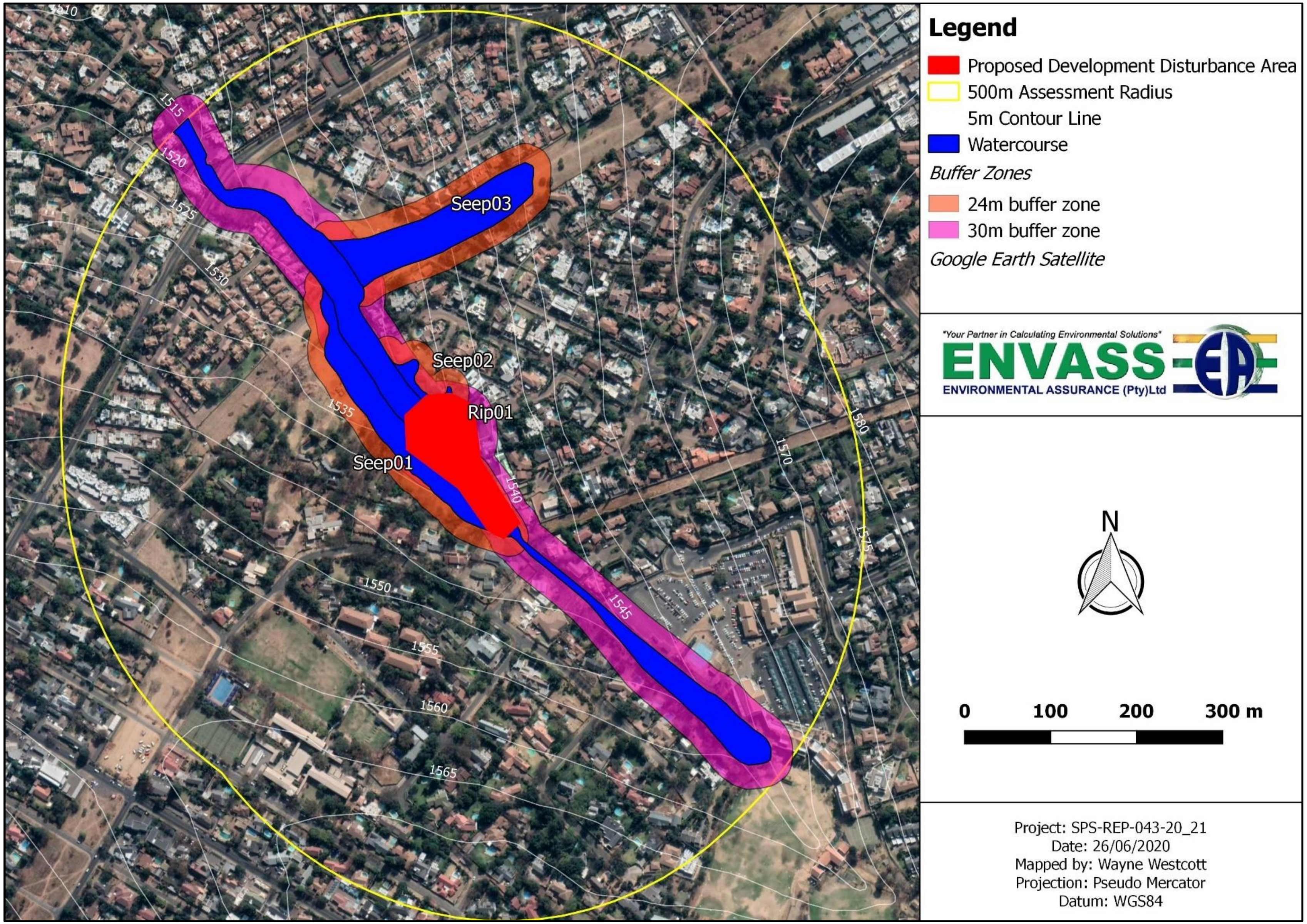

Figure 18: Illustration of the construction phase buffer zones calculated for the at-risk systems within the study area (Black arrow- flow direction).

6.9 Risk Assessment Matrix (DWS, 2016)

The significance of the perceived impacts associated with the proposed development on the receiving aquatic environment were assessed using the DWS Risk Assessment Matrix (RAM) (DWS, 2016). This assessment was conducted by considering the activities and the associated perceived impacts that were to take place during the pre-construction, construction, rehabilitation and operational phases of the proposed development. The activities were analysed according to their impact on various drivers and responses, of which the following were the primary: flow regime, biota, physicochemical water quality and habitat (geomorphology and vegetation). When evaluating the perceived impacts of the proposed activities on the at-risk watercourses, the impact significance was ascertained assuming that the recommended mitigation measures will be implemented in order to reduce the impact significance. Thus, the impact assessment provided in this report presents the perceived impact significance *post*-mitigation.

Table 32 presents a summarised Risk Assessment Matrix (RAM), which was adapted from the DWS (2016) RAM. The full RAM can be made available from ENVASS on request. In cases where a specific aspect associated with an activity has been calculated to be of moderate significance pre-mitigation (see 'risk rating' column), there may be an opportunity to reduce the significance to low with the implementation of the mitigation measures presented under **Section 7** if the initial significance score is below 80 in **Table 32**. The mitigation measures presented in **Section 7** must be implemented to reduce the borderline low/moderate aspects to a low significance rating (i.e. ≤55).

Table 32: Summary Risk Assessment Matrix of the proposed development (DWS, 2016).

	Activity	Aspect	Impacts	Severity	Consequence	Likelihood	Significance	Risk Rating	Borderline Low/Moderate
Pre-Construction Phase	Establishment of the site camp and the erection of temporary stores, offices, workshops and ablution facilities within previously disturbed land.	*Increase in surface-area of hardened surfaces.*	Potential encroachment by Invasive and Alien Plant Species (IAPS); Potential destruction of native and/or indigenous plant species; Disruption to soil profile and consequent creation of excess sediment; Compaction of the soil profile; Removal of potential natural resources and culturally significant species; Alteration to the physicochemical properties of the downstream systems.	1.00	3.00	10	30.00	**Low**	N/A
		Clearing and grubbing		1.25	3.25	8	26.00	**Low**	N/A
		Potential application of herbicide to clear land.		1.25	3.25	9	29.25	**Low**	N/A
		Accidental spilling of waste and/or potentially harmful pathogens into the environment.		1.25	3.25	8	26.00	**Low**	N/A
		Construction vehicle activities.		1.50	3.50	12	42.00	**Low**	N/A
	Demarcation of buffer zones and no-go areas and the creation of spoil sites (topsoil separate from subsoil), waste	*Erection of silt fencing around all spoil sites and waste dumps (including coverage).*	Disruption of the soil profile, and thus creation of excess sediment; Potential disturbance to native and/or indigenous plant species; Aesthetic and potentially noise disturbance within the area;	1.00	3.00	9.00	27.00	**Low**	N/A
		The dumping of waste and spoil		1.25	4.25	11	46.75	**Low**	N/A

	Activity	Aspect	Impacts	Severity	Consequence	Likelihood	Significance	Risk Rating	Borderline Low/Moderate
	dump sites and construction vehicle routes.	*at the designated sites using haulage routes.*							
		Input of dropper or wooden poles to extend danger tape or paint for easy identification.		1.00	3.00	8.00	24.00	**Low**	N/A
	Construction vehicle movement within the study area, but outside of the delineated watercourses and their associated buffer zones.	*Movement of construction vehicles over loose soil particles.*	Alteration of the soil profile permeability by continuous compaction, thus changing the surface flow regime downslope; Creation of excess sediment, which may suffocate hydric floral species and alter the water quality if it enters the downstream systems; Reduction of the water quality of the downstream systems.	1.25	3.25	12	39.00	**Low**	N/A
		Different terrestrial soil structures baring excess weight.		1.25	3.25	12	39.00	**Low**	N/A
		Accidental spills (e.g. hydrocarbons, chemicals, cement, asphalt etc.) outside of watercourses.		1.25	3.25	10	32.50	**Low**	N/A
Construction Phase	Rehabilitation of existing Benmore Dam site.	*Temporary diversion of the stream via cofferdam or berms.*	Removal of sediment from suspension, and thus increased creation of increased velocity and	2.00	5.00	8	40.00	**Low**	N/A

	ACTIVITY	ASPECT	IMPACTS	SEVERITY	CONSEQUENCE	LIKELIHOOD	SIGNIFICANCE	RISK RATING	BORDERLINE LOW/MODERATE
		Excavation to bedrock within the stream to an approximately average depth of 2m for foundations.	erosion potential downslope; Direct excavation and thus disturbance of instream, riparian and wetland habitat; **Positive Impacts:** Formalisation of the current erosion area and reduction of excess sediment travelling downstream;	5.00	8.00	10	80.00	**MOD**	**Low**
		Construct spillway: Infill material, compact surface and pour concrete into the Spillway shutters, as well as the sidewalls and chutes.		5.00	12.00	11	132.00	**MOD**	*Cannot be remediated to Low*
		Lay outlet/scour pipe, concrete plinth, aprons and chute.		5.00	8.00	9	72.00	**MOD**	**Low**
	Inundation of an estimated extent of 1.02 ha of watercourse (i.e. portions of Rip01, Seep01 and Seep02).	*Flooding of currently un-inundated portions of Rip01 and Seep01.*	Inundation of portions of riverine and wetland habitat; Potential for below environmental flow release requirements impacting on downstream aquatic habitat; Disruption of movement of fauna downstream of proposed development.	5.00	9.00	12	108.00	**MOD**	*Cannot be remediated to Low*
		Controlled flow release downstream.		5.00	10.00	12	120.00	**MOD**	*Cannot be remediated to Low*
		Impediment to faunal migration.		1.25	5.25	9	47.25	**Low**	N/A

	ACTIVITY	ASPECT	IMPACTS	SEVERITY	CONSEQUENCE	LIKELIHOOD	SIGNIFICANCE	RISK RATING	BORDERLINE LOW/MODERATE
			Positive Impact: Creation of open space dam for faunal species to inhabit and to provide aesthetic appeal to surrounding land-users.						
Post-construction Phase	Implementation of slope stabilisation mitigation measures.	*Construction of retaining walls and gabion structures.*	**Positive Impact:** Stabilisation of the potential erosion surface and containment of the sediment; Increased surface rough and thus reduce surface-runoff velocity downslope; Partial remediation of the cut and fill activities.	1.00	3.00	8	24.00	**Low**	N/A
		Install geotextiles (e.g. geojutes) on slopes greater than 1:1.75m.		1.75	3.75	9	33.75	**Low**	N/A
		Reshape and revegetate the impacted terrestrial slopes.		1.75	3.75	9	33.75	**Low**	N/A
	De-establishment of site camp, spoil sites, waste dumps etc. and rehabilitate temporary access/haulage roads	*Tillage of areas of bare-soil and revegetate with a mixture of indigenous grass and woody tree species.*	**Positive impacts:** Increase surface roughness and reduce the velocity of the surface runoff; Decrease erosion potential; Increase biodiversity; Remove all potential contaminants; Reinstate natural topography.	1.75	3.75	9	33.75	**Low**	N/A
		Reshape local topography to natural slope		1.75	3.75	9	33.75	**Low**	N/A

	ACTIVITY	ASPECT	IMPACTS	SEVERITY	CONSEQUENCE	LIKELIHOOD	SIGNIFICANCE	RISK RATING	BORDERLINE LOW/MODERATE
	Use of the proposed development.	*Increased human presence.*	With increased presence of humans comes the risk of littering and the harvesting of indigenous floral species; **Positive Impacts:** Reduced flooding of downstream properties as a result of the proposed development; Creation of an open space that will improve the biodiversity of the area and encourage faunal inhabitation.	1.00	3.00	8	24.00	Low	N/A
		Stormwater control mechanism.		1.00	3.00	8	24.00	Low	N/A
		Open space.		1.00	3.00	8	24.00	Low	N/A

6.10 Impact Statement

In summary, the proposed development is assumed to involve the excavation of the currently degraded dam site to bedrock, the reshaping of the basin to the required dimensions and the inundation of the entire basin behind a spillway, of which the designs were not provided to the ENAVSS specialist. A siltation pond will form part of this and will be directly connected to the primary dam site. Based on this simplified explanation of the proposed development, the following aspects were calculated to be the most significant impacts in a post-mitigation state:

- The excavation, infill and subsequent formalisation of un-inundated portions of Rip01, Seep01 and Seep02; and
- Construction of a permanent flow barrier within Rip01, which will consequently alter the sediment capacity and quantity of flow to downstream aquatic habitats.

As a result of the abovementioned aspects not having the potential to be mitigated to a low significance rating in a post-mitigation state, the proposed development will **not** fall within the ambit of a General Authorisation (GA) in terms of DWS GN No. 506, published within GG no. 40229 of 2016, but will instead need to be subject to a full WULA processes. Regardless of this, the applicant must implement all mitigation and rehabilitation measures presented within this report and the project-specific EMPr. Cognisance of the cumulative impact of the siltation of the proposed development site must be had and accounted for during the design and operational phase of this proposed development.

7 MITIGATION AND/OR REHABILITATION STRATEGY

The NEMA (Act no 107 of 1998), specifies the following under Chapter 1, Section 2(4) regarding sustainable development and the management of sensitive ecosystems:

(**a**), "Sustainable development requires the consideration of all relevant factors including the following:

- (i) That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- (ii) that pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- (vi) that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised;
- (vii) that a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions; and
- (viii) That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied."

(**r**) Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

Therefore, to encourage the above to become a reality the precautionary principle was applied within this study to ensure that cost-effective measures are implemented to proactively prevent degradation of the region's water resources and terrestrial biodiversity and the social systems that depend on these ecosystems and habitats. To further guide the preservation of the at-risk watercourses and terrestrial habitats within the study area, the mitigation hierarchy was applied (**Figure 19**). Its application is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity (DEA, 2013). **With regard to the proposed development, it is envisioned that the activity will fall within the Rehabilitation hierarchical category. Although the aspects will involve the inundation of portions of wetland and aquatic habitats, it is assumed that the open space site will provide valuable ESS to the surrounding natural and anthropogenic environment, if rehabilitation efforts are strictly implemented and monitoring, which will sufficiently remediate the direct impacts on the currently severely degraded site.**

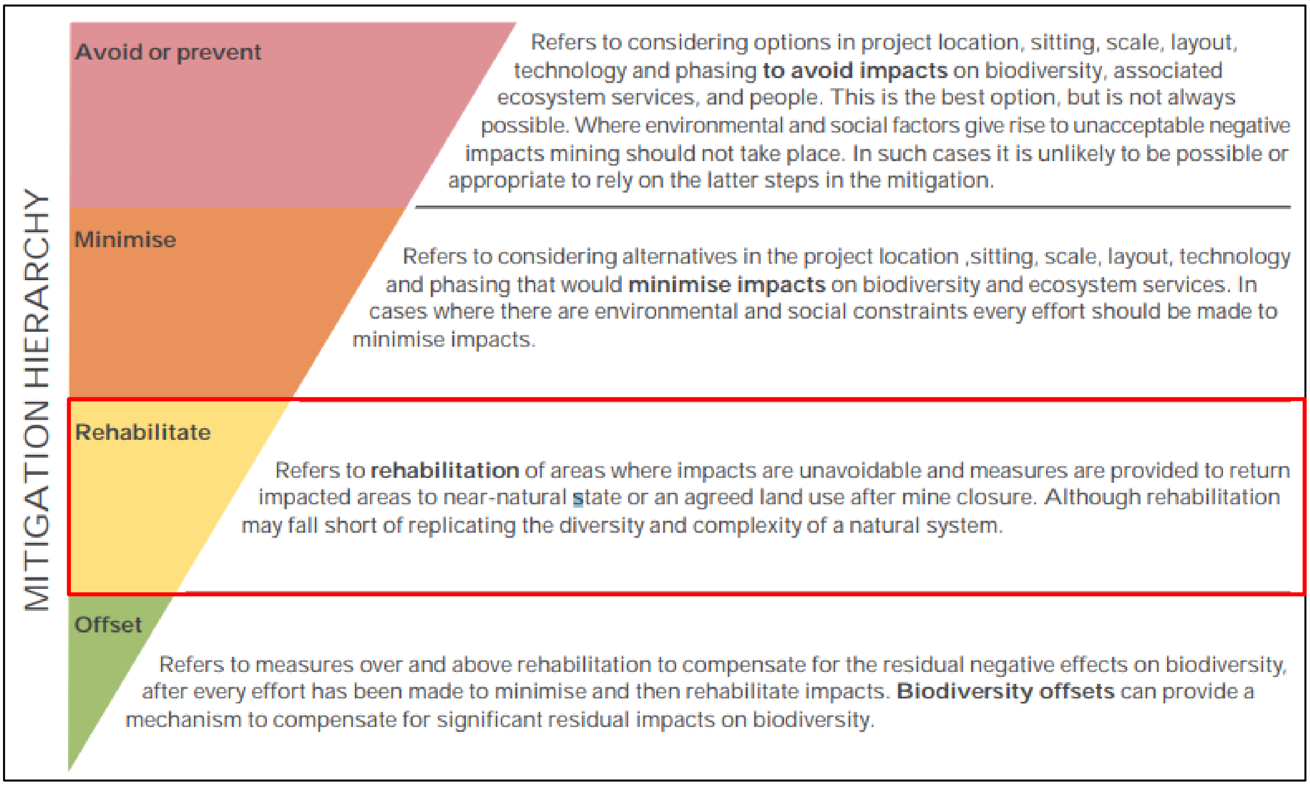

Figure 19: The mitigation hierarchy for dealing with negative impacts on biodiversity (DEA, 2013).

The following sections will present the recommended mitigation and/or rehabilitation measures that must be included in the project-specific EMPr document and may be considered by the DWS and GDARD/DEA case officers for inclusion in the project WULA and EA.

7.1 Design Phase

Development Layout

- A stilling basin, or reno mattress should be incorporated into the design downstream of the primary spillway. Flow dissipators should be included to reduce flow velocity during storm events.
- The proposed development must stay within the existing disturbed footprint of the dams as far as reasonably possible to avoid direct impacts from occurring to the surrounding watercourses.
- The spillway associated with the primary dam must be situated within the existing dam wall footprint to avoid further alterations occurring to the baselevel, which may have cumulative impacts on the downstream aquatic habitats.
- The base of the spillway must be placed on the current stream bed to avoid alteration to baselevel and reduce the risk of undercutting and scouring occurring downstream.
- Low flows must be taking into consideration when designing the spillway and chutes. It will be imperative that constant flow be fed to downstream aquatic habitats. To guide this process, the high and low flow environmental flow requirements must be calculated for Rip01, which must be used to allow for adequate flow to downstream systems.

- The sediment pond envisioned to be connected to the primary dam site must be constructed within the existing footprint of the small farm dam which is situated at 26° 05' 31.22" S, 28° 02' 37.38" E to avoid further direct disturbance of Seep01.
- The access/haulage route to the proposed development site should be from Muscovy Road, which is the shortest paved route to site, to avoid the wetland systems surrounding the watercourse. If this will not be possible, the required Section 21(c) and (i) water uses must be applied for to access the sites from the north west, presumably over Seep01. A single access route over Seep01 should be laid and created with an artificial surface, or wooden planks to avoid direct contact between construction vehicles and the watercourse surface. The strict rehabilitation of the access route must be included in a detailed Rehabilitation, Landscaping and Monitoring Programme that must be drafted for the entire project. **It must be stated that the option of access across Seep01 is not recommend and all other avenues should be investigated prior to this decision being made.**

Stormwater Management

- An in-depth Stormwater Management Plan (SWMP), which must be driven by a risk-averse approach, must be drafted for all aspects of the proposed development and over different hydrological cycles.
- No stormwater must be attenuated outside of the proposed development site.
- All stormwater infrastructure within the site must contain flow dissipation structures/measures, as the reduced groundcover within the study area is prone to high velocity surface wash that may encourage preferential flow-paths from forming, and thus rill/gully erosion occurring.
- No stormwater infrastructure must be directed directly into a watercourse, but instead towards a section of vegetated land, or flow dissipators, adjacent to the watercourse.

Site Layout

- Stockpiles and topsoil storage areas must be situated outside of the calculated watercourses and their associated buffer zones, or the 1:100-year flood lines. The furthest threshold must be adhered to. They must be positioned in previously disturbed areas to reduce the overall impact on biodiversity. Erosion control measures including silt fences, low soil berms and/or shutter boards must be put in place around the stockpiles to limit sediment runoff from stockpiles.
- Hazardous material storage areas must not be within 50 m of any watercourse or within the 1:100-year flood line. The furthest threshold must be adhered to. Hazardous storage areas to be hard surfaced and bunded with an impermeable liner to protect groundwater quality and undercover. The bunded area catch pit must have at least 110% the storage capacity of the total stored quantity. Only the volume of hazardous materials required for the project may be temporarily stored.
- All delineated watercourses and other no-go areas (buffer zones) must be demarcated with danger-tape and dropper poles to ensure that site works and external parties do not traverse within the no-go areas.

7.2 Construction Phase

Site-specific

- Temporary diversion of the stream must ensure that consistent pre-development flow is delivered to the downstream systems during construction. No upstream ponding must occur as a result of diversion measures.
- Sediment traps must be places directly downslope of all open excavation areas. No earthen berms must be constructed within the delineated watercourses.
- Where mechanically possible, all movement of construction vehicles within the delineated watercourses and their associated buffer zones must take place on an artificial surface (i.e. HDPE) or wooden planks.
- The base of the spillway must be on the same level as the current stream bed to avoid elevation of the baselevel.
- To attract biodiversity to the site and remove nutrient and toxicants from the waterbody, it is recommended that a floating wetland be developed for the proposed development site. This will need to be guided by a suitably qualified wetland ecologist when the final design and master layout of the proposed development has been confirmed. Significant research has been conducted on this, which will guide the process (Wright *et al*., 2017; Frenzel, 2018).
- Adequate wingwalls must be development to stabilise the riparian banks downslope to avoid erosion niche points from developing.

General

- Construction must take place within the dry season (i.e. April to mid-September) to reduce the risk of erosion and sedimentation of the downstream systems during construction.
- A chronological plan of construction must be developed:
  - Construction must be immediately followed by rehabilitation;
  - Excavation of any soils in the watercourses must be done to allow the storage of soil in sequence;
  - Soil replacement must be conducted in same sequence as excavated;
  - Soil surfaces must not be left open for lengthy periods to prevent erosion;
  - Affected surface vegetation must be removed, appropriately stored then reinstated, concurrently with construction, as close to their original position as possible, to reduce the possibility of longer-term change to the vegetation community. The vegetation must be removed keeping the root systems intact as far as possible;
  - If required vegetation plugs can be sorted from areas adjacent to the construction site, under the supervision of a suitably qualified ECO.
- Environmental inductions and training must include the contents of the above construction method statement.
- Excess dust observed in the vicinity of the proposed development must be noted and the appropriate dust suppression techniques implemented to ensure no excess sediment input into the surrounding freshwater resources.
- Cut and fill must be avoided where possible during the set-up of the construction site camp. The utilisation of already heavily disturbed areas should be encouraged.

- Removal of vegetation must only be done when essential for the construction of the proposed development. Do not allow any disturbance to the adjoining natural vegetation cover or soils. All disturbed areas must be prepared and then revegetated to the satisfaction of the ECO as per the relevant EMPr to be composed.
- All potential contaminants / hazardous materials must be bunded in the site camp to prevent runoff into the surrounding environment. A drainage system must be established for the construction camp. The drainage system must be regularly checked to ensure an unobstructed water flow. Establish cut-off drains and berms to reduce stormwater flow through the construction site. The contractor must prepare a SWMP (which may form part of the construction method statement) to ensure that all construction activities do not cause, or precipitate, soil erosion sediment which may result in sediment input into the surrounding environment. The designated responsible person on site, as indicated in the SWMP (usually the contractor/ECO) must ensure that no construction work takes place before the stormwater control measures are in place and must include post-construction/operational/rehabilitation phase stormwater requirements.
- No contaminated runoff or grey water is allowed to be discharged from the construction site camp.
- The demarcated watercourses must be protected from erosion and direct or indirect spills of pollutants (e.g. sediment, refuse, sewage, cement, oils, fuels, chemicals, wastewater etc.).
- All exposed surfaces within the construction site camp must be checked for IAPS monthly and any identified IAPS must be removed by hand pulling/uprooting and appropriately disposed of. Herbicides should **only** be utilised where manually removing is not possible. Herbicides utilised are restricted to products which have been certified safe for use in watercourse areas by an independent testing authority. The ECO must be consulted before the purchase of any herbicide.
- Water used on-site must be from an approved source. Should the water be extracted from a natural source, a water use licence must be acquired from DWS before abstraction. Water use on the site must be recorded and monitored.
- The digging of pit latrines is not allowed under any circumstances.
- None of the open areas or the surrounding environment may be used as ablution facilities.
- The recommended buffer zones (**Section 6.11**) must be implemented to maintain basic aquatic processes, services and values, reduce impacts from upstream activities and adjacent land-use practices, meeting life-need requirements for aquatic and semi-aquatic species, providing habitat for terrestrial species and providing ancillary societal benefits.

7.3 Rehabilitation Phase

- It is the responsibility of the developer to appoint a suitably experienced wetland ecologist to develop, and a rehabilitation contractor to implement, an approved Rehabilitation, Landscaping and Monitoring Plan. The specialist must have a sound knowledge of the vegetation types and communities of the site and his/her appointment must be approved by the ECO. The plan shall include (but not limited to):

    - A detailed species list of those species that should be used to landscape the post-construction landscape, specifically relating to the floating wetland and riparian zone;
    - Surface shaping and landscaping requirements;
    - Maintenance requirements of the site; and
    - Monitoring requirements for the area post-construction.
- Concurrent rehabilitation of disturbed area surrounding the proposed development must occur. This should include the establishment of fast propagating poaceae species, such as Rhodes Grass, to stabilise the soil profile.
- All post-construction building material and waste must be cleared in accordance with the abovementioned rehabilitation plan or EMPr, before revegetation takes place.
- Erosion features that have developed as a result of construction/operation related disturbances are required to be stabilised. This may also include the need to deactivate any erosion head cuts/rills/gullies that may have developed by either compacted soil infill, rock plugs, gabions or any other suitable measures.
- Slopes that have been altered due to construction/operation must be reshaped to replicate the original condition and contours.
- Any areas, which fall outside of the site, that have been compacted are required to be ripped to allow for the establishment of vegetation. This ripping must not result in the mixing of sub- and topsoil.
- No imported soil material may be utilised for rehabilitation, unless it can be ensured that it is free of any IAPS seeds.
- It is the property owner's responsibility to continuously monitor the area for alien species during the contract and establishment period, and any alien species encountered must be removed.
- Removal of these species shall be undertaken in a way which prevents any damage to the remaining indigenous species and inhibits the re-infestation of the cleaned areas.
- All alternative tracks and footpaths created during the operational phase should be appropriately rehabilitated (e.g. tillage and revegetation of the affected areas). This rehabilitation should result in improved surface roughness and increased infiltration along with reduced stormwater flow and consequently reduced rill erosion.
- Any haulage or access roads (legal or illegal) which were created must be decommissioned and rehabilitation to reinstate the natural vegetation, increase the surface roughness and resultantly increase infiltration (e.g. tillage and revegetation) post-construction.
- All construction waste materials must be removed, and temporary structures (e.g. offices, workshops, storage containers, ablution facilities) dismantled, from site and the surrounding environment, this will need to be checked by the ECO and the various contractors.
- The reinstatement of the longitudinal slope profiles, which have been altered, must be rehabilitated if possible. The soil horizons must be reinstated on the correct structural order and the vegetation groundcover over the disturbed area revegetated according to the site-specific rehabilitation plan.

7.4 Operational Phase

- Regular monitoring of the structural integrity of the proposed development must be conducted at a frequency using specific criteria by a suitably qualified civil engineer. This should ideally be conducted by the design engineer.
- Biannual aquatic biomonitoring of the sites presented within this study must be conducted by an accredited SASS5 biomonitoring practitioner who is also professionally registered with SACNASP. The results should be submitted to the DWS case officer for review.
- No open/bare soil must be evident onsite during operation to avoid erosion occurring. This should be managed and addressed by the conservation entity responsible for the open space.
- Continuous IAPS control and eradication must occur onsite, guided by an IAPS Control and Management Plan to be drafted by a suitably qualified botanist.

8 MONITORING REQUIREMENTS

The monitoring of the watercourses will be essential for the maintenance and/or improvement of the PES scores that were calculated for the at-risk watercourses within the study area. The mitigative recommendations stated above must be incorporated into the project-specific EMPr and compliance with the requirements/recommendations must be audited by a suitability qualified independent, or site ECO. The key to a successful EMPr is appropriate monitoring and review to ensure effective functioning of the EMPr and to identify and implement corrective measures in a timely manner. Monitoring for non-compliance must be undertaken on a daily basis during the construction phase by the contractors under the guidance of the Project Manager / ECO / Engineer. An appropriately timed audit report should be compiled by the independent ECO. Paramount to the reporting of non-conformance and incidents is that appropriate corrective and preventative action plans are developed and adhered to. Photographic records of all incidents and non-conformances must be retained. This is to ensure that the key impacts on the receiving aquatic habitats are adequately managed and mitigated against and that the rehabilitation of any disturbed areas within any system is successful.

A monitoring programme must be in place not only to ensure compliance with the EMPr throughout the construction and operational phases, but also to monitor any environmental issues and impacts during the vegetation establishment phase during rehabilitation. Compliance against the EMPr must be monitored during the construction/operational phase monthly by an ECO. The period and frequency of monitoring required post-construction must be determined by a suitably qualified botanist and approved by the ECO. Once the initial transplants / plugs are planted during the rehabilitation phase, a suitably qualified professional must conduct weekly site visits to remove IAPS (in accordance with the latest revised NEM:BA requirements) and address any revegetation concerns until revegetation is considered successful (i.e. >80% indigenous cover). A generally accepted monitoring period of revegetated areas after this initial period is monitoring every 3 months for the first 12 months and every 6 months thereafter until the vegetation has successfully been established. If the revegetated areas have inadequate surface coverage (less than 30% within 9 months after re-vegetation) the disturbed areas should be prepared and re-vegetated again.

- The cost-effective qualitative monitoring of the rehabilitation area may be time based through the use of periodic photographs taken from permanent photo viewpoints. These points are required to be established during site inception. The timeline created between the pre- and post-rehabilitation photos will provide an invaluable visual representation of the progress that is conveyed in a straightforward manner. The photographer should be an environmental scientist (may be the site ECO), therefore allowing an expert assessment of the site adding to the qualitative information gathered from the photographs.

The below mentioned criteria must be adhered to, ensuring the quality of the information collected:

  - Establishment of the photo points must be completed during site inception/establishment. This will allow for pre-rehabilitation imagery spanning more than a once off photograph.

- These points should be permanently marked and assigned a unique identify number to ensure continual relocation and accuracy of the photographs. GPS coordinates should be recorded of each site. This is to ensure if any markers are removed or vandalised then they can be replaced.
- Photo point locations should be easily relocated and accessible and must not be obscured by future vegetation growth.
- The level of detail captured must be appropriate to the area that has undergone rehabilitation.
- Photo record forms must be development and utilised for every photo taken. The information required will be project name, location, unique identity number, directional point (e.g. North, South), date, time, photographers name and additional comments.
- Qualitative ecological information that must be visually interpreted and recorded at the same time as taking the photograph include:
  - Extent of the site vegetation ground cover.
  - General level of plant growth, substrate levels, and water levels.
  - General observations of water quality such as clarity and presence of litter.
  - Evidence of anthropogenic presence and bird species.
  - Vegetation condition, extent of alien invasive plants; and
  - Evidence of erosion and close monitoring of the post-construction erosion-control measures which must be implemented.

This is to ensure that the key impacts on the aquatic and terrestrial habitats are adequately managed and mitigated against and that rehabilitation of any disturbed areas within the study area is successful.

9 CONCLUSION AND RECOMMENDATIONS

Subsequent to conducting a field survey of the proposed development site, a total of one (1) riverine and three (3) wetland systems were delineated within the study area. Out of these systems, three (3) were determined to be at-risk of being impacted on by the proposed development, namely; Rip01, Seep01 and Seep02. These systems were observed and calculated to have been largely modified as a result of historic and current infrastructural development, livestock grazing, urbanisation and consequent invasion by several IAPS. This resulted in all at-risk systems calculating PES scores falling within a Class D (Largely modified). This was however not mirrored by the EIS of the at-risk wetland systems, which were calculated to have been of high EIS to the surrounding natural and anthropogenic environment, predominantly as a result of remnant floral species of the critical endangered Mesic Highveld Grassland (Group 4) being identified and the systems providing a valuable ecological corridor within the urban area. The EIS of the at-risk riverine system was calculated to have been moderate, as a result of the low aquatic integrity of the system, which was confirmed by implementation of the SASS5 biomonitoring tool, the results of which determined the macroinvertebrate community to fall within a Ecostatus class E/F (Seriously modified). However, the system was, like the wetlands, determined to constitute as an invaluable ecological corridor and migratory route within the region and as such must be conserved for conservation purposes.

Based on the calculated PES, ESS, EIS and overall integrity scored, and the presumed construction method that will be applied on site, a RAM was undertaken for the proposed development. It was determined that the following aspects could not be mitigated down to a low significance score post-mitigation: 1) The excavation, infill and subsequent formalisation of un-inundated portions of Rip01, Seep01 and Seep02; and 2) the Construction of a permanent flow barrier within Rip01, which will consequently alter the sediment capacity and quantity of flow to downstream aquatic habitats. In line with DWS GN No. 506, published within GG no. 40229 of 2016, the proposed development will therefore need to be subject to a full WULA process.

Considering the project as a whole, it is the specialist's substantive opinion that the proposed development continues, provided that the following take place and/or be implemented:

- All buffer zones, mitigation and/or rehabilitation measures presented within this report and the site-specific EMPr are strictly implemented and subsequently monitored through a formal monitoring programme approved by the competent authority (DWS).

The following should be considered as conditions within the relevant WULA:

- A detailed Rehabilitation and Landscaping Programme should be drafted for the project to guide the post-construction landscape and ensure that the area exhibits the required level of biodiversity. An IAPS Control and Management Plan should be incorporated into this programme.
- Biannual aquatic biomonitoring should be conducted by an accredited SASS5 practitioner at the sites presented within this report on a biannual basis to monitor the overall integrity of the stream and potential impacts that the proposed development may have on the system. This will guide any remediation actions that may be required.

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11 APPENDIX A: SPECIALIST'S QUALIFICATIONS

EMPLOYEE NAME	**WAYNE JOHN WESTCOTT**
POSITION	**BUSINESS UNIT MANAGER/ WETLAND & AQUATIC ECOLOGIST**
DETAILS	**Office: 29 Greenmeadow Lane, Hillcrest, Durban.** **M: 079 491 8685; F: 012 460 3071** **E mail: Wayne@envass.co.za**

EDUCATION AND QUALIFICATIONS

2015	**BSc Honours in Water Resource Management** Department of Environmental Science, Rhodes University
2014	**BSc in Environmental Science and Geography/Geology** Department of Environmental Science, Rhodes University
2010	**Matriculation (IEB Examination)** Stanford Lake College, Limpopo

PROFESSIONAL AFFILIATIONS

Professionally registered with the South African Council of Natural Scientific Professionals (SACNASP) (no. 117334)

Wetland Society of South Africa and KwaZulu-Natal

EXPERIENCE

Employer	**Environmental Assurance (Pty) Ltd. (ENVASS)**
Period	November 2018 – Current
Position	**Business Unit Manager and Divisional Head: Wetland and Aquatics**
Responsibilities	Proposal composition, budget tracking, marketing, fieldwork and report planning, primary client liaison, Freshwater Habitat (wetlands and rivers) Impact Assessments, DWS Risk Assessment Matrix, Aquatic Biomonitoring etc.

Employer	**KSEMS Environmental Consulting**
Period	August 2016 – November 2018
Position	**Project Manager: Specialist Division**
Responsibilities	Proposal composition, budget tracking, marketing, fieldwork and report planning, primary client liaison, Freshwater Habitat (wetlands and rivers) Impact Assessments, DWS Risk Assessment Matrix, Aquatic Biomonitoring etc.

Employer	**Westfalia Technological Services**
Period	January 2016 – August 2016
Position	**Environmental Scientist**
Responsibilities	Compilation and management of the Water Management Plan for South Africa, Wetland and Aquatic Delineation Assessments, Compilation and management of Environmental Action and Management Plans, Invasive Alien Species Control Plans, ensure compliance with Tesco, Woolworths and GlobalGap Standards etc.

EXTERNAL COURSES

2019	**Introduction to Hydropedology** Digital Soils Africa
2019	**Foundations of Project Management** University of Cape Town
2017	**Soil Classification and Land Capability** Department of Agriculture, Forestry and Fisheries (DAFF), Cedara College
2017	**SASS5 Aquatic Biomonitoring Accreditation** Department of Water and Sanitation (DWS)
2016	**Introduction Environmental Impact Assessments (EIA) Procedures** Rhodes University, EOH Coastal and Environmental Services
2016	**Tools for Wetland Assessment** Rhodes University (Presented by Prof. William 'Fred' Ellery)
2016	**South African Green Industries Council (SAGIC) Invasive Species Training** SAGIC
2015	**ESRI GIS Conference Workshops and Seminars** ESRI South Africa
2015	**Google Earth Pro Workshop** Rhodes University Environmental Science Department

WETLAND AND AQUATIC WORK

Project	Role	Description	Client	Year
Quarterly SASS5 Biomonitoring of the Tronox Fairbreeze Mine (Quarter 2- 2020).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2020
Quarterly SASS5 Biomonitoring of the Tronox Hillendale Mine (Quarter 2- 2020).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2020
Quarterly SASS5 Biomonitoring of the Tronox Central Processing Plant (Quarter 2- 2020).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2020

WETLAND AND AQUATIC WORK				
Project	**Role**	**Description**	**Client**	**Year**
Biannual SASS5 Biomonitoring of the Glencore Lydenburg Smelter (Dry season 2020), MP.	Lead Author	Specialist aquatic work	Glencore	2020
Biannual SASS5 Biomonitoring of the NECSA facility (Dry season 2020), NW.	Lead Author	Specialist aquatic work	NECSA	2020
Wetland impact assessment of the proposed Benmore Dam rehabilitation project within Benmore, GP.	Lead Author	Specialist wetland work	GA Environment	2020
Aquatic biomonitoring baseline study of the Sundays River in the vicinity to the existing Olifantskop WWTW, KZN.	Lead Author	Specialist aquatic work	ACER Africa	2020
Wetland delineation and impact assessment of the proposed Mareesburg Haulage Road, MP.	Lead Author	Specialist wetland work	EastPlat	2020
Wetland delineation and impact assessment of the proposed Mpumalanga Business Hive, KZN.	Lead Author	Specialist wetland work	Hanslab	2020
Wetland delineation and impact assessment of the proposed Die Kom and Graauwduin mining extensions at Tronox Namaqua Sands, WC.	Lead Author	Specialist wetland work	Tronox Namaqua Sands	2020
Wetland delineation and rehabilitation plan for the Lydenburg Smelter site, LP.	Lead Author	Specialist wetland work	Glencore	2020
Quarterly SASS5 Biomonitoring of the Tronox Fairbreeze Mine (Quarter 1- 2020).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2020
Quarterly SASS5 Biomonitoring of the Tronox Hillendale Mine (Quarter 1- 2020).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2020
Quarterly SASS5 Biomonitoring of the Tronox Central Processing Plant (Quarter 1- 2020).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2020
Biannual SASS5 Biomonitoring of the South Deep Gold mine (Wet season 2019), GP.	Lead Author	Specialist aquatic work	Goldfields	2020
Aquatic impact assessment and toxicity testing of a riverine system downstream of Sovereign Foods, NW.	Lead Author	Specialist wetland and aquatic work	Sovereign Foods	2020
Biannual SASS5 Biomonitoring of the Zululand Anthracite Colliery Wet season 2019), KZN.	Lead Author	Specialist aquatic work	Zululand Anthracite Colliery	2020
Biannual Wetland Assessment of the Phalanndwa Colliery Extension (Wet season- 2020), MP.	Lead Author	Specialist wetland work	Canyon Resources	2020

WETLAND AND AQUATIC WORK				
Project	**Role**	**Description**	**Client**	**Year**
Wetland and Aquatic Impact Assessment of the proposed Ekuvukeni Bulk Water Pipeline and WWTW, KZN.	Lead Author	Specialist wetland and aquatic work	ACER Africa	2019
Wetland Rehabilitation and Management Plan for the proposed Grootfontein Mine, GP.	Lead Author	Specialist wetland work	Brikor	2019
Freshwater Habitat Impact Assessment of the Proposed Mareesburg Haul Road, LP.	Lead Author	Specialist wetland and aquatic work	EastPlats	2019
Freshwater Habitat Impact Assessment of the Proposed L311 and P176 District Roads, KZN.	Lead Author	Specialist wetland and aquatic work	Hanslab	2019
Freshwater Habitat Impact Assessment of the Proposed P280 District Road, KZN.	Lead Author	Specialist wetland and aquatic work	Hanslab	2019
Freshwater Habitat Impact Assessment of the Proposed Majola Bridge, KZN.	Lead Author	Specialist wetland and aquatic work	Hanslab	2019
Biannual Wetland and Aquatic Assessment of the Exxaro Leeuwpan Colliery, MP (Wet- 2019).	Lead Author	Specialist wetland & aquatic work	Exxaro	2019
Quarterly SASS5 Biomonitoring of the Tronox Fairbreeze Mine (Quarter 4- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Hillendale Mine (Quarter 4- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Central Processing Plant (Quarter 4- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Siyaya Estuarine Assessment for the existing Tronox Fairbreeze Mine, KZN (Wet- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Freshwater Habitat Impact Assessment of the Proposed Mtunzini Sewer Reticulation System, KZN.	Lead Author	Specialist wetland and aquatic work	ACER Africa	2019
Freshwater Habitat Impact Assessment of the Proposed D919 Road Upgrade, KZN.	Lead Author	Specialist wetland and aquatic work	KZN DoT	2019
Aquatic Impact Assessment of the Proposed Mtunzini Waste Water Treatment Works, KZN.	Lead Author	Specialist aquatic work	ACER Africa	2019
Biannual Wetland and Aquatic Assessment of the Exxaro Leeuwpan Colliery, MP (Dry- 2019).	Lead Author	Specialist wetland & aquatic work	Exxaro	2019
Siyaya Estuarine Assessment for the existing Tronox Fairbreeze Mine, KZN (Dry 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Biannual Wetland Assessment of the Phalanndwa Colliery Extension (Wet season- 2019)	Lead Author	Specialist wetland work	Canyon Resources	2019

WETLAND AND AQUATIC WORK				
Project	**Role**	**Description**	**Client**	**Year**
Biannual SASS5 Biomonitoring of the Phalanndwa Colliery (Wet season- 2019)	Lead author	Specialist aquatic work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Zululand Anthracite Colliery (Dry season 2018).	Lead Author	Specialist aquatic work	Zululand Anthracite Colliery	2019
Biannual Wetland Assessment of the Phalanndwa Colliery Extension (Dry season- 2019)	Lead Author	Specialist wetland work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Phalanndwa Colliery (Dry season- 2019)	Lead author	Specialist aquatic work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Singani Colliery Sites (Wet season- 2019).	Lead author	Specialist aquatic work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Hakhano Colliery Sites (Wet season- 2019).	Lead author	Specialist aquatic work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Khanye Colliery Sites (Wet season- 2019).	Lead author	Specialist aquatic work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Bronkhorstspruit Siding Sites (Wet season- 2019).	Lead author	Specialist aquatic work	Canyon Resources	2019
Wetland Impact Assessment of the Rietkuil Siding, GP (Wet season 2019).	Lead Author	Specialist wetland work	Canyon Coal	2019
Biannual SASS5 Biomonitoring of the Blinkpan Railway Siding, MP (Wet season 2019).	Lead Author	Specialist aquatic work	Makoya Group	2019
Quarterly SASS5 Biomonitoring of the Tronox Fairbreeze Mine (Quarter 3- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Hillendale Mine (Quarter 3- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Central Processing Plant (Quarter 3- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Wetland Impact Assessment of the Ukufisa Colliery, GP (Dry season 2019).	Lead Author	Specialist wetland work	Canyon Coal	2019
Biannual SASS5 Biomonitoring of the South Deep Gold mine (Dry season 2019)	Lead Author	Specialist aquatic work	Goldfields	2019
Biannual SASS5 Biomonitoring of the Singani Colliery Sites (Dry season 2019).	Lead Author	Specialist aquatic work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Hakhano Colliery Sites (Dry season 2019).	Lead Author	Specialist aquatic work	Canyon Resources	2019
Biannual SASS5 Biomonitoring of the Khanye Colliery Sites (Dry season 2019).	Lead Author	Specialist aquatic work	Canyon Resources	2019

WETLAND AND AQUATIC WORK				
Project	**Role**	**Description**	**Client**	**Year**
Biannual SASS5 Biomonitoring of the Bronkhorstspruit Siding Sites (Dry season 2019).	Lead Author	Specialist aquatic work	Canyon Resources	2019
Quarterly SASS5 Biomonitoring of the Tronox Fairbreeze Mine (Quarter 2- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Hillendale Mine (Quarter 2- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Central Processing Plant (Quarter 2- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Freshwater Habitat Impact Assessment of the Proposed Woodmead Estate, KZN.	Lead Author	Specialist wetland and aquatic work	ACER Africa	2019
Freshwater Habitat Impact Assessment of the Proposed Hluhluwe Rhino Reserve, KZN.	Lead Author	Specialist wetland and aquatic work	ACER Africa	2019
Freshwater Habitat Impact Assessment of the Proposed Paling Manganese Mine, Northern Cape (NC).	Lead Author	Specialist wetland and aquatic work	PMG Mining	2019
Quarterly SASS5 Biomonitoring of the Tronox Fairbreeze Mine (Quarter 1- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Hillendale Mine (Quarter 1- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Quarterly SASS5 Biomonitoring of the Tronox Central Processing Plant (Quarter 1- 2019).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2019
Biannual SASS5 Biomonitoring of the Blinkpan Railway Siding, MP (wet season 2018).	Lead Author	Specialist aquatic work	Makoya Group	2019
Wetland Impact Assessment of the Ukufisa Colliery, GP (Wet season 2018).	Lead Author	Specialist wetland work	Canyon Coal	2019
Biannual SASS5 Biomonitoring of the South Deep Gold mine (Wet season 2018)	Lead Author	Specialist aquatic work	Goldfields	2018
Biannual SASS5 Biomonitoring of the Zululand Anthracite Colliery (Wet season 2018).	Lead Author	Specialist aquatic work	Zululand Anthracite Colliery	2018
Biannual SASS5 Biomonitoring of the Singani Colliery Sites (Wet season 2018).	Lead Author	Specialist aquatic work	Canyon Resources	2018
Biannual SASS5 Biomonitoring of the Hakhano Colliery Sites (wet season 2018).	Lead Author	Specialist aquatic work	Canyon Resources	2018
Bi-annual SASS5 Biomonitoring of the Khanye Colliery Sites (wet season 2018).	Lead Author	Specialist aquatic work	Canyon Resources	2018

WETLAND AND AQUATIC WORK				
Project	**Role**	**Description**	**Client**	**Year**
Biannual SASS5 Biomonitoring of the Bronkhorstspruit Siding Sites (wet season 2018).	Lead Author	Specialist aquatic work	Canyon Resources	2018
Biannual SASS5 Biomonitoring of the East Plats Western Limb Sites (wet season 2018).	Lead Author	Specialist aquatic work	Eastern Platinum	2018
Biannual SASS5 Biomonitoring of the East Plats MB Sites (wet season 2018).	Lead Author	Specialist aquatic work	Eastern Platinum	2018
Quarterly SASS5 Biomonitoring of the Tronox Fairbreeze Mine (Quarter 4- 2018).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2018
Quarterly SASS5 Biomonitoring of the Tronox Hillendale Mine (Quarter 4- 2018).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2018
Quarterly SASS5 Biomonitoring of the Tronox Central Processing Plant (Quarter 4- 2018).	Lead Author	Specialist aquatic work	Tronox KZN Sands	2018
Biannual SASS5 Biomonitoring of the Lydenburg Smelter Sites (wet season 2018).	Lead Author	Specialist aquatic work	Glencore	2018
Updated Aquatic Impact Assessment for the Existing Tweefontein Waste Water Treatment Works.	Lead Author	Specialist aquatic work	Ix Engineering	2018
Freshwater Habitat Impact Assessment of the Proposed Construction of the Vulindlela Bulk Water Supply Pipeline, KwaZulu-Natal (KZN).	Lead Author	Specialist wetland and aquatic work	Umgeni Water	2018
Freshwater Habitat Impact Assessment of the Proposed National Route 2 (N2) Wild Coast Toll Highway, Section 20, Auxiliary Roads and Material Sources, Eastern Cape (EC).	Co-author	Specialist wetland and aquatic work	SANRAL & Aurecon Group	2018
Freshwater Habitat Impact Assessment of the Proposed Verulam Housing Development, KZN.	Lead Author	Specialist wetland and aquatic work	Cassandra Naidoo	2018
Freshwater Habitat Impact Assessment of the Proposed Umtshezi East Bulk Water Pipeline, KZN.	Lead Author	Specialist wetland and aquatic work	Acer Africa	2018
Wetland Rehabilitation and Monitoring Plan for the Cato Manor Sewage Pipeline Leakage within Bellair, KZN.	Co-author	Specialist rehabilitation works	eThekwini Metropolitan Municipality: Water and Sanitation	2018
Freshwater Habitat Impact Assessment of the Proposed Diesel Locomotive Workshop and Siding at the Richard's Bay Port, KZN.	Co-author	Specialist wetland and aquatic work	Transnet	2017

WETLAND AND AQUATIC WORK				
Project	**Role**	**Description**	**Client**	**Year**
Wetland and Aquatic Rehabilitation Plan for the Proposed Diesel Locomotive Workshop and Siding at the Richard's Bay Port, KZN.	Co-author	Specialist wetland and aquatic work	Transnet	2017
Wetland and Aquatic Rehabilitation Implementation Plan for the Dube Precinct (Phase 1), KZN.	Lead Author	Specialist wetland and aquatic work	ACSA & Dube Tradeport (La Mercy Joint Venture)	2017
Freshwater Habitat Impact Assessment of the Proposed Upgrade of the Umbumbulu MR30 Road, KZN.	Lead Author	Specialist wetland and aquatic work	Nyeleti Engineering Consulting	2017
Eskom Road Emergency Maintenance, KZN	Internal reviewer	Specialist wetland and aquatic work	CBR Investments	2017
Freshwater Habitat Impact Assessment of the Proposed Upgrade to the National Route 8 (N8) between Thaba Nchu and Tweespruit and the use of the Eden and Devonshire Borrow Pits, Free State (FS).	Lead Author	Specialist wetland and aquatic work	SANRAL & Royal HaskoningDHV	2017
Freshwater Habitat Impact Assessment of the Proposed Upgrade of the National Route 2 (N2) from the Durban Airport to the iLovu River, KZN.	Lead Author	Specialist wetland and aquatic work	SANRAL & GIBB Engineering	2017
Freshwater Habitat Impact Assessment of the Proposed Construction of the Bloemfontein N8 Ring-road, FS.	Lead Author	Specialist wetland and aquatic work	The Free State Department of Police, Roads & Transport and Nyeleti Consulting	2016
Freshwater Habitat Impact Assessment of the Proposed Upgrade to the N2 Gwaaing River Bridge, Western Cape (WC).	Lead Author	Specialist wetland and aquatic work	SANRAL & GIBB Engineering	2016
Freshwater Habitat Impact Assessment of the Proposed Construction of the Mzimkhulwana Bridge, KZN.	Internal review	Specialist wetland and aquatic work	Samani Engineering Consulting	2016
Freshwater Habitat Impact Assessment of the Emergency Maintenance Work for the P197-3 Road Culverts, KZN.	Lead Author	Specialist wetland and aquatic work	Samani Engineering Consulting	2016
Freshwater Habitat Impact Assessment of the Proposed Keystone Petrol Filling Station, KZN.	Internal reviewer	Specialist wetland and aquatic work	Keystone Developments	2016

WETLAND AND AQUATIC WORK				
Project	**Role**	**Description**	**Client**	**Year**
Freshwater Habitat Impact Assessment of the Kusa-kusa Irrigation Scheme, KZN.	Internal reviewer	Specialist wetland and aquatic work	Delta BEC	2016
Freshwater Habitat Impact Assessment of the Re-establishment of the P73 road Borrow Pits, KZN.	Internal reviewer	Specialist wetland and aquatic work	Samani Engineering Consulting	2016
Freshwater Habitat Impact Assessment of the Proposed Upgrade to the P740 and D985 Roads and Establishment of Two Borrow Pits, KZN.	Co-author	Specialist wetland and aquatic work	Samani Engineering Consulting	2016
Freshwater Habitat Impact Assessment of the Proposed Upgrade to the P728 District Road, KZN.	Co-author	Specialist wetland and aquatic work	Samani Engineering Consulting	2016
Freshwater Habitat Impact Assessment of the Proposed Baboyi River Bridge, KZN.	Co-author	Specialist wetland and aquatic work	Samani Engineering Consulting	2016
Wetland Delineation Report for the Proposed Ngyico Wetland Tourism Development, EC.	Lead Author	Specialist wetland work	Rhodes University	2015
Delineation and Assessment of Several Wetlands within the Kromme River Catchment, EC.	Field work and assessments	Research work	Rhodes University	2015

TERRESTRIAL WORK				
Project	**Role**	**Description**	**Client**	**Year**
Vegetation impact assessment of the proposed Mpumalanga Business Hive, KZN.	Lead Author	Specialist botanical work	Hanslab	2020
Updated Terrestrial Biodiversity Assessment of the Siyanda Bakgatla Union Mine site in Swartklip, LP.	Lead author	Specialist fauna and flora work	Siyanda Bakgatla	2020
Invasive and Alien Plant Species (IAPS) Survey of the Royal Bafokeng Platinum Mine properties near Suncity, NW.	Lead author	Specialist botanical work	Royal Bafokeng Platinum	2020
Vegetation Impact Assessment of the Proposed Ekuvukeni Bulk Water Pipeline and WWTW, KZN.	Lead author	Specialist botanical work	ACER Africa	2019
Biodiversity Screening for a Prospecting Right at the Vlakfontein Farm 281 IR, GP.	Lead author	Specialist botanical work	Ilangabi Investments	2019
Vegetation Impact Assessment of the Proposed Nhlabane Road Upgrade, KZN.	Lead author	Specialist botanical work	ACER Africa	2019
Vegetation Impact Assessment of the Proposed Mtunzini Sewer Reticulation System and WWTW, KZN.	Lead author	Specialist botanical work	ACER Africa	2019

TERRESTRIAL WORK				
Project	**Role**	**Description**	**Client**	**Year**
Vegetation Impact Assessment of the Proposed D919 Road Upgrade, KZN.	Lead Author	Specialist botanical work	KZN DoT	2019
Vegetation Impact Assessment of the Proposed Eskom Sub-station and Powerline to the Lwala Mine, LP.	Lead Author	Specialist botanical work	ACER Africa	2019
Vegetation Impact Assessment of the Proposed Rhino Ridge tented camp within the Hluhluwe Nature Reserve, KZN.	Lead Author	Specialist botanical work	ACER Africa	2019
Vegetation Impact Assessment of the Proposed N2, Section 20 Auxiliary Roads and Material Sources, EC.	Internal reviewer	Specialist botanical work	SANRAL & Aurecon Group	2018
Vegetation Rehabilitation Plan for the Proposed N2, Section 20 Auxiliary Roads and Material Sources, EC.	Internal Reviewer	Rehabilitation work	SANRAL & Aurecon Group	2018
Vegetation Impact Assessment of the Proposed Verulam Housing Development, KZN.	Internal reviewer	Specialist botanical work	Cassandra Naidoo	2018
Ecological Impact Assessment for the Proposed Upgrade of the N8 Road between Thaba Nchu and Tweespruit and the use of the Eden and Devonshire Borrow Bits, FS.	Lead Author	Specialist botanical and faunal work	SANRAL & Royal HaskoningDHV	2017
Vegetation Impact Assessment of the Proposed Upgrade top the Magwaza Road (L2980) Road, KZN.	Co-author	Specialist botanical work	Samani Engineering Consulting	2016
Vegetation Impact Assessment of the Proposed Construction of the Mangwenya Pedestrian Bridge, KZN.	Lead Author	Specialist botanical work	Samani Engineering Consulting	2016
Vegetation Transect and Data Collection on the *Pheonix reclinate* Species within Willowvale, EC.	Field work and assessments	Research	Rhodes University	2015
Botanical Assessment of the Grass Species within the Mogalakwena Platinum Mine Community Game Reserve, Limpopo.	Lead Author	Research	Anglo Platinum	2014

OTHER ENVIRONMENTAL WORK				
Project	**Role**	**Description**	**Client**	**Year**
Soil impact assessment of the Jindal Africa Kiepersol Mine, MP.	Lead Author	Soil Assessment	Jindal Africa	2020

OTHER ENVIRONMENTAL WORK				
Project	**Role**	**Description**	**Client**	**Year**
Soil Impact Assessment of the Yellow Sunshine site, GP.	Lead Author	Soil Assessment	Yellow Sunshine	2019
Phase 1 Soil Impact Assessment of the Lynca Meats site, MP.	Lead Author	Soil Assessment	Lynca Meats	2019
Project Manager of Environmental Remediation Works on Three Nampak Flexible Sites in SA	Project manager	Management of all finances and construction related activities	Nampak Products Ltd.	2017-2018
Basic Assessment (BA) for the Proposed National Route 2 (N2) Wild Coast Toll Highway, Section 20, Auxiliary Roads and Material Sources, Eastern Cape (EC).	EAP/Lead author	Environmental management	SANRAL & Aurecon Group	2018
Scoping and Environmental Impact Assessment (S&EIA) for the Proposed Establishment of the 28ha Dolerite Quarry Associated with the N2, Section 20, EC.	EAP/Lead author	Environmental management	SANRAL & Aurecon Group	2018
Water Use License Application (WULA) for the Proposed National Route 2 (N2) Wild Coast Toll Highway, Section 20, Auxiliary Roads and Material Sources, Eastern Cape (EC).	EAP/Lead author	Environmental management	SANRAL & Aurecon Group	2018
BA for the Proposed Construction of the Umbumbulu Pump Station, KZN.	EAP/Lead author	Environmental management	Umgeni Water	2017
WULA for the Proposed Construction of the Umbumbulu Pump Station, KZN.	EAP/Lead author	Environmental management	Umgeni Water	2017
Environmental Control Officer (ECO) Audits of the Upgrade to the N5 Road, KZN.	ECO	Compliance audit	SANRAL	2017
ECO Audits of the Upgrade to the D1252 District Road, KZN.	ECO	Compliance audit	Samani Engineering Consultants	2017

CERTIFICATION

I, **WAYNE JOHN WESTCOTT**

Declare that, to the best of my knowledge, all the information contained herein is true.

Signature: ____________________

On the 28th day of June 2020