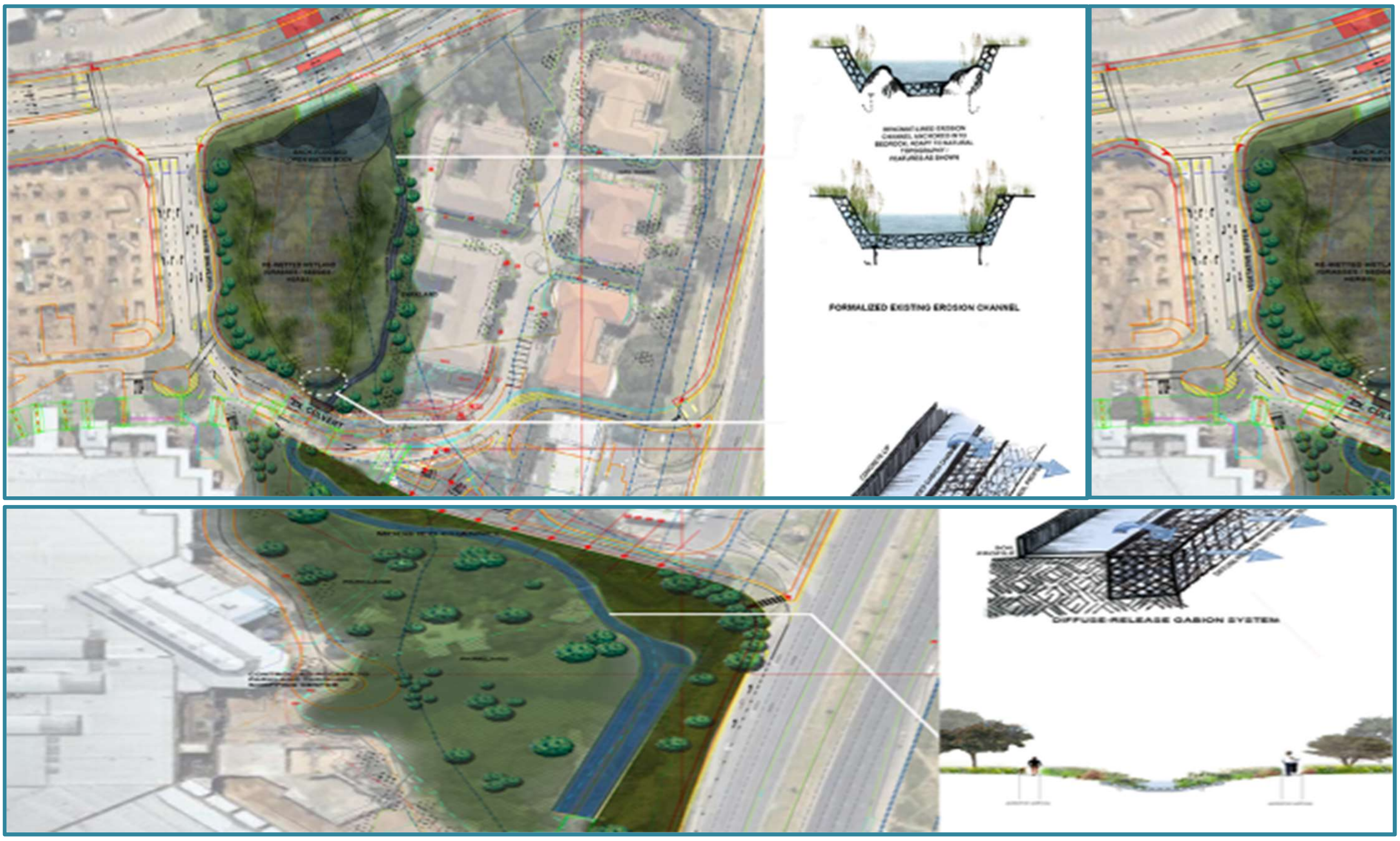
KEKANA ESKOM:
Wetland Baseline and Impact Assessment

Prepared for:

NSOVO ENVIRONMENTAL CONSULTING

Prepared by:

Willem Lubbe
for
WaterMakers



June 2024

Declaration of Independence by Specialist

I, **WILLEM LUBBE**, in my capacity as a specialist consultant, hereby declare that I -

- act as an independent consultant;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability;
- undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered; and
- as a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member.

07/03/2024

Date

Willem Lubbe Pr.Sci.Nat
Wetland Principle Specialist
SACNASP Reg. No. 004750

EXECUTIVE SUMMARY

Eskom Kekana servitude project entails the Kekana Substation Site and Kekana –Pelly-Temba Main loop in-loop out transmission line. Servitude acquisition for the proposed Kekana 132/22kV substation is a 1.5ha site. The Kekana –Pelly-Temba Main loop in-loop out which involves acquiring a 31m wide servitude for the approximate 7km 132kV double circuit loop-in loop out line from the existing Pelly-Temba Main 132kV line to Kekana substation.

Nsovo Environmental Consulting was contracted to review the area and conduct the Environmental Impact Assessment (EIA) on their behalf. Subsequently, WaterMakers was appointed by Nsovo Environmental Consulting as independent specialists to conduct the relevant wetland-related studies in order to facilitate the required environmental authorisation and water use licence processes. The present study represents the baseline and wetland impact assessment of the study and aims to inform responsible decision making with regards to the project.

In order to enable an adequate description of potential wetland habitat and so as to ensure that the wetland study conducted is applicable for both an Environmental Authorisation as well as a Water Use Licence Application, the following approach was to be undertaken:

- Desktop assessment
- The wetland delineation should be conducted following the guidelines contained in the DWAF Guideline document entitled "A Practical Field Procedure for Identification and delineation of wetlands and riparian areas" (DWAF, 2005; 2008);
- Corroborate field and desktop data and classify confirmed wetlands into hydrogeomorphic units;
- Determine the functionality of wetlands, using a Level 2 Wet-EcoServices (Kotze *et al.*, 2005) assessment for wetlands within the study area;
- Determine the Present Ecological Status (PES) of identified wetlands within the study area through applying a Level 2 Wet-Health assessment (Macfarlane *et al*., 2008);
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands by utilising methodology described by Rountree (2013);
- Determine and ground truth the NFEPA status of any wetlands on site, if any;
- Impact assessment for the proposed activities as well as potential mitigation measures.

Site visits to the area to be affected by the proposed activity has been undertaken in February 2019, several site visits in 2020, 2021 as well as in July, September and October of 2023. A detailed description of the methodology used to address the above Terms of Reference is provided in Appendix A.

Thirty-one hydro-geomorphic units (HGM), comprising three HGM types, namely a valley bottom wetland with a channel, valley bottom wetland without a channel as well as a hillslope seepage wetland connected to a watercourse, were delineated and classified within the study area and within two kilometre surrounding the study area.

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services, including sediment trapping, nitrate removal, toxicant removal, erosion control, carbon storage, maintenance of biodiversity and water supply for human use. Each

wetland's ability to contribute to ecosystem services within the study area was also dependant on the particular wetland's Present Ecological State in relation to a benchmark or reference condition. Present Ecological State scores was determined for wetlands within the study area using Wet-Health Level 2 assessment which indicated that in general wetlands have been seriously modified as a result of extensive sand mining operations that have taken place on various scales and over several decades, still continuing at present. Sand mining operations have impacted more severely towards the north of the study area where population densities and associated anthropogenic pressures and impacts escalates

The Ecological Importance and Sensitivity assessment was undertaken to rank water resources in terms of provision of goods and services or valuable ecosystem functions which benefit people, biodiversity support and ecological value and reliance of subsistence users. In general, most of the identified HGM units attained low to very low scores for their respective Ecological Importance and Sensitivity analysis as a result of the temporary nature of the majority of wetlands as well as due to anthropogenic impacts, especially extensive sand mining within the study area's wetlands and their respective catchments. However, two seepage wetlands scored high as a result of the uniqueness and intact nature. The Apies River also received high scores as a result of the regional hydrological and functional as well as the high ratio of permanent zonation associated with this valley bottom wetland. Direct human benefit associated with the wetlands within the study area included water supply, cultivation of agricultural plots and food gardens, water supply to commercial pivots, subsistence and recreational hunting, collection of building materials and firewood as well as grazing of livestock.

The impact assessment identified the destruction of wetland and riparian habitat, changes to the surface and sub-surface flows as well as sedimentation as the major potential impacts during the construction and operational phases. Several general and specific mitigation measures are proposed. All three alternatives are considered to have the same potential impacts when compared, with no preferential route from a wetland perspective, the emphasise must fall on site specific mitigation for each scenario /route. Further, illegal sand mining is so rife in and surrounding the study area that all three substation sites could potentially be effected by erosion processes associated with sand mining activities.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EC	Ecological Category
FEPA	Freshwater Ecosystem Priority Area
GPS	Global Positioning System
HGM	Hydrogeomorphic
NBA	National Biodiversity Assessment
NFEPA	National Freshwater Ecosystem Priority Areas project
NWRS	National Water Resource Strategy
PES	Present Ecological State
SAIAB	South African Institute for Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
VEGRAI	Vegetation Reponses Assessment Index
WMA	Water Management Areas
WRC	Water Research Commission
WWF	Worldwide Fund for Nature

1. INTRODUCTION

1.1 Project Description

Eskom Kekana servitude project entails the Kekana Substation Site and Kekana –Pelly-Temba Main loop in-loop out transmission line. Servitude acquisition for the proposed Kekana 132/22kV substation is a 1.5ha site. The Kekana –Pelly-Temba Main loop in-loop out which involves acquiring a 31m wide servitude for the approximate 7km 132kV double circuit loop-in loop out line from the existing Pelly-Temba Main 132kV line to Kekana substation.

Nsovo Environmental Consulting was contracted to review the area and conduct the Environmental Impact Assessment (EIA) on their behalf. Subsequently, WaterMakers was appointed by Nsovo Environmental Consulting as independent specialists to conduct the relevant wetland-related studies in order to facilitate the required environmental authorisation and water use licence processes. The present study represents the baseline and wetland impact assessment of the study and aims to inform responsible decision making with regards to the project.

1.2 Scope of Work

In order to enable an adequate description of potential wetland habitat and so as to ensure that the wetland study conducted is applicable for both an Environmental Authorisation as well as a Water Use Licence Application, the following approach was to be undertaken:

- Desktop assessment
- The wetland delineation should be conducted following the guidelines contained in the DWAF Guideline document entitled "A Practical Field Procedure for Identification and delineation of wetlands and riparian areas" (DWAF, 2008);
- Corroborate field and desktop data and classify confirmed wetlands into hydrogeomorphic units;
- Determine the functionality of wetlands, using a Level 2 Wet-EcoServices (Kotze *et al.*, 2005) assessment for wetlands within the study area;
- Determine the Present Ecological Status (PES) of identified wetlands within the study area through applying a Level 2 Wet-Health assessment (Macfarlane *et al*., 2008);
- Determine the Ecological Importance and Sensitivity (EIS) of identified wetlands by utilising methodology described by Rountree (2013);
- Determine and ground truth the NFEPA status of any wetlands on site, if any;
- Impact assessment for the proposed activities as well as potential mitigation measures.

A site visit to the area to be affected by the proposed activity was undertaken on the 20th, 21st, 22nd and 23rd of January 2015 as well as site visits in March 2024. A detailed description of the methodology used to address the above Terms of Reference is provided in Appendix A.

1.3 Assumptions and Limitations

During the course of the present study, the following limitations were experienced:

- In order to obtain definitive data regarding the biodiversity, hydrology and functioning of particular wetlands, studies should ideally be conducted over a number of seasons and over a number of years.

The current study relied on information gained during multiple field surveys conducted during several seasons, desktop information for the area, as well as professional judgment and experience;

- Wetland and riparian areas within transformed landscapes, such as urban and/or agricultural settings, or mining areas with existing infrastructure, are often affected by disturbances that restrict the use of available wetland indicators, such as hydrophytic vegetation or soil indicators (e.g. as a result of dense stands of alien vegetation, dumping, sedimentation, infrastructure encroachment and infilling). As such, wetland and riparian delineations as provided are based on indicators where available and the author's interpretation of the current extent and nature of the wetlands and riparian areas associated with the proposed activity;
- Some precision agricultural techniques such as topographical manipulation and soil redistribution ploughing were evident within the study area which in some instances could obscure pedological signs of wetness and hydric soil forms;
- Wetland and riparian assessments are based on a selection of available techniques that have been developed through the Department of Water and Sanitation (DWS). These methods are, however, largely qualitative in nature with associated limitations due to the range of interdisciplinary aspects that have to be taken into consideration. Current and historic anthropogenic disturbance within and surrounding the study area has resulted in soil profile disturbances as well as successional changes in species composition in relation to its original /expected benchmark condition;
- Delineations of wetland areas were largely dependent on the extrapolation of field indicator data obtained during field surveys, 5m contour data for the study area, and from interpretation of geo-referenced orthophotos and satellite imagery as well as historic aerial imagery data sets received from the National Department of Rural Development and Land Reform. As such, inherent ortho-rectification errors associated with data capture and transfer to electronic format are likely to decrease the accuracy of wetland boundaries in many instances; and
- Wetlands outside of the study area boundary was extrapolated using aerial imagery, although some sampling was done outside of the study boundaries in order to confirm findings and better interpret hydropedological characterisation of the study area.
- Cumulative impacts should be considered from a regional level, thus DWS Mpumalanga.

2. GENERAL CHARACTERISTICS

2.1 Location

The study area is located south of Hammanskraal, City of Tshwane Local Municipality in the Gauteng Province. The study area lies within Quarter Degree Grid Cell (QDGC) 2528AD between 25°24'02.66" – 25°27'40.12" south and 28°15'02.38" – 28°14'25.33" east (Figure 1).

2.2 Biophysical Attributes

2.2.1 Climate

The study area experiences a strong seasonal summer rainfall with dry winters with the mean annual precipitation between 550mm and 600mm. Frost is experienced fairly frequently with maximum temperatures in January up to 36ºC while the minimum in July drops to -0.4ºC (Mucina and Rutherford, 2006.)

2.2.2 Historic vegetation overview

The study area is situated within the Savanna Biome (Rutherford & Westfall, 1994). The Savanna Biome is the largest Biome in southern Africa, occupying over one-third of the surface area of South Africa (Mucina & Rutherford, 2006). It is characterised by a grassy ground layer and a distinct upper layer of woody plants. Where this upper layer is near the ground the vegetation may be referred to as Shrubveld, where it is dense, as Woodland, and the intermediate stages are locally known as Bushveld (Mucina & Rutherford, 2006).

The Savanna Biome is further divided into smaller units known as vegetation types. According to Mucina & Rutherford (2006), the study area is situated within the Central Sandy Bushveld vegetation type. Central Sandy Bushveld occurs in Limpopo, Mpumalanga, Gauteng and North West Provinces. The landscape is low and undulating with catenas and sandy plains supporting tall trees such as *Terminalia sericea* and *Burkea africana* while *Combretum* woodland dominates shallow soils. *Acacia, Ziziphus* and *Euclea* are found on eutrophic sands and less sandy soils (Mucina & Rutherford, 2006). The Nationally Protected tree, *Sclerocarya birrea* subsp. *caffra* (Marula) is common in this vegetation type while endemic species include *Mosdenia leptostachys* and *Oxygonum dregeanum* subsp. *canescens* var. *dissectum.* According to Mucina & Rutherford (2006), Central Sandy Bushveld is classified as Vulnerable with less than 5% conserved and 24% transformed*,*

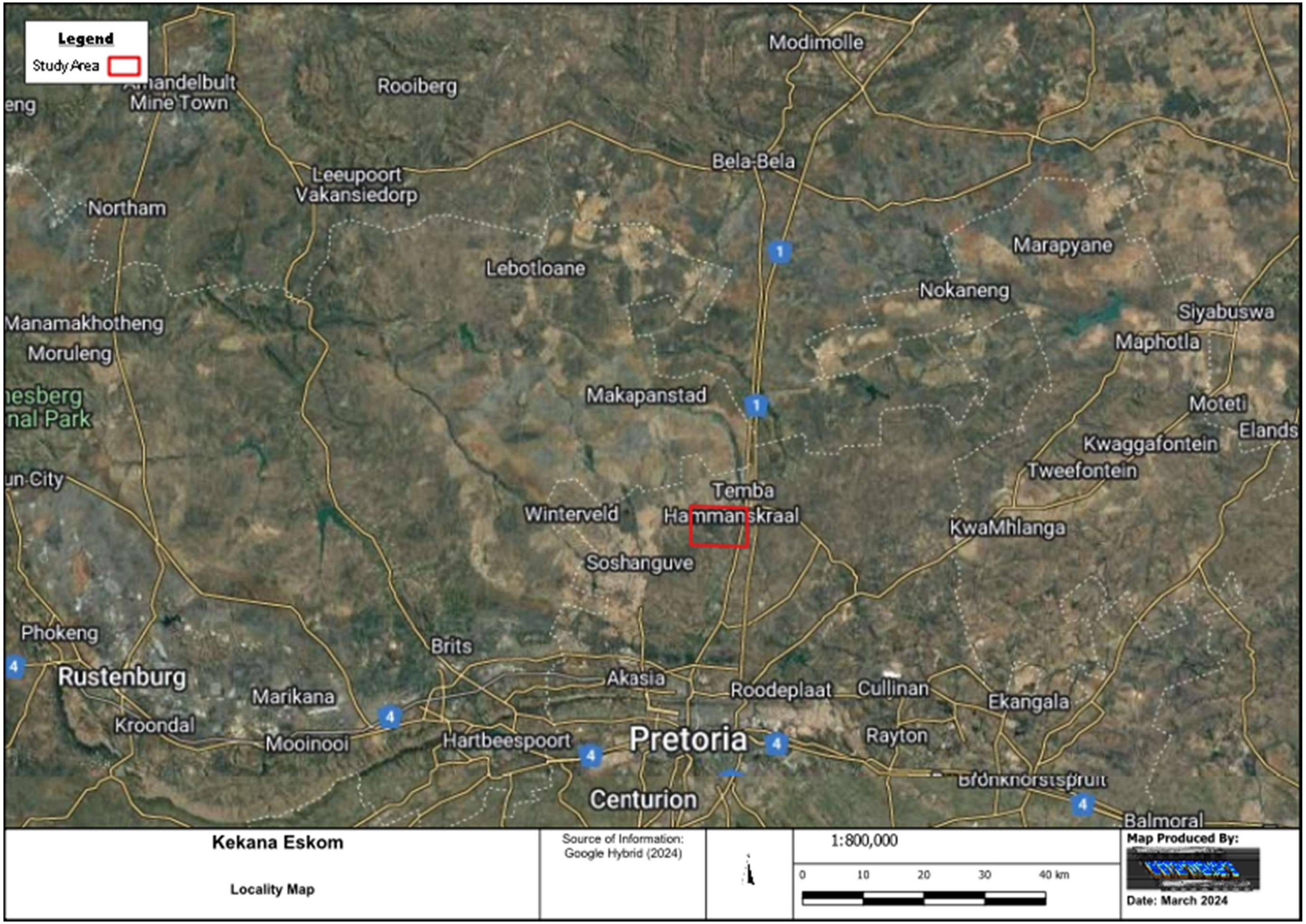


Figure 1: Locality map for the study area

2.2.3 Geology

According to Bamford (2014), the study area is situated on the Hammanskraal Formation which occurs on the Springbok Flats Basin and include ancient Proterozoic rocks of the Vaalian and Mokolian eras to the south with Permian rocks of the Ecca Group to the north (Bamford, 2014). The study area is dominated by the Lebowa granite suite which contains granites which are approximately 2050 million years old, therefore representing a very old landscape (Bamford, 2014) (figure 2).

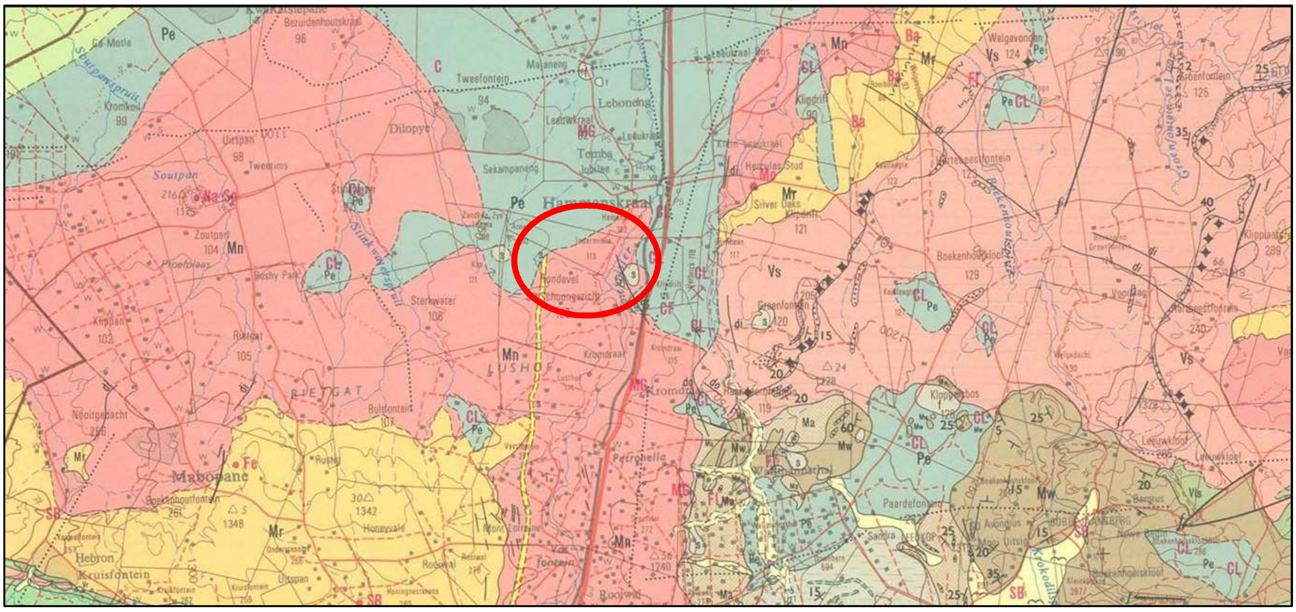


Figure 2: Geology of the study areas (2628 Pretoria 1:250 000; Department of Mines – Geological Survey) with the approximate study areas indicate by red polygons of the map inset

2.2.4 Associated Aquatic Ecosystems and Drainage

The According to SEF (2015), the study area is located within Quaternary Catchments A23F of the Apies/Pienaars sub-management area of the Crocodile (West) and Marico water management area (WMA). The Crocodile (West) and Marico WMA is straddled between the North West, Limpopo and Gauteng provinces along the north east portion of the South African border with Botswana. The major rivers (Crocodile and Marico Rivers) drain the catchment in the north-easterly direction and form the Limpopo River at their confluence, which then flows eastwards to the Indian Ocean (DWAF, 2004; RHP, 2005). The diverse economic activities occurring within this management area including extensive irrigation for agriculture, urban and industrial complexes of northern Johannesburg and Pretoria, as well as Platinum mining north-east of Rustenburg, make this WMA the largest proportional contributor to the country's national economy, as measured by Gross Domestic Product (DWAF, 2004; RHP, 2005). It should be noted that the water utilisation of naturally occurring surface water within this catchment has reached its full potential and does not meet current water demands. Consequently, a substantial portion of water used originates from incoming water transfer schemes from the Vaal River system and other sources, while the dolomitic groundwater aquifers along the southern region supplement and support urban and irrigation activities (DWAF, 2004).

The main watercourse associated with the study area was the Apies River and its catchment area drains the Pretoria Central Business District (CBD), parts of central eastern suburbs, and most of the industrial and urban areas of western Pretoria. Due to the largely impermeable surfaces of these urban areas, a high surface water runoff is channelled into the upper reaches of this system, which most likely causes a change to the natural flow regime and impacts water quality (RHP, 2005). Although this main stem watercourse associated with the study area expresses a perennial nature, there are numerous non-perennial tributaries that join the Apies River that are also associated with the study area, one of which is referred to as the Stinkwaterspruit and/or upper reaches of the Tshwane River. With regards to the slope category of these associated watercourses, the section of the Apies River between Bon Accord Dam and Leeukraal Dam was likely to be defined as a transitioning zone between Upper Foothills and Lower Foothills, the lower reaches of the Stinkwaterspruit/Tshwane River are classed as Lower Foothills (SEF, 2015).

At the time of the 2004 National Biodiversity Assessment (NBA), the heterogeneity signature of these associated watercourses was defined as Bushveld Basin 1, which was previously noted to exhibit a Critically Endangered conservation status, as less than 1% of the length of these river type exhibited good (A or B ecological category) or moderate (C ecological category) conditions (Nel *et al*., 2004). More recently, the 2011 NBA confirmed this ecosystem threat status and revealed that less than 5% of the river ecosystem type was situated within formally protected areas, which corresponded to an ecosystem protection level defined as not protected (Nel & Driver, 2012).

2.2.5 National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA; now Department of Water and Sanitation, or DWS), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF),

South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and
- Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

The first aim uses systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development. The second aim comprises a national and sub-national component. The national component aims to align DWS and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems. The sub-national component aims to use three case study areas to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes at a sub-national level (Driver et al., 2011). The project further aims to maximize synergies and alignment with other national level initiatives such as the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation.

Based on current outputs of the NFEPA project (Nel *et al.*, 2011), several FEPA wetlands were identified in the study area. A set of FEPA wetlands and wetland clusters were identified approximately 1.5 kilometres north of the Kekana Alternative 1 route as well as one depression FEPA wetland south of the Kekana Alternative 2 line route (Figure 3).

2.2.6 Wetland Vegetation Group

According to Nel et al. (2011), the study areas falls mostly within the Central Bushveld Group 3 wetland vegetation group and a small section Central Bushveld Group 2 vegetation group towards the east of the study area. According to Macfarlane et al. (2014), the Central Bushveld Group 2 is regarded as being vulnerable and the Central Bushveld Group 3 wetland vegetation group is regarded as being Endangered (Macfarlane et al., 2014). All of the desktop identified FEPA wetlands form part of Central Bushveld Group 3 wetland vegetation group and were identified by experts at regional review workshops as containing wetlands with biodiversity features, but with no valid reasons documented.

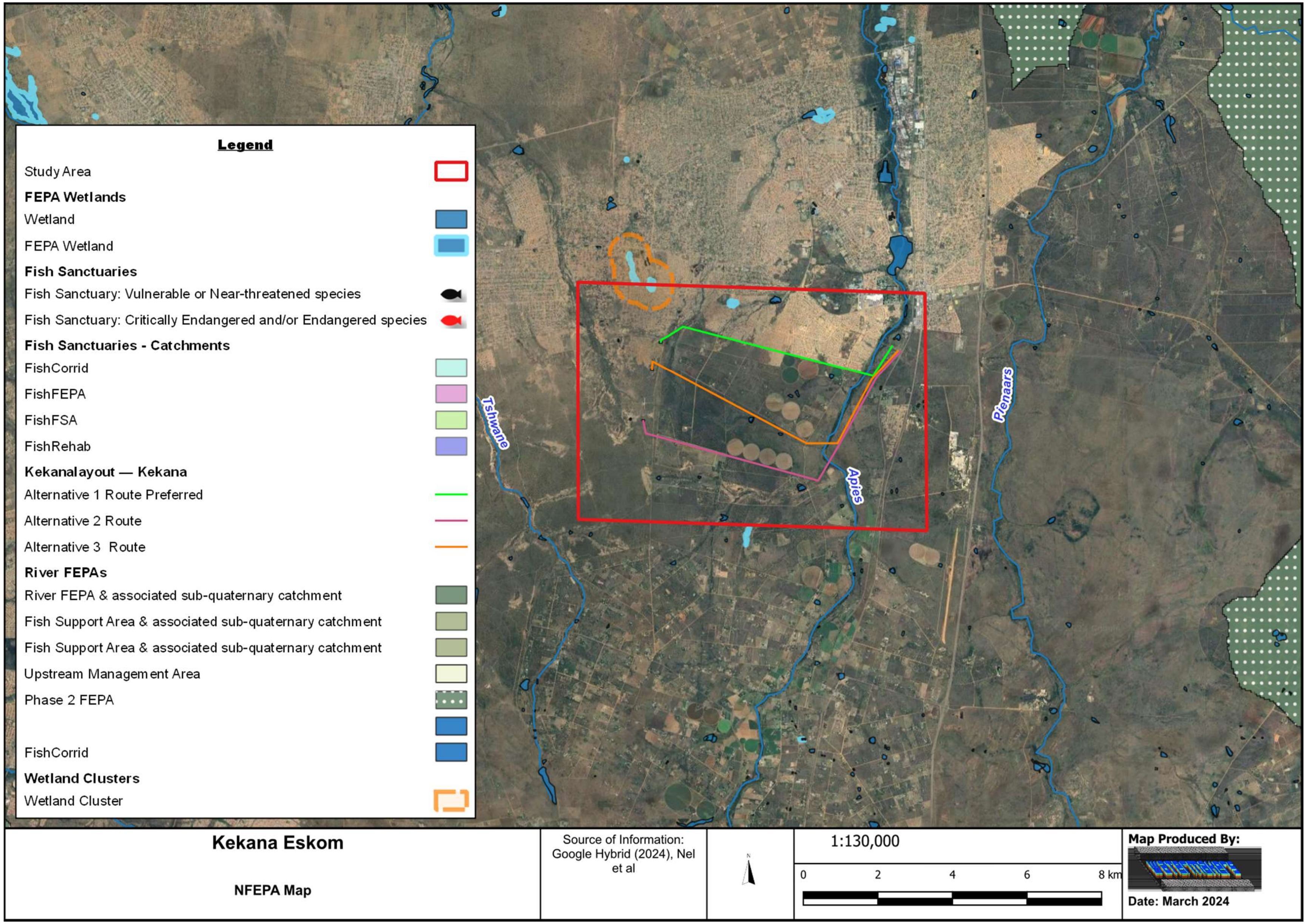


Figure 3: NFEPA map indicating closest FEPA features in relation to the study area

3. ASSOCIATED WETLANDS

3.1 Wetland soils

According to the Department of Water Affairs and Forestry (2005), the permanent zone of a wetland will always have either Champagne, Katspruit, Willowbrook or Rensburg soil forms present, as defined by the Soil Classification Working Group (1991). The seasonal and temporary zones of the wetlands will have one or more of the following soil forms present (signs of wetness incorporated at the form level): Kroonstad, Longlands, Wasbank, Lamotte, Estcourt, Klapmuts, Vilafontes, Kinkelbos, Cartref, Fernwood, Westleigh, Dresden, Avalon, Glencoe, Pinedene, Bainsvlei, Bloemdal, Witfontein, Sepane, Tukulu, Montagu. Alternatively, the seasonal and temporary zones will have one or more of the following soil forms present (signs of wetness incorporated at the family level): Inhoek, Tsitsikamma, Houwhoek, Molopo, Kimberley, Jonkersberg, Groenkop, Etosha, Addo, Brandvlei, Glenrosa, Dundee (Department of Water Affairs and Forestry, 2005). Hydric soil forms identified within the study area included the soil forms Avalon, Bainsvlei, Bloemdal, Dresden, Glencoe, Glenrosa, Katspruit, Rensburg, Longlands, Westleighs, Tukula, Kroonstad, Sepane and Wasbank.

Hydric soil forms identified within the temporary and seasonal zonation supported the Sepane, Pinedene, Wasbank and Constantia soil forms as well as possibly also the Klapmuts, Vilafontes, Kinkelbos soil forms. Soil form and Munsell colours indicated that temporary zonation dominated within wetlands of the majority of the study area. The Katspruit soil form was identified within permanent zonation of wetland habitat. Terrestrial soil forms within the study area included the Clovelly, Hutton, Valsrivier, Avalon, Sterkspruit and Mispah soil forms.

According to Bamford (2014) the study area forms part of a very old and weathered landscape (approx. 2050 million years old) which resulted in the relaxed gradients and well established hydropedological landscape processes associated with wetlands in the study area. The granites within the study area produced large quartz fragments which supports hydraulic connectivity in the landscape and produced relatively large portions of interflow soils (situated between higher lying recharge areas dominated by deeper terrestrial soils and the responsive soils within the wetlands themselves). The interflow soils recognised by their E-horizons are favourably sand mined as a result of the absence of colloidal material making it suitable for plaster sand (Photograph 1).

According to the DWAF (2005), soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence due to the fact that soil wetness indicators (redoximorphic features) remain in wetland soils, even if they are degraded or desiccated, in most instances. It is important to note that the presence or absence of redoximorphic features within the upper 500mm of the soil profile alone is sufficient to identify the soil as being hydric (a wetland soil), or non-hydric (non-wetland soil) (Collins, 2005). Several redoximorphic features were present within soil profiles of the delineated wetland areas, including black, orange and red mottles as well as rhizospheres (Photograph 2).

Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of iron and manganese oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Redoximorphic features typically occur in three types (Collins, 2005):

- **A reduced matrix** - i.e. an *in situ* low chroma (soil colour), resulting from the absence of $Fe^{3}+$ ions which are characterised by "grey" colours of the soil matrix.
- **Redox depletions** - the "grey" (low chroma) bodies within the soil where Fe- Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur.
- **Redox concentrations** - Accumulation of iron and manganese oxides (also called mottles). These can occur as:
  - Concretions - harder, regular shaped bodies;
  - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours; and,
  - Pore linings – zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognised as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.

Photograph 1: Remaining bottom portion of E-horizon with some orange mottles visible within a sand mined area

The new Soil Classification working Group (2018) classification system has incorporated several changes to the previous soil classification Soil Classification Working Group (1991). The new open classification system allows for the classification of whole-soil profiles which potentially enhances studies of water flows in river basins where soil morphology is recognised as an important hydrological indicator of water flow paths and storage mechanisms in hillslopes. The new Soil Classification working Group (2018) soil classification system's open classification structure also allows "natural soils" and "anthropogenic materials" to be separated at the highest category with their respective criteria and structures. This was relevant in the study area itself where historic borrowpit activities are responsible for the complete removal of horisons while more recently applied precision farming techniques are likely responsible for soil disturbances and topographical manipulation to increase maize production. Physically disturbed anthrosols identified within the study area included Grabouw 1000 and Grabouw 2000 cf, transported technosols included Witbank 1100, Witbank 1300, Cullinan 1000 whereas hydric technosols included Stilfontein 3100.

Photograph 2: Orange mottles (indicated by arrows) within a reduced matrix of a valley bottom wetland of the study area. Also note the reduced matrix indicated by grey coloration

3.2 Wetland and Riparian Vegetation

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act (Act 36 of 1998). Using vegetation as a primary wetland indicator however, requires undisturbed conditions (DWAF, 2005) which were not the situation within or surrounding the study area. Further, a cautionary approach must be taken as vegetation alone cannot be used to delineate a wetland, as several species, while common in wetlands, can occur extensively outside of wetlands. When examining plants within a wetland, a distinction between hydrophilic (vegetation adapted to life in saturated conditions) and upland species must be kept in mind. There is typically a well-defined 'wetness' gradient that occurs from the centre of a wetland to its edge that is characterised by a change in species composition between hydrophilic plants that dominate within the wetland to upland species that dominate on the edges of, and outside of the wetland (DWAF, 2003).

Wetland areas with permanent and seasonal zonation and associated high water tables contained hydrophylic plants such as *Typha capensis*, *Juncus* sp., *Cyperus* sp*., Pycereus macranthus, Pycerus nitidus*, *Schoenoplectus brachyceras, Fimbristylis* sp*.* and *Isolepis* sp.. Wetlands associated with temporary hillslope seepage areas consisted of a mixture of facultative wetland and terrestrial species such as *Thermeda triandra, Miscanthus sp., Eragrostis plana, Eragrostis gummiflua*, *Aristida junctiformus, Andropogan* sp*., Setaria sphacelata, Hyparrenhia* sp., *Helichrysum* sp., *Monopsis decipiens*, *Nidorella anomala*. *Sporobolus* sp., and *Anthericum* sp. Alien species were noted in the site including *Cirsium vulgare*, *Campuloclinium macrocephalum*, *Bidens pilosa* and *Tagetes minuta*.

Riparian vegetation associated with the Apies River was characterised by a number of indigenous trees, reeds and shrubs such as *Combretum erythrophyllum, Rhus lancea, Phragmites australis* and *Buddleja salvifolia*. Invasive weedy plants along the river banks included *Amaranthus hybridus*, *Verbena bonariensis, Lantana camara, Mirabilis jalapa*, *Persicaria* sp., as well as *Arundo donax* which was dominant in some locations.

3.3 Delineated Wetland and Riparian Areas

According to the National Water Act (Act no 36 of 1998) a wetland is defined as, "*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*." Wetlands typically occur on the interface between aquatic and terrestrial habitats and therefore display a gradient of wetness – from permanent, to seasonal, to temporary zones of wetness - which is often represented in their plant species composition, as well as their soil characteristics. It is important to take cognisance of the fact that not all wetlands have visible surface water. An area which has a high water table just below the surface of the soil is as much a wetland as a pan that only contains water for a few weeks during the year.

Terrain unit which is another indicator of wetland areas refers to the land unit in which the wetland is found. Wetlands can occur across all terrain units from the crest to the valley bottom. Many wetlands occur within valley bottoms, but wetlands are not exclusively found within depressions.

In practice all indicators should be used in any wetland assessment / delineation exercise, the presence of redoximorphic features being most important (if present), with the other indicators being confirmatory. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland and to delineate the boundary of a wetland. According to the DWAF delineation guidelines, the more wetland indicators that are present, the higher the confidence of the delineation. In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where indicators are no longer present. Wetland boundaries determined within the study area focused on identifying terrain units, soil forms, perceived organic content and the presence of vegetation species that are adapted to saturated conditions.

Thirty-one hydro-geomorphic units (HGM), comprising three HGM types, namely a valley bottom wetland with a channel, valley bottom wetland without a channel as well as a hillslope seepage wetland connected to a watercourse, were delineated and classified within the study area and within at least two kilometres surrounding the study area. HGM units encompass three key elements (Kotze *et al.*, 2005):

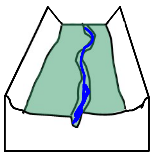
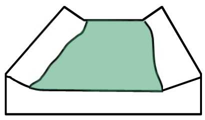
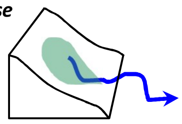
(1) Geomorphic setting. This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
(2) Water source. There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
(3) Hydrodynamics, which refers to how water moves through the wetland.

Confidence for delineations were low due to the very disturbed nature for the majority of the wetlands which were also temporary in their benchmark state (further complicating the delineation processes. It should also be noted that although several of the valley bottom wetlands currently contain a channel, these were likely unchannelled before the advent of anthropogenic impacts within the wetland's catchment and within the wetland itself. Both valley bottom and hillslope seepage wetlands have very relaxed gradients (mostly below 1 % but as low as 0.6%) which further support the unchannelled nature of the wetlands in their pre-impacted state. The HGM units identified within the study area are presented in Figure 3.

Desktop identified FEPA wetlands in the north west of the study area were delineated as HGM 29, a hillslope seepage. Some of the identified wetlands east of HGM 29 were already destroyed as a result of sand mining activities, including an identified FEPA depression just below Temba. The other FEPA identified wetland situated some distance south of the study area was delineated as HGM 22, a hillslope seepage wetland.

Table 1 describes some of the characteristics that form the basis for the classification of the HGM units within and surrounding the study area.

Table 1: Wetland hydro-geomorphic type typically supporting inland wetlands in South Africa and also present within the study area (adapted from Kotze *et al*., 2005)

Hydro-geomorphic types	**Description**	**Source of water maintaining the wetland[1]**	
		Surface	**Sub-surface**
Valley bottom with a channel 	Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***
Valley bottom without a channel 	Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/ ***
Hillslope seepage feeding a watercourse 	Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a watercourse.	*	***

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

Water source: * Contribution usually small
*** Contribution usually large
*/ *** Contribution may be small or important depending on the local circumstances


Wetland

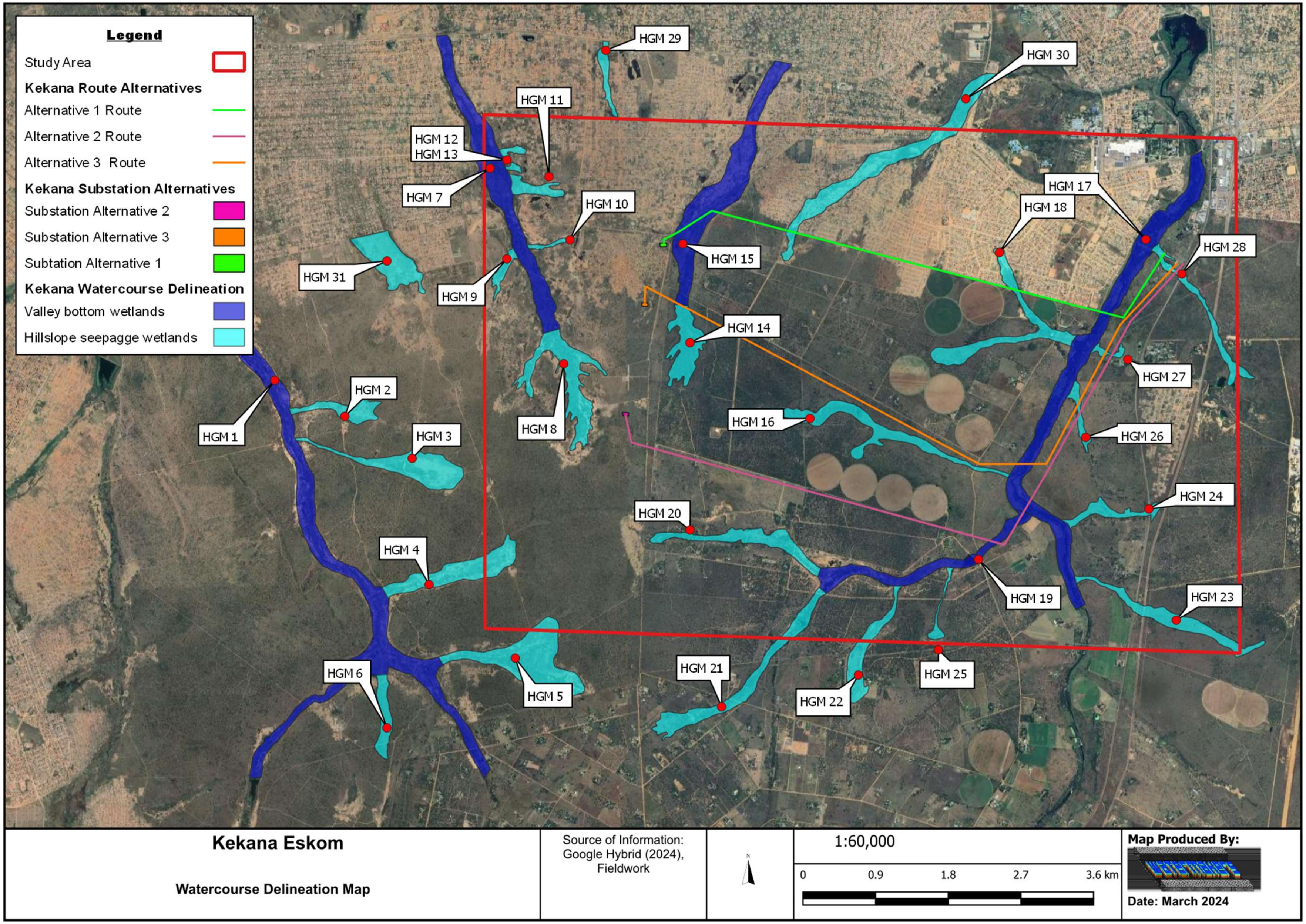


Figure 4: Delineated wetlands within the study area and within 500m

3.4 Functional and Present Ecological State Assessment

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. Many of these functional benefits therefore contribute directly or indirectly to increased biodiversity within the study area as well as downstream of the study area through provision and maintenance of appropriate habitat and associated ecological processes (Table 2).

Table 2: Potential wetland services and functions in study area

Function	Aspect
Water balance	Streamflow regulation
	Flood attenuation
	Groundwater recharge
Water purification	Nitrogen removal
	Phosphate removal
	Toxicant removal
	Water quality
Sediment trapping	Particle assimilation
Harvesting of natural resources	Reeds, Hunting, etc.
Foraging	Water for animals
	Grazing for animals

Hydro-geomorphic units are inherently associated with hydrological characteristics related to their form, structure and particularly their position in the landscape. This, together with the biotic and abiotic character (or biophysical environment) of wetlands, means that certain wetland types are able to contribute better to some ecosystem services than to others (Kotze *et al.,* 2005) (Table 3).

Table 3: Preliminary rating of the hydrological benefits potentially provided by a wetland given its particular hydro-geomorphic type (Kotze *et al*., 2005)

WETLAND HYDRO-GEOMORPHIC TYPE	HYDROLOGICAL BENEFITS POTENTIALLY PROVIDED BY THE WETLAND							
	Flood attenuation		Stream flow regulation	Erosion control	Enhancement of water quality			
	Early wet season	Late wet season			Sediment trapping	Phos-phates	Nitrates	Toxicants[2]
Valley bottom - channelled	+	0	0	++	+	+	+	+
Valley bottom - unchannelled	+	+	+?	++	++	+	+	++
Hillslope seepage feeding a stream channel	+	0	+	++	0	0	++	++

[2]Toxicants are taken to include heavy metals and biocides

Rating:
- 0 Benefit unlikely to be provided to any significant extent
- \+ Benefit likely to be present at least to some degree
- ++ Benefit very likely to be present (and often supplied to a high level)

Each wetland's ability to contribute to ecosystem services within the study area is also dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. Present Ecological State scores were determined for wetlands within the study area using

Wet-Health assessments. Through the use of a scoring system, the perceived departure of elements of each particular system from the "natural-state" was determined (current state versus anticipated future rehabilitated state). The following elements were considered in the assessment:

- Hydrologic: Flow modification (has the flow, rates, volume of run-off or the periodicity changed);
- Geomorphic (Canalisation, impounding, topographic alteration and modification of key drivers);
- Biota (Changes in species composition and richness, Invasive plant encroachment, over utilization of biota and land-use modification)

The Present Ecological State and functionality of wetlands within the study area are discussed below. In various instances hydro-geomorphic units shared similar characteristics and impacts and were therefore assessed together. In general, from a Wet-Health perspective, most wetlands have been seriously modified as a result of extensive sand mining operations that have taken place on various scales and over several decades, still continuing at present (Figure 4). Sand mining operations have impacted more severely towards the north of the study area where population densities and associated anthropogenic pressures and impacts escalates. Sandy wetland soils and interflow soils containing E-horizons are usually mined first (used for plaster) followed by terrestrial soils that are utilised for building material. Although the hydrological driver (recharge within the natural to semi natural catchment) still remains, it is often the removal of the interflow soils which causes a major disruption in the hydrological support to the wetlands, especially since both valley bottoms and especially hillslope seepage wetlands are dependent on lateral seepage within the study area. Figure 5 summarises Wet-health assessment result within the study area.

Figure 5: Typical sand mining operations undertaken within the study area (Google earth, 2015)

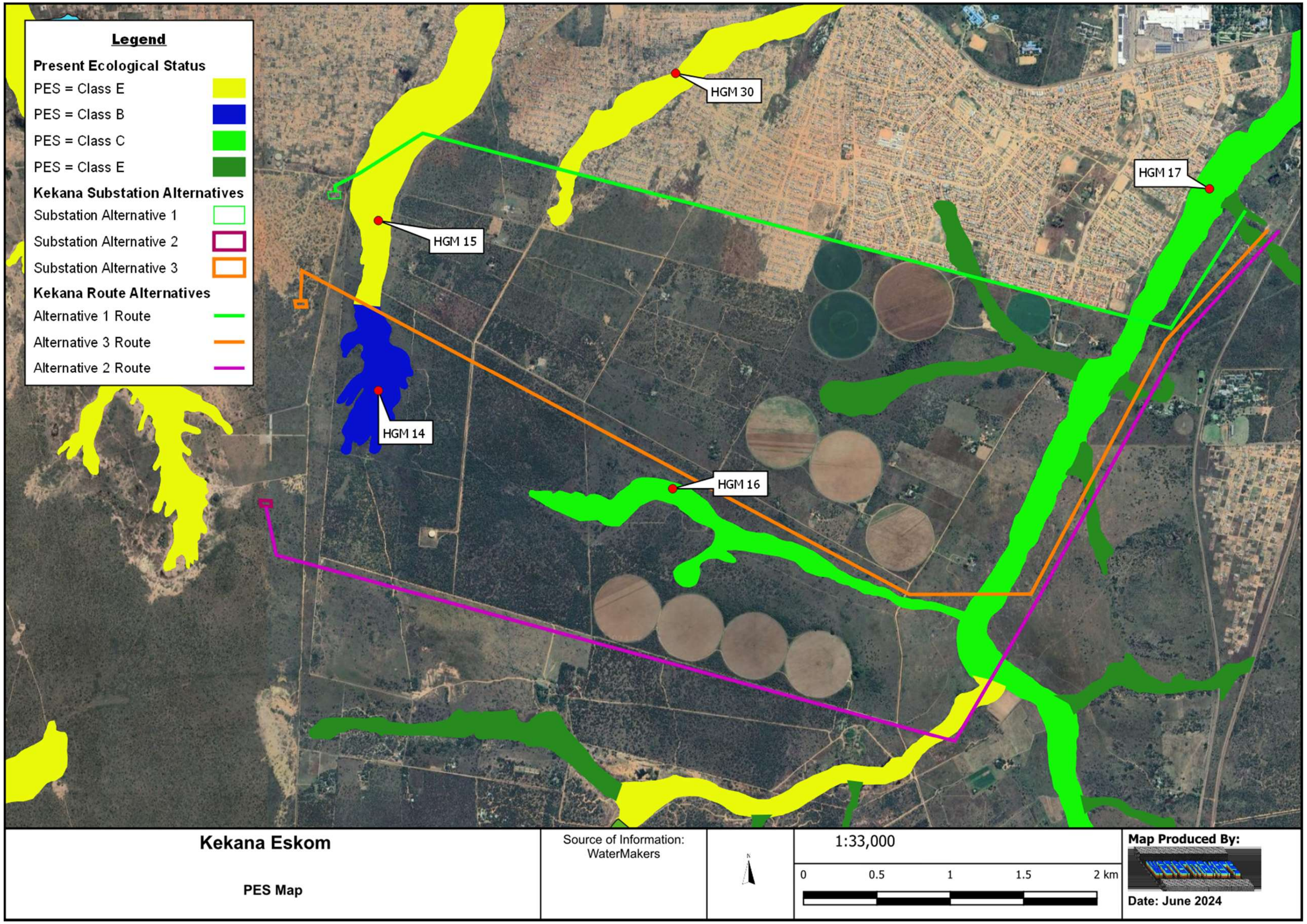


Figure 6: Wet-health PES score results obtained for wetlands within the study area

HGM 1, HGM 2, HGM 3, HGM 4, HGM 5 and HGM 6

This wetland complex consisted of a valley bottom wetland with several supporting hillslope seepages. The wetland complex has been seriously modified as a result of intensive sand mining operations which has completely altered the majority of the wetlands (Photograph 3). From a hydrological perspective, water inputs from its main channel and lateral seepage have been largely disrupted, while retention patterns have been critically modified as a result of no rehabilitation being associated with sand mining activities. The net removal of material from the wetlands critically modified the geomorphology of the wetlands. The original wetland's associated vegetation has been replaced with a patch-work of terrestrial, facultative and obligatory wetland plant species recolonizing disturbed areas. A few connecting seepages south of the study area are less affected by the sand mining activities and therefore provide some hydrological input to the delineated valley bottom wetland through the valley bottom's main channel. Combined weighted scores obtained for the wetland indicated a PES Category E (seriously modified; Table 4). Further, although the catchment of the wetlands is largely natural, overgrazing practices that has continued for several decades have significantly lowered the basal cover which increased run-of received by the wetlands. If no rehabilitation measures are put in place, the predicted trajectory of change for wetlands are expected to be a slight deterioration over the next five years.

Photograph 3: Intensive sand mining operations in the north of the study area within HGM 1

Table 4: Wet-Health scores for HGM 1, HGM 2, HGM 3, HGM 4, HGM 5 and HGM 6

Hydrology	Geomorphology	Vegetation	PES category
7.5	9.1	7.1	E (7.8)

From a functional perspective, ecosystem services are expected to be seriously reduced as a result of the destruction of wetland habitat (Figure 6). Some flood attenuation is expected to take place as a result of the relaxed gradient associated with the wetlands and potentially within the multitude of excavation depressions that resulted from the ad hoc sand mining operations. However, as erosional process are expected to be high as a result of the lack of adequate vegetation cover and disturbed soil profiles, flood attenuation capacity of the wetlands could easily diminish as erosional processes advances. Functionality for the wetland could potentially increase substantially through appropriate rehabilitation measures.

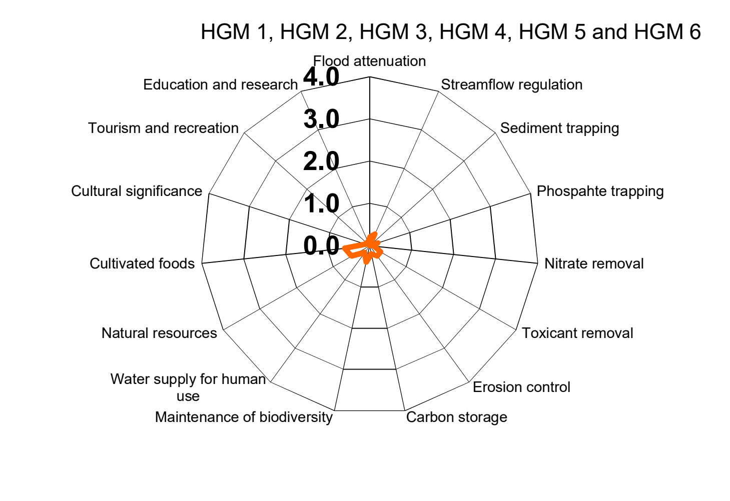


Figure 7: Radar diagram illustrating ecosystem services for HGM 1, HGM 2, HGM 3, HGM 4, HGM 5 and HGM 6

<u>HGM 7, HGM 8, HGM 9, HGM 10, HGM 11, HGM 12 and HGM 13</u>

This wetland complex also consisted of a valley bottom wetland with several supporting hillslope seepages. Combined weighted scores obtained for the wetland indicated a PES Category E (seriously modified; Table 5). The wetland complex have been seriously modified as a result of similar impacts as described for the wetland complex discussed above (extensive sand mining operations which have completely altered the majority of the wetlands). HGM 8 retained some representative vegetation species and geomorphology, however, from a hydrological perspective it was also seriously impacted by sand mining just outside the periphery of the seepage wetland.

Table 5: Wet-Health scores for HGM 7, HGM 8, HGM 9, HGM 10, HGM 11, HGM 12 and HGM 13

Hydrology	Geomorphology	Vegetation	PES category
6.6	7.1	6.2	E (6.6)

From a functional perspective, ecosystem services are expected to be seriously reduced as a result of the destruction of wetland habitat (Figure 7). The maintenance of biodiversity was increased as a result of the occurrence of some representative vegetation in HGM 8 which is also located in the vicinity of HGM 14 which likely supports several biodiversity features. Some limited natural resources are provided as fire wood and grazing as well as subsistence and recreational hunting. Functionality for the wetland could potentially increase substantially through appropriate rehabilitation measures especially towards the north and on the periphery of HGM 8.

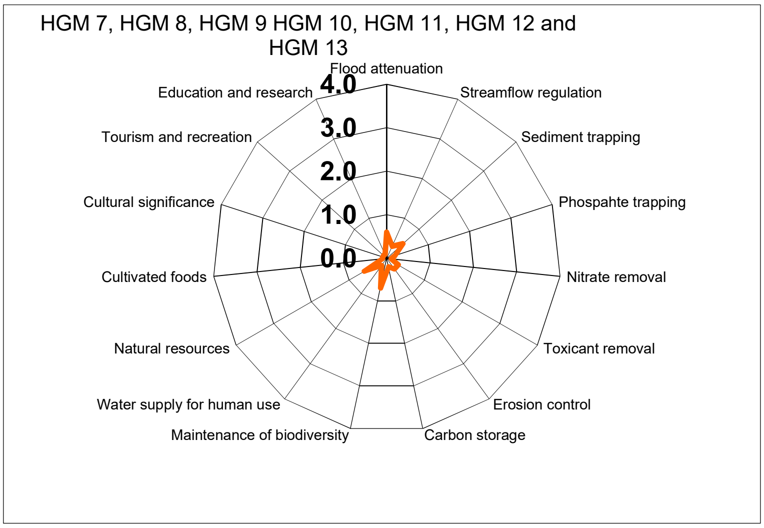


Figure 8: Radar diagram illustrating ecosystem services for HGM 7, HGM 8, HGM 9, HGM 10, HGM 11, HGM 12 and HGM 13

HGM 14

HGM 14 was determined to be largely natural with some loss of natural habitats (PES Category B; Table 6). Modifications to this system include possible changes to the hydrology of the system as a result of increased run-off from historic agricultural fields in the south of the seepage wetland and its associated catchment. A small dam was situated on the periphery of the wetland but was not expected to have a major influence on the hydrology. Vegetation composition was representative as the camp in which the wetland was situated was utilised as a game camp.

Table 6: Wet-Health scores for HGM 14

Hydrology	Geomorphology	Vegetation	PES category
2.2	1.7	1.8	B (1.9)

This hillslope seepage system highest scoring eco-services attributes were maintenance of biodiversity, nitrate removal and streamflow regulation (Figure 8). The accumulation of organic matter and fine sediments in the wetland soils results in the wetland slowing down the sub-surface movement of water down the slope. This “plugging effect” increases the storage capacity of the slope above the wetland, and prolongs the contribution of water to the stream system during low flow periods (Kotze, 2005). Seepage wetlands are commonly considered to supply a number of water quality enhancement benefits, for example, removing excess nutrients and inorganic pollutants produced by agriculture, industry and domestic waste (Rogers *et al*., 1985; Gren, 1995; Ewel, 1997; Postel, 1997). Hillslope seepages generally would be expected to have a relatively high nitrogen removal potential. Nitrogen and specifically nitrate removal could be expected as the groundwater emerges through low redox potential zones within the wetland soils, with the wetland plants contributing to the necessary supply of organic carbon. Particularly effective removal has been recorded of nitrates from diffuse sub-surface flow, as characterizes hillslope seepages (Muscutt *et al*., 1993). From a biodiversity perspective HGM 14 represented a rather unique wetland being dominated by *Spirostachys africana* (Tamboti) woodland which could potentially provide habitat for fauna and flora species of conservation concern based on the wetlands intact nature (Photograph 4). Wetland functionality in general was reduced as a result of the very temporary nature of the wetland despite the wetlands intact nature.

Photograph 4: Artificial dam on the periphery of *Spirostachys africana* (Tamboti) dominated hillslope seepage woodland.

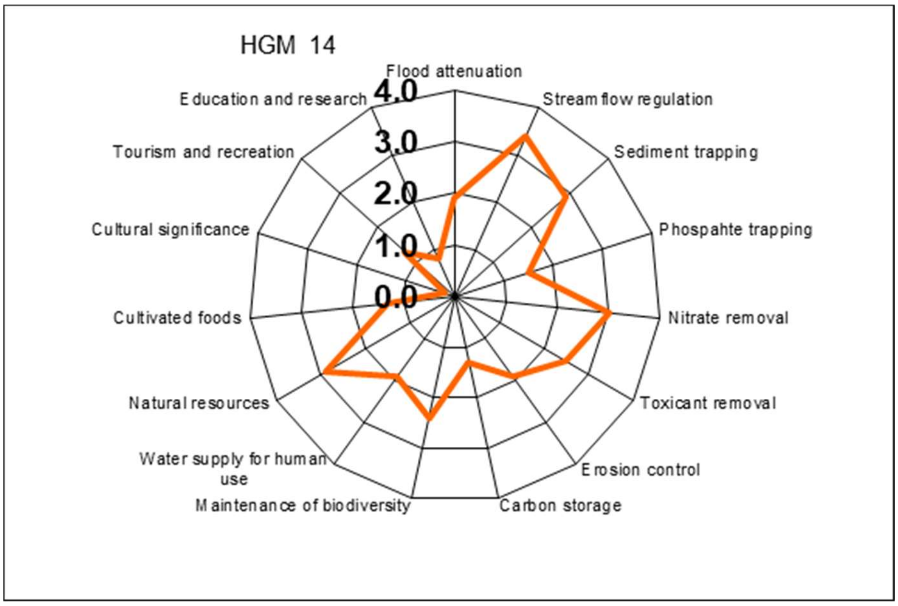


Figure 9: Radar diagram illustrating ecosystem services for HGM 14

HGM 15

Combined weighted scores for this valley bottom wetland indicated the wetland to be seriously modified (PES Category E; Table 7). The wetland however is intact and largely natural in the wetlands upper reaches and gradually decreases in PES towards the north where it is critically modified. Impacts include typical sand mining activities as previously discussed as well as some subsistence farming, overgrazing, rural and infrastructure development as well as channelization directly north of the delineated wetland.

Table 7: Wet-Health scores for HGM 15

Hydrology	Geomorphology	Vegetation	PES category
6.1	6.3	5.9	E (6.1)

From a functional perspective ecosystem services were reduced as a result of the poor PES as well as the temporary nature of the wetland. Highest scoring attributes included flood attenuation, cultivated foods and provision of natural resources (Figure 9).

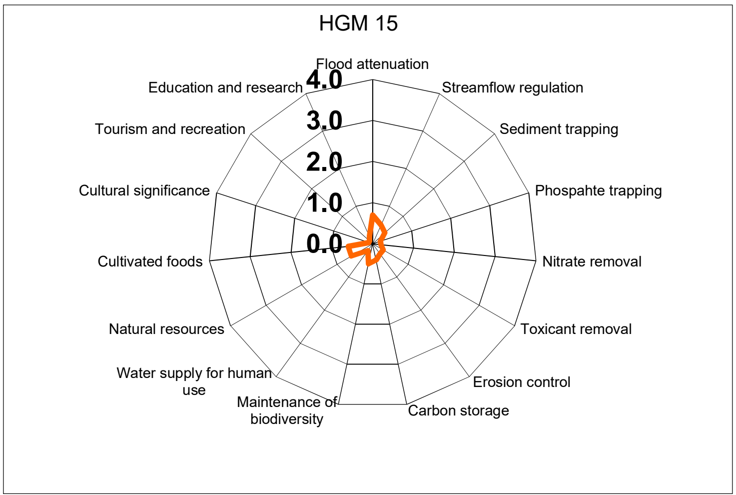


Figure 10: Radar diagram illustrating ecosystem services for HGM 15

HGM 16

HGM 16 was determined to be moderately modified with some loss of natural habitats (PES Category C; Table 8). Modifications to this system include possible changes to the hydrology of the system as a result of increased run-off as a result of some reduced basal cover through historic overgrazing of the seepage wetland's associated catchment. Vegetation structure and composition was similar to the intact HGM 14.

Table 8: Wet-Health scores for HGM 14

Hydrology	Geomorphology	Vegetation	PES category
2.2	1.7	2.8	C (2.2)

This hillslope seepage system highest scoring eco-services attributes were maintenance of biodiversity, nitrate removal and streamflow regulation (Figure 10).

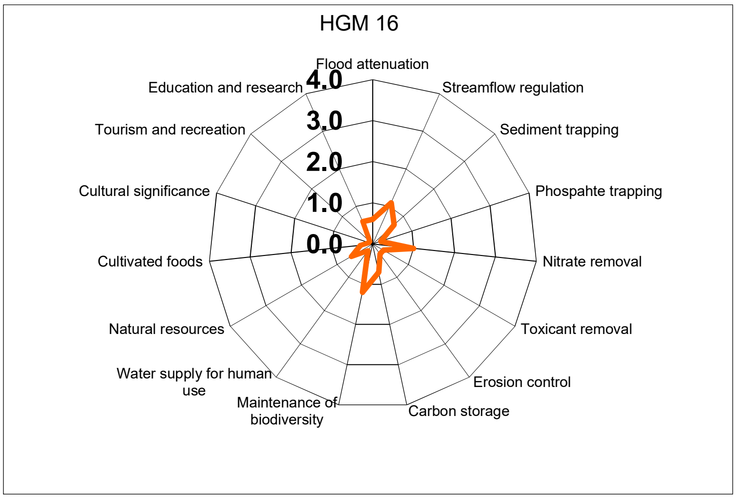


Figure 11: Radar diagram illustrating ecosystem services for HGM 14

HGM 17

HGM 17, the Apies River, represents a channelled valley bottom wetland within the study area before changing into a true floodplain a few kilometres north of the study area. Small floodplain features such as meander cut-off's are present in the northern section of the delineated wetland.

The PES for HGM 17 was considered to be largely modified (PES category D; Table 9) as a result of several historic and current impacts. Catchment impacts within the vicinity of the delineated wetland related mostly to commercial farming activities in the south. Towards the north of the delineated wetland it is likely that sediment input to the river has increased from the original benchmark condition as a result of erosion problems, subsistence farming (on the riverbank) and network of dirt roads. The northern section of the associated catchment becomes more urbanised and denser (Hammanskraal) with an increase in hardened surfaces (and associated increase in peak flow discharge rates), channel incision becomes more prominent especially where deeper soil profiles exist. A deeper channel and flow control (Bonacord Dam) are likely to have decreased flood frequency and velocities. Several instream barriers, bridges as well as other linear infrastructure transects the river at various localities. Alien vegetation infestation has led to a change in species composition of especially the riparian vegetation while basal cover and surface roughness has typically been reduced as a result of utilisation of the river banks for subsistence farming at various localities. The largest impact on the hydrology and geomorphology of the system was perceived to be channel incision.

Table 9: Wet-Health scores for HGM 19

Hydrology	Geomorphology	Vegetation	PES category
4.4	4.0	4.5	D (4.3)

From a functional perspective this channelled valley bottom wetland received its highest score for maintenance of biodiversity, flood attenuation, sediment trapping (Figure 11). Some elements of natural vegetation were retained as well as a relatively high sinuosity of the stream channel, affording the system potential to maintain biodiversity (especially as a biodiversity corridor) and trap sediment. The functionality of HGM 17 rated highest within the study area as a result of the relatively large permanent zonation and associated opportunity to deliver ecosystem services

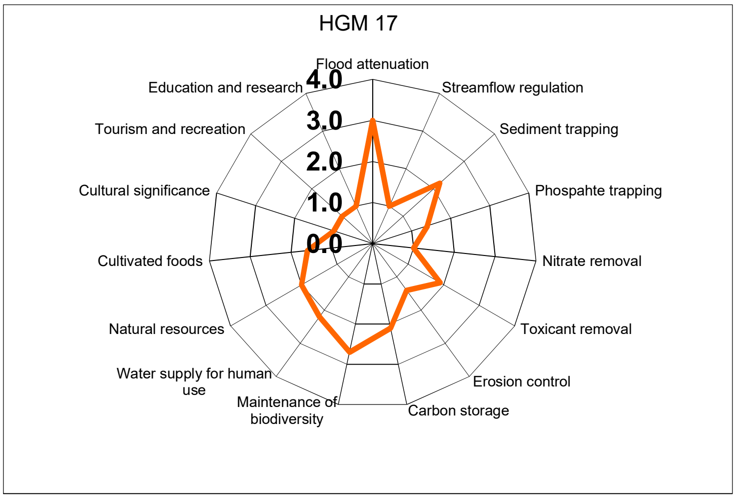


Figure 12: Radar diagram illustrating ecosystem services for HGM 17

<u>HGM 19</u>

Combined weighted scores for this valley bottom wetland indicated the wetland to be seriously modified (PES Category E; Table 10). The valley bottom wetland underwent heavy sand mining activities in the past with typical associated impacts described previously. Although some revegetation with pioneer species of sand mined areas have taken place, impacts on the hydrology and geomorphology remains.

Table 10: Wet-Health scores for HGM 19

Hydrology	Geomorphology	Vegetation	PES category
7.1	8.7	5.9	E (7.2)

From a functional perspective ecosystem services were reduced as a result of the poor PES as well as the temporary nature of the wetland (Figure 12). Highest scoring attributes included flood attenuation, cultivated foods and provision of natural resources.

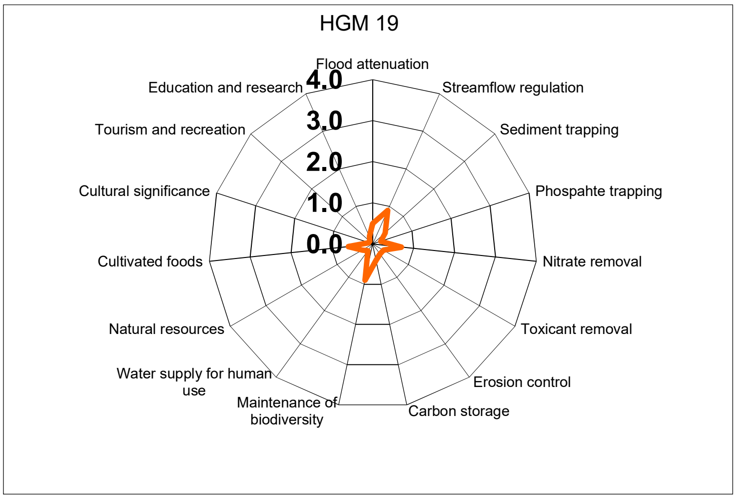


Figure 13: Radar diagram illustrating ecosystem services for HGM 19

<u>HGM 18, HGM 20, HGM 21, HGM 22, HGM 23, HGM 24, HGM 25, HGM 26, HGM 27 and HGM 28</u>

The majority of these hillslope seepages have been largely modified (PES Category D; Table 11) as a result of especially agricultural activities either within or on the periphery of these wetlands. Other impacts effecting the hydrology and geomorphology of these wetlands include several farm dams as well as an extensive dirt road network transecting wetlands which increases concentrated run-off into the seepage wetlands. Small sand mining activities and changes in species composition as a result of various types of farming activities were also evident.

Table 11: Wet-Health scores for HGM 18, HGM 20, HGM 21, HGM 22, HGM 23, HGM 24, HGM 25, HGM 26, HGM 27 and HGM 28

Hydrology	**Geomorphology**	**Vegetation**	**PES category**
4.1	3.9	4.1	D (4.0)

This hillslope seepage system highest scoring eco-services attributes were maintenance of biodiversity, nitrate removal and streamflow regulation (Figure 13). Ecosystem services in general were higher within these wetlands than in the north west of the study area although the temporary nature of the wetlands reduced their capability to deliver ecosystem services.

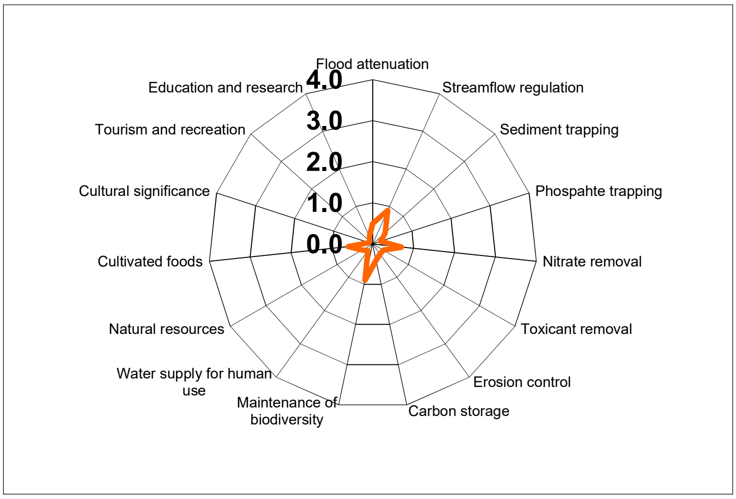


Figure 14: Radar diagram illustrating ecosystem services for HGM 18, HGM 20, HGM 21, HGM 22, HGM 23, HGM 24, HGM 25, HGM 26, HGM 27 and HGM 28

HGM 30

Combined weighted scores for this hillslope seepage wetland indicated the wetland to be seriously modified (PES Category E; Table 12). Impacts include typical sand mining activities as previously discussed as well as historic farming activities within the wetland as evident by several sclarification marks on aerial imagery. Other impacts negatively effecting the hydrology and geomorphology of the wetland include infilling (in the north of the delineated wetland) overgrazing as well as residential and infrastructure development (especially road and sewerage infrastructure).

Table 12: Wet-Health scores for HGM 30

Hydrology	Geomorphology	Vegetation	PES category
7.1	7.3	6.9	E (7.1)

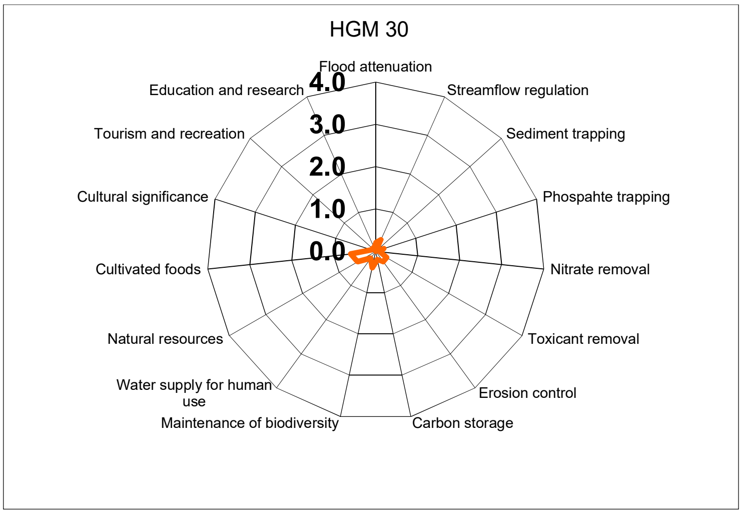


Figure 15: Radar diagram illustrating ecosystem services for HGM 30

From a functional perspective ecosystem services were reduced as a result of the poor PES as well as the temporary nature of the wetland. Highest scoring attributes included flood attenuation, cultivated foods and provision of natural resources (firewood and grazing)

HGM 31

Combined weighted scores for this hillslope seepage wetland indicated the wetland to be critically modified (PES Category F; Table 13). Impacts include extensive subsistence farming within the wetland as well as on the wetlands periphery as well as sand mining activities especially towards the south of the wetland. Connectivity of the wetland towards the north was severed as a result of informal residential and associated infrastructure development.

Table 13: Wet-Health scores for HGM 31

Hydrology	Geomorphology	Vegetation	PES category
7.9	8.0	8.9	F (8.2)

From a functional perspective ecosystem services were reduced as a result of the poor PES as well as the temporary nature of the wetland (Figure 15). Highest scoring attributes included flood attenuation, cultivated foods and provision of natural resources (firewood and grazing)

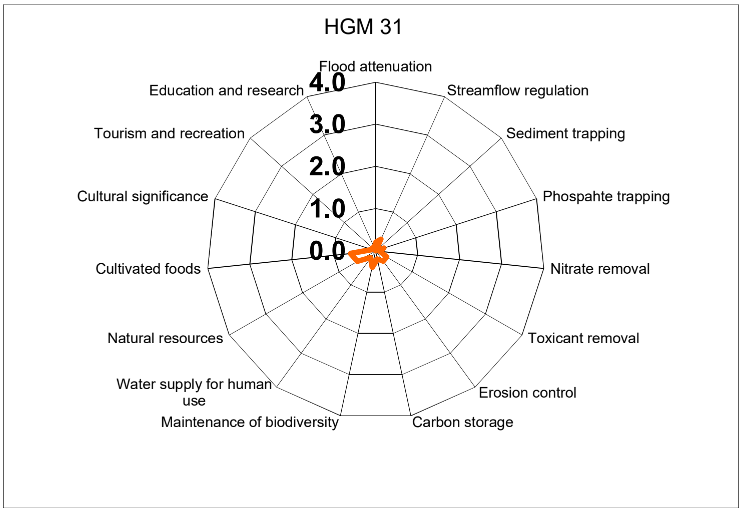


Figure 16: Radar diagram illustrating ecosystem services for HGM 31

3.5 Ecological Importance and Sensitivity

All wetlands, rivers, their flood zones and their riparian areas are protected by law and no development is allowed to negatively impact on rivers and river vegetation. The vegetation in and around rivers and drainage lines play an important role in water catchments, assimilation of phosphates, nitrates and toxins as well as flood attenuation. Quality, quantity and sustainability of water resources are fully dependent on good land management practices within the catchment.

The Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank water resources in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- Biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

Water resources which have high values for one or more of these criteria may thus be prioritised and managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), hydrological functional importance (where water resources provide critical functions upon which people may be dependent, such as water quality improvement) or their role in providing direct human benefits (Rountree, 2013).

Ecological Importance and Sensitivity results for each of the HGM units identified to be associated with the study area are listed in Table 14.

Table 14: Ecological Importance and Sensitivity scores for wetland

Wetland Complex	Parameter	Rating (0 - 4)	Confidence (1 – 5)
HGM 1, HGM 2, HGM 3, HGM 4, HGM 5 and HGM 6	**Ecological Importance & Sensitivity**	Low (1.0)	3.4
	Hydrological / Functional Importance	Very low (0.6)	3.5
	Direct Human Benefits	Very low (0.4)	3
HGM 7, HGM 8, HGM 9, HGM 10, HGM 11, HGM 12 and HGM 13	**Ecological Importance & Sensitivity**	Low (1.2)	3.4
	Hydrological / Functional Importance	Very low (0.7)	3.5
	Direct Human Benefits	Very low (0.4)	3.0
HGM 14	**Ecological Importance & Sensitivity**	Very High (3.6)	2.4
	Hydrological / Functional Importance	Moderate (2.1)	2.5
	Direct Human Benefits	Moderate (2.4)	3.0
HGM 15	**Ecological Importance & Sensitivity**	Low (1.7)	3.1

	Hydrological / Functional Importance	Very low (0.7)	2.5
	Direct Human Benefits	Very low (0.8)	3
HGM 16	**Ecological Importance & Sensitivity**	High (3.0)	2.4
	Hydrological / Functional Importance	Low (1.8)	3.5
	Direct Human Benefits	Low (1.1)	3.0
HGM 17	**Ecological Importance & Sensitivity**	High (3.0)	2.6
	Hydrological / Functional Importance	High (3.2)	3.5
	Direct Human Benefits	Moderate (2.3)	3.0
HGM 19	**Ecological Importance & Sensitivity**	Very low (0.9)	2.8
	Hydrological / Functional Importance	Very low (0.8)	3.1
	Direct Human Benefits	Very Low (0.3)	3.0
HGM 18, HGM 20, HGM 21, HGM 22, HGM 23, HGM 24, HGM 25, HGM 26, HGM 27 and HGM 28	**Ecological Importance & Sensitivity**	Low (1.2)	2.4
	Hydrological / Functional Importance	Low (1.3)	3.1
	Direct Human Benefits	Very Low (0.8)	2.0
HGM 30	**Ecological Importance & Sensitivity**	Very low (0.8)	2.1
	Hydrological / Functional Importance	Very low (0.9)	2.6
	Direct Human Benefits	Very Low (0.9)	3.3
HGM 31	**Ecological Importance & Sensitivity**	Very low (0.2)	2.1
	Hydrological / Functional Importance	Very low (0.2)	2.6
	Direct Human Benefits	Low (1.0)	3.3

In general, most of the identified HGM units attained low to very low scores for their respective Ecological Importance and Sensitivity analysis as a result of the temporary nature of the majority of wetlands as well as to the presence of anthropogenic impacts, especially extensive sand mining within the study area's wetlands and their respective catchments. However, HGM 14 and HGM 16 scored high as a result of the uniqueness and intact nature of these seepage wetlands. HGM 14 and HGM 16 represent wooded seepage wetlands which are the only representative seepage wetlands remaining in an area which have otherwise been desiccated through especially sand mining activities. HGM 17 (Apies River) also received high scores as a result of the regional hydrological and functional as well as the high ratio of permanent zonation associated with the valley bottom wetland. According to DWA (2012), the Apies River feeds into the Moretele floodplain complex just north of the study area which is regarded as the second largest floodplain in the Bushveld Ecoregion and represents the southern-most natural distribution of Wild Rice (*Oryza longistaminata*) in Africa. The floodplain is used extensively by the surrounding communities for fishing and grazing and is also regarded as an important birding area, with the floodplain and surrounding area supporting 362 of the 461 species recorded in the North West Province. The wetland also includes traditionally sacred sites which have high cultural significance.

Direct human benefit associated with the wetlands within the study area included water supply, cultivation of agricultural plots and food gardens, water supply to commercial pivots, subsistence and recreational hunting, collection of building materials and firewood as well as grazing of livestock.

3.6 Freshwater Ecosystem Buffers

Buffer zones associated with water resources have been shown to perform a wide range of functions, and have been proposed as a standard measure to protect water resources and associated biodiversity on this basis. These functions can include (Macfarlane & Bredin, 2016):

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

However, despite the range of functions potentially provided by buffer zones, buffer zones are unable to address all water resource-related problems. For example, buffers can do little to address impacts such as hydrological changes caused by for example stream flow reduction activities or changes in flow brought about by abstractions or upstream impoundments. Buffer zones are also not the appropriate tool for mitigating against point-source discharges (e.g. sewage outflows), which can be more effectively managed by targeting these areas through specific source-directed controls (Macfarlane & Bredin, 2016). Nevertheless, buffer zones are well suited to perform functions such as sediment trapping and nutrient retention which can significantly reduce the impact of activities taking place adjacent to water resources. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts linked with diffuse storm water runoff from land-uses / activities planned adjacent to water resources. These must, however, be considered in conjunction with other mitigation measures which may be required to address specific impacts for which buffer zones are not well suited (Macfarlane & Bredin, 2016). Further, it should also be noted that the buffer zones determined below did not consider any species-specific buffer requirements that might be necessitated.

Determination of the preliminary buffer requirements for the wetland features associated with the proposed development (typical Eskom distribution infrastructure) followed the approach of Macfarlane & Bredin (2016), whereby the preliminary required buffers were developed based on various factors, including assumed building densities, slope, annual precipitation, rainfall intensity, channel width, catchment to wetland ratio, etc. Accordingly, preliminary buffer requirements for the identified wetlands were determined to be variable depending on the specific adjacent slope condition, historic impacts, associated gradient as well as management regime applied. The DWS buffer model calculated a scientific buffer for the development of 25m. However, a 30m buffer is required by GDARD and therefore applies.

4. ASSESSMENT OF IMPACTS

Any developmental activities in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the impacts caused by the proposed activities and to provide a description of potential mitigation required so as to limit the perceived impacts on the natural environment.

4.1 Impact Assessment Methodology

The environmental impacts are assessed with mitigation measures (WMM) and without mitigation measures (WOMM) and the results presented in impact tables which summarise the assessment. Mitigation and management actions are also recommended with the aim of enhancing positive impacts and minimising negative impacts.

In order to assess these impacts, the proposed development has been divided into two project phases, namely the construction and operational phase. The criteria against which these activities were assessed are discussed below.

Nature of the Impact
This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.

Extent of the Impact
A description of whether the impact will be local, limited to the study area and its immediate surroundings, regional, or on a national scale.

Duration of the Impact
This provides an indication of whether the lifespan of the impact would be short term (0-5 years), medium term (6-10 years), long term (>10 years) or permanent.

Intensity
This indicates the degree to which the impact would change the conditions or quality of the environment. This was qualified as low, medium or high.

Probability of Occurrence
This describes the probability of the impact actually occurring. This is rated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any prevention measures).

Degree of Confidence
This describes the degree of confidence for the predicted impact based on the available information and level of knowledge and expertise. It has been divided into low, medium or high.

The following risk assessment was used to determine the significance of impacts:

Significance = (Magnitude + Duration + Scale) x Probability

The maximum potential value for significance of an impact is 100 points. Environmental impacts can thus be rated as high, medium or low significance on the following basis:

- High environmental significance 60 – 100 points
- Medium environmental significance 30 – 59 points
- Low environmental significance 0 – 29 points

Table 10 illustrates the scale used to determine the overall ranking.

Table 15: Scale used to determine significance ranking

Magnitude (M)		**Duration (D)**	
Description	**Numerical value**	**Description**	**Numerical value**
Very high	10	Permanent	5
High	8	Long-term (ceases at end of operation)	4
Moderate	6	Medium-term	5-15 years
Low	4	Short-term	0 – 5 years
Minor	2	Immediate	1
Scale (S)		**Probability (P)**	
Description	**Numerical value**	**Description**	**Numerical value**
International	5	Definite (or unknown)	5
National	4	High	4
Regional	3	Medium	3
Local	2	Low	2
Site	1	Improbable	1
None	0	None	0

4.2 Impact Assessment

The possible impacts of the proposed project on the delineated wetlands and riparian habitat within the study area during the various phases are presented below. Table 10, Table 11 and Table 12 list a summary of the possible risks that could occur within the construction phase, the operational phase and the decommissioning phase, respectively. In determining the applicability of measures to be undertaken to limit impacts on the associated wetlands, it is recommended that the environmental impact hierarchy to be adhered to should follow:

- Avoidance of impact – the design and route planning of the new powerline must first take into consideration the environmental sensitivities of the site and undertake to avoid impacts wherever possible.

- Minimisation of impact – where impacts to the wetland are unavoidable, the route design and infrastructure design must be undertaken in such a way as to minimise the impacts associated with their activities; and

- Mitigation of impact – once all possible impacts have been avoided and minimised as far as possible, the remaining significant impacts must be mitigated on site. This can be undertaken through control measures during construction and maintenance of the powerline, and through effective rehabilitation measures.

- Off-set mitigation – where avoidance, minimisation and mitigation measures fail or are not possible, an appropriate off-set approach should be followed.

Table 16: Primary impacts arising during construction phase relating to the associated wetland ecosystems

Possible impact	Source of impact
Sedimentation of wetlands	Runoff from construction activities and clearing of natural and secondary vegetation
Destruction of wetland habitat and associated loss of wetland functionality	Destruction of hydric soils and hydrophytic vegetation
Changes to surface and sub-surface flow regimes	Excavations of pits / trenches, channelling as a result of large machinery, removal and disturbances to vegetation.

Table 20: Primary impacts arising during operation phase relating to the associated wetland ecosystems

Possible impact	Source of impact
Destruction of wetland habitat and associated loss of wetland functionality	Maintenance crews working in wetlands

Table 21: Primary impacts arising during closure phase relating to the associated wetland ecosystems

Possible impact	Source of impact
Decrease in wetland functionality	Dependant on closure approach.

4.2.1 Construction Phase

5.2.1(a) Sedimentation of watercourse

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	Local (2)	Long term (4)	Moderate (6)	High (4)	Medium (48)	Medium
With mitigation measures	Site (1)	Short-term (2)	Low (4)	Medium (3)	Low (21)	Medium

Description of Impact

The clearing of natural vegetation and the stripping of topsoil and sub-soils for placing pylons will potentially result in increased runoff of sediment from the site into watercourses associated with the study area.

Mitigation Measures

- The layout and placement of pylons should take cognisance of the delineated wetland and riparian boundaries. The layout design should therefore place infrastructure as far from wetland boundaries as practically possible. Alternative 1 route has one pylon that is situated within a valley bottom wetland and should thus be moved outside of the wetland and associated buffer (Figure 17).

- The layout and placement of pylons should also take cognisance of the delineated wetlands at the start of the three alternative routes. The precise hook-up to the existing Eskom infrastructure is within proximity of HGM 28 (Figure 18). It is recommended that a wetland specialist in combination with Eskom engineers formulate a site specific works plan to ensure wetland habitat is not negatively impacted during the construction process.

- Due to the possible encroachment of pylons onto wetland habitat and associated buffers, a wetland monitoring program must be established to ensure that a wetland specialist monitors potential impacts during the construction and initial operational phases.

- A wetland monitoring program must be in place prior to construction to pro-actively detect threats to wetlands before it can cause damage through an adaptive management approach, e.g. the initiation of new concentrated drainage pathways and erosion processes as a result of new access roads etc. It is recommended that a wetland specialist have a minimum of at least two visit during the construction process, one visit after construction is completed as well as a site visit shortly after the first two major flood events. The wetland specialist needs to ensure that no negative impacts on wetlands have occurred or that processes have been initiated that could harm wetlands in the future, e.g. preferential flow paths or erosion.

- Develop soil management measures for the route and construction sites which will prevent runoff of sediment into the associated watercourses, e.g. scheduling the construction phase during low rainfall periods, installing soil curtains and use of swales to capture run-off water and settle suspended materials etc.

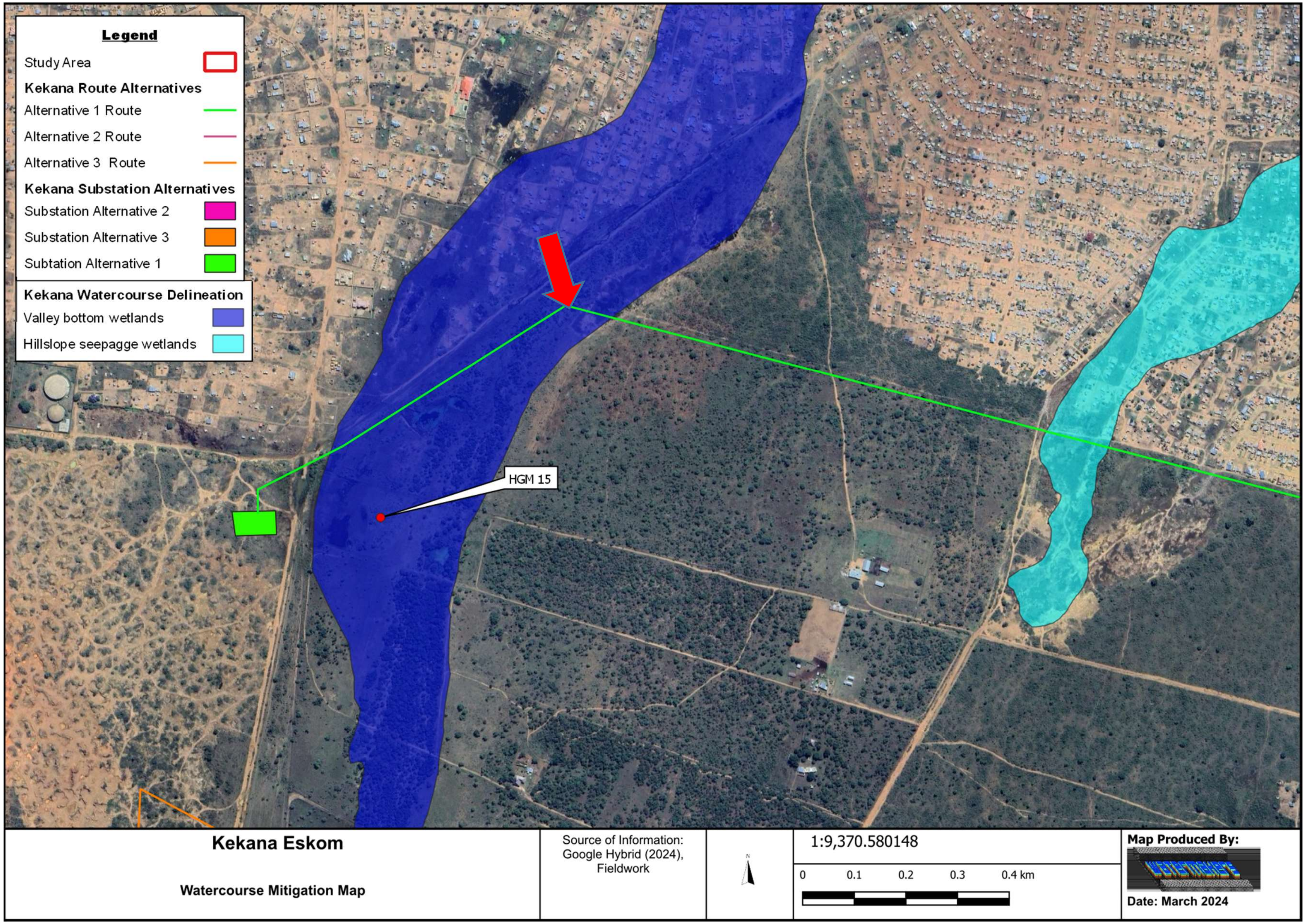


Figure 17: Pylon for Alternative 1 route that needs to be moved out of HGM 15 indicated by red arrow

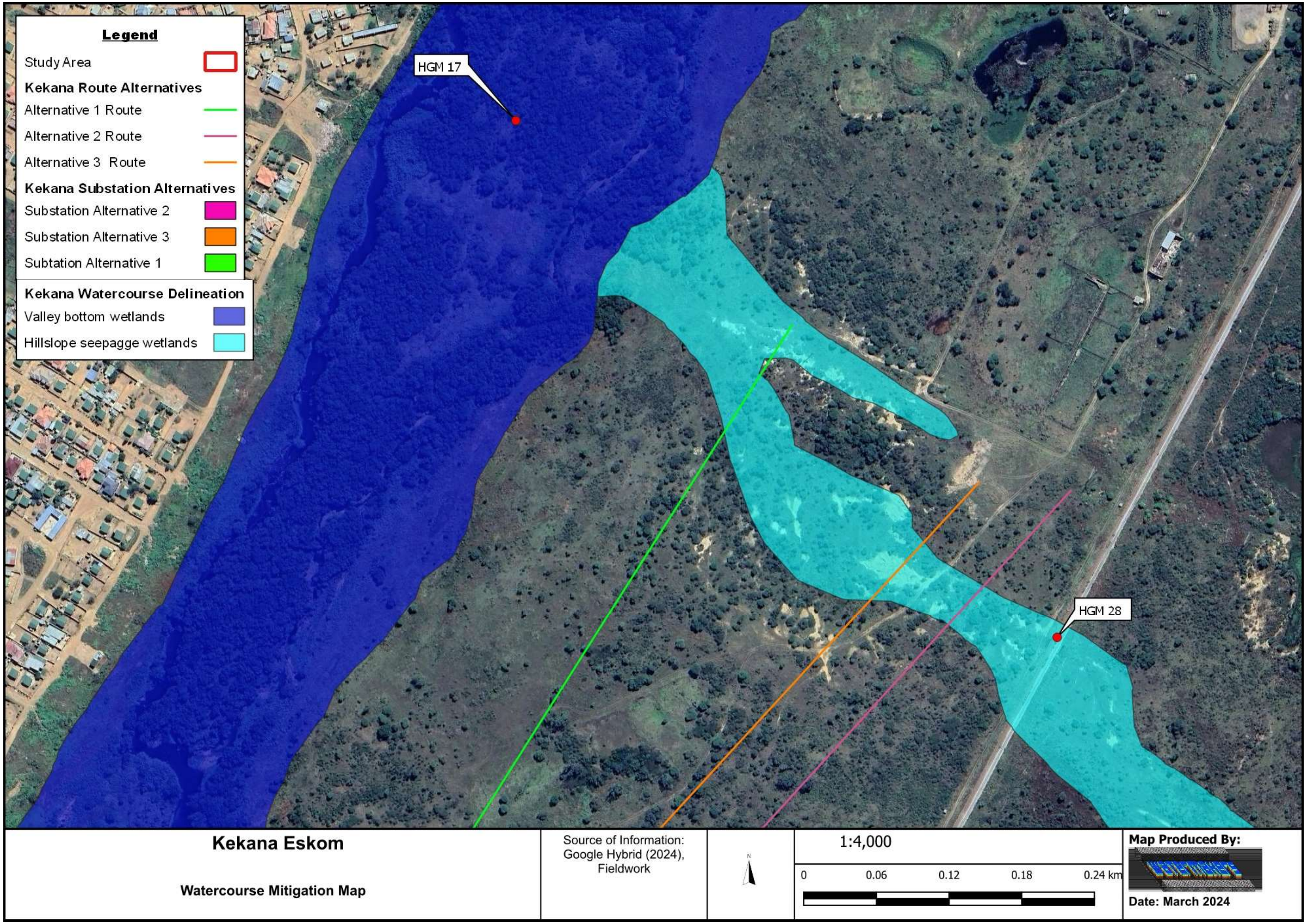


Figure 18: Map indicating proximity to HGM 28 to the three alternatives starting position.

Description of Impact

The footprint of new infrastructure and construction activities could infringe or destroy wetland habitat and associated biota through removal of hydrophytic vegetation and or hydric soils. Activities could potentially also negatively affect supporting hydrological sources of wetlands.

Mitigation Measures

- Avoid construction activities in wetlands as far as possible through proper planning, demarcation and appropriate environmental awareness training. Appropriate wetland buffer zones (minimum of 30m from the outer edge of wetlands) and no-go areas must be assigned wherever practically possible.
- All construction staff must be informed of the need to be vigilant against any practice that will have a harmful effect on wetlands e.g. Do not take short-cuts through valley bottoms (wetlands) but use existing road infrastructure.
- Any proclaimed weed or alien species that germinate during the construction period shall be cleared as per the recommendation of the Environmental Control Officer (ECO).
- Caution must be taken to ensure building materials are not dumped or stored within the delineated wetland zones
- Emergency plans must be in place in case of spillages into wetland systems.
- Littering and contamination of water sources during construction must be mitigated by effective construction camp management.
- All construction materials including fuels and oil should be stored in a demarcated area that is contained within a bunded impermeable surface to avoid spread of any contamination (outside of wetlands or wetland buffer zones).
- Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area, in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase.

5.2.1 (c) Changes to surface and sub-surface flow regimes of wetlands

	Scale	**Duration**	**Magnitude**	**Probability of occurrence**	**Significance**	**Confidence**
Without mitigation measures	Local (2)	Long term (4)	Moderate (6)	High (4)	Medium (48)	Medium
With mitigation measures	Site (1)	Short-term (2)	Low (4)	Medium (3)	Low (21)	Medium

Description of Impact

Linear construction activities, excavations, removal and disturbances to vegetation could create preferential flow paths and/or cut off existing flow paths on the surface as well as sub-surface. Hydrology is an important driver of wetlands and changes thereto could have various negative impacts on wetlands and their associated functionality.

Mitigation Measures

- Avoid construction activities in wetlands or preferential hydrological pathways supporting wetlands through proper planning, appropriate design and minimising the construction footprint as per previous impacts discussed.
- Soils should be replaced in the same order as removed.
- Where it is absolutely necessary for the use of machinery, limit the footprint of impact to a minimum through appropriate planning, e.g. keeping turning circles outside of the wetland. Where vehicle tracks have formed rehabilitate immediately by levelling (where possible by hand)
- Access and monitoring roads must be constructed with the slope of the landscape in mind, thereby constructing access roads along contours rather than perpendicular to contours which could cause preferential pathways for surface runoff to develop. The access roads must have as small as possible footprint (preferably only two track) and should be appropriately vegetated
- Re-vegetation of the affected areas should be done as priority.
- Make use of existing roads and tracks where feasible, rather than creating new routes through vegetated areas;
- Vegetation and soil must be retained in position for as long as possible, and removed immediately ahead of construction / earthworks in that area (DWAF, 2005);
- Runoff from roads must be managed to avoid erosion and pollution problems. Where excessive loose sediment is created, attenuation swales and / or soils screens should be installed;
- Construction vehicles are to be maintained in good working order, to reduce the probability of leakage of fuels and lubricants;
- A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
- Storage of potentially hazardous materials should be above any 100-year flood line, or as agreed with the ECO. These materials include fuel, oil, cement, bitumen etc.;
- Sufficient care must be taken when handling these materials to prevent pollution;

- Surface water draining off contaminated areas containing oil and petrol would need to be channelled towards a sump which will separate these chemicals and oils;
- Oil residue shall be treated with oil absorbent such as Drizit or similar and this material removed to an approved waste site;
- Concrete and tar shall only be mixed on mixing trays and in areas which have been specially demarcated for this purpose;
- All concrete and tar that is spilled outside these areas shall be promptly removed by the Contractor and taken to an approved dumpsite;
- After all the concrete / tar mixing is complete all waste concrete / tar shall be removed from the batching area and disposed of at an approved dumpsite;
- Storm water shall not be allowed to flow through the batching area. Cement sediment shall be removed from time to time and disposed of in a manner as instructed by the Consulting Engineer;
- All construction materials liable to spillage are to be stored in appropriate structures with impermeable flooring;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- Portable septic toilets are to be located outside of the 1:100 year floodline;
- Under no circumstances may ablutions occur outside of the provided facilities;
- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;
- In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water and Sanitation (DWS) must be informed immediately;
- Where construction in close proximity to sewer lines is unavoidable then excavations must be done by hand while at all times ensuring that the soil beneath the sewer lines is not destabilised;
- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;
- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed;
- The construction site should be cleaned daily and litter removed;
- Conduct on-going staff awareness programs so as to reinforce the need to avoid littering; and

- Backfill must be compacted to form a stabilised and durable blanket; and

4.2.2 Operational Phase

5.2.2 (a) Destruction of wetland habitat and associated loss of wetland functionality

	Scale	**Duration**	**Magnitude**	**Probability of occurrence**	**Significance**	**Confidence**
Without mitigation measures	Local (2)	Long term (4)	Low (4)	High (4)	Medium (40)	Medium
With mitigation measures	Site (1)	Short-term (2)	Low (4)	Medium (3)	Low (21)	Medium

Description of Impact

Maintenance activities are likely to have a lower impact than construction activities, except for worst case scenarios where sections of the powerline might have to be reconstructed. Wetland habitat could be impacted on or be destroyed through maintenance operations e.g. through removal of hydrophytic vegetation and or hydric soils.

Mitigation Measures

- Mitigation measures for worst case scenarios would be the same as for the construction phase

8.2.1 Decommissioning Phase

8.2.3.a Loss of wetland functionality during removal operations

	Scale	**Duration**	**Magnitude**	**Probability of occurrence**	**Significance**	**Confidence**
Without mitigation measures	Local (2)	Long term (4)	Moderate (6)	High (4)	Medium (48)	Medium
With mitigation measures	Site (1)	Short-term (2)	Low (4)	Medium (3)	Low (21)	Medium

The assumed life expectancy of the powerline is likely to be long term with an unforeseen closure date. An appropriate closure and rehabilitation plan should be designed and implemented if decommissioning is to take place.

4.3 Risk Assessment Matrix (Based on DWS 2023 publication: Section 21 c and I water use Risk Assessment Protocol)

In addition to the approach presented above, a further assessment of potential risks associated with the various activities on the receiving aquatic ecosystem was done in accordance with Department of Water and Sanitation Notice 509 of 2016. The risk matrix for impacts associated with the proposed development, as required by DWS, is presented in Appendix B. It should be borne in mind that when assessing the impact significance following the DWS Risk Assessment Matrix, determination of the significance of the impact assumes that mitigation measures as listed within the present report are feasible and will be implemented, and as such does not take into consideration significance before implementation of mitigation measures. Accordingly, should proposed mitigation measures not be deemed feasible, a re-evaluation of the impact significance may be required.

The DWS Risk Assessment Matrix, in terms of GA 509, calculated the significance of perceived impacts on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the freshwater resources assessed that is situated within 500m from the proposed development. By assessing the severity, spatial scale, duration and frequency of the proposed ESKOM infrastructure relocation, the risk to the potentially affected resource quality was determined to be low for all aspects during the construction and operational phases. The low risk identified was based on all recommended mitigation measures being implemented as outlined within this report (both within the impact assessment and mitigation measures listed below)

<u>General mitigation measures</u>

- Develop soil management measures for the route and substation construction sites which will prevent runoff of sediment into the associated watercourses, e.g. scheduling the construction phase during low rainfall periods, installing soil curtains and use of swales to capture run-off water and settle suspended materials etc.
- Usually substations and associated infrastructure are bedded with gravel which is a good medium to curtail excessive precipitation run-off. However, if the proposed development is to include several hardened surfaces which could increase peak flows received by wetlands, attenuation facilities should be designed which diffusely releases water. Further, wetland rehabilitation in the vicinity of such infrastructure is then also highly recommended.
- A wetland monitoring program must be in place to pro-actively detect threats to wetlands before it can cause damage through an adaptive management approach, e.g. the initiation of new concentrated drainage pathways and erosion processes as a result of new access roads etc. It is recommended that a wetland specialist (preferential) or ecologist have at least one visit during the construction process and one visit after construction is completed. The wetland specialist needs to ensure that no negative impacts on wetlands have occurred or that processes have been initiated that could harm wetlands in the future, e.g. preferential flow paths or erosion
- Avoid construction activities in wetlands as far as possible through proper planning, demarcation and appropriate environmental awareness training. Where an alignment crosses an HGM unit.

Construction crews must approach the drainage line from the terrestrial habitat's side, and not cross through the drainage line or watercourse

- All construction staff must be informed of the need to be vigilant against any practice that will have a harmful effect on wetlands e.g. Do not take short-cuts through valley bottoms or drainage lines (wetlands) but use existing road infrastructure.
- Any proclaimed weed or alien species that germinate during the construction period shall be cleared as per the recommendation of the vegetation assessment (GIBB, 2016).
- Caution must be taken to ensure building materials are not dumped or stored within the delineated wetland zones
- Emergency plans must be in place in case of spillages into wetland systems.
- Littering and contamination of water sources during construction must be mitigated by effective construction camp management.
- All construction materials including fuels and oil should be stored in a demarcated area that is contained within a bunded impermeable surface to avoid spread of any contamination (outside of wetlands or wetland buffer zones).
- Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area, in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase.
- Soils should be replaced in the same order as removed.
- Where it is absolutely necessary for the use of machinery, limit the footprint of impact to a minimum through appropriate planning, e.g. keeping turning circles outside of the wetland. Where vehicle tracks have formed rehabilitate immediately by levelling (where possible by hand), eg. Vehicle tracks
- Re-vegetation with appropriate species of the affected areas should be done as priority.
- Construction vehicles are to be maintained in good working order, to reduce the probability of leakage of fuels and lubricants;
- A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
- Storage of potentially hazardous materials should be above any 100-year flood line, or as agreed with the ECO. These materials include fuel, oil, cement, bitumen etc. No fuels or chemicals should be stored within or near the wet pit mining areas;
- Machinery and vehicles utilised for the operation must be serviced and maintained in an appropriate work shop area. Surface water draining off contaminated workshop areas containing oil and petrol would need to be channelled towards a sump which will separate these chemicals and oils. Oil residue shall be treated with oil absorbent such as Drizit or similar and this material removed to an approved waste site;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- Portable septic toilets are to be located outside of the 1:100 year floodline;
- Under no circumstances may ablutions occur outside of the provided facilities;

- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;

5. CONCLUSION AND RECOMMENDATIONS

Thirty-one hydro-geomorphic units (HGM), comprising three HGM types, namely a valley bottom wetland with a channel, valley bottom wetland without a channel as well as a hillslope seepage wetland connected to a watercourse, were delineated and classified within the study area and within two kilometre surrounding the study area.

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services, including sediment trapping, nitrate removal, toxicant removal, erosion control, carbon storage, maintenance of biodiversity and water supply for human use. Each wetland's ability to contribute to ecosystem services within the study area was also dependant on the particular wetland's Present Ecological State in relation to a benchmark or reference condition. Present Ecological State scores was determined for wetlands within the study area using Wet-Health Level 2 assessment which indicated that in general wetlands have been seriously modified as a result of extensive sand mining operations that have taken place on various scales and over several decades, still continuing at present. Sand mining operations have impacted more severely towards the north of the study area where population densities and associated anthropogenic pressures and impacts escalates

The Ecological Importance and Sensitivity assessment was undertaken to rank water resources in terms of provision of goods and services or valuable ecosystem functions which benefit people, biodiversity support and ecological value and reliance of subsistence users. In general, most of the identified HGM units attained low to very low scores for their respective Ecological Importance and Sensitivity analysis as a result of the temporary nature of the majority of wetlands as well as due to anthropogenic impacts, especially extensive sand mining within the study area's wetlands and their respective catchments. However, two seepage wetlands scored high as a result of the uniqueness and intact nature. The Apies River also received high scores as a result of the regional hydrological and functional as well as the high ratio of permanent zonation associated with this valley bottom wetland. Direct human benefit associated with the wetlands within the study area included water supply, cultivation of agricultural plots and food gardens, water supply to commercial pivots, subsistence and recreational hunting, collection of building materials and firewood as well as grazing of livestock.

The impact assessment identified the destruction of wetland and riparian habitat, changes to the surface and sub-surface flows as well as sedimentation as the major potential impacts during the construction and operational phases. Several general and specific mitigation measures are proposed. All three alternatives are considered to have the same potential impacts when compared, with no preferential route from a wetland perspective, the emphasise must fall on site specific mitigation for each scenario /route. Further, illegal sand mining is so rife in and surrounding the study area that all three substation sites could potentially be effected by erosion processes from sand mining activities.

6. BIBLIOGRAPHY

Barnes, K.N. (ed.) (1998): *The Important Bird Areas of Southern Africa*, Johannesburg: BirdLife South Africa.

Bamford, M (2014). Palaeontological Impact Assessment for the Proposed development of the Hammanskraal Business Process Outsourcing and Technology Park, Gauteng. Desktop study for Strategic Environmental focus

Collins, N.B. (2005). *Wetlands: The basics and some more*. Free State Department of Tourism, Environment and Economic Affairs

Department of Water Affairs and Forestry. (2005). *A practical field procedure for identification and delineation of wetlands and riparian areas*. Department of Water Affairs and Forestry, Pretoria, South Africa

Department of Water Affairs and Forestry. (2008). *Updated Manual for the identification and delineation of wetlands and riparian areas*. Department of Water Affairs and Forestry, Pretoria, South Africa

Ewel, C. (1997). Water quality improvement by wetlands. In: Daily G (ed), *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington, D. C.

GEM-science, (2011a). Aquatic Report. Ecology Report. Mining Right Application on the farm. BOSCHPOORT 211 IR. Ref. No. MP 30/5/1/2/2/504 MR. Prepared for: Hoyohoyo Mining (Pty) Ltd

GEM-science, (2011b). Environmental Management Program. Mining Right Application on the farm. Boschpoort 211 IR portion 1. Ref. No. MP 30/5/1/2/2/504 MR. Prepared for: Hoyohoyo Mining (Pty) Ltd

Gren, I. (1995). The value of investing in wetlands for nitrogen abatement. *European Review of Agricultural Economics* 22: 157–172

Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. & Collins, N.B. (2008). *WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08*. WRC Report No. 339/08. Water Research Commission, Pretoria, South Africa

McCarthy, T.S. and Venter, J.S., (2006). *Increasing pollution levels on the Witwatersrand recorded in the peat deposits of the Klip River Wetland*. South African Journal of Science 102, January/February 2006, p 27 – 3

Macfarlane, D., Holness, S.D., von Hase, A., Brownlie, S., Dini, J.A. & Kilian, V. (2016). *Wetland Offsets: A Best Practice Guideline for South Africa*. WRC Report TT 660/16. Water Research Commission, Pretoria, South Africa

Macfarlane, D.M. & Bredin, I.P. (2016). *Buffer zone guidelines for rivers, wetlands and estuaries. Part 1: Technical Manual*. WRC Report No. TT 715/1/17. Water Research Commission, Pretoria, South Africa

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. & Goge, C. (2008). *WET-Health: A technique for rapidly assessing wetland health*. WRC Report No. TT340/09. Water Research Commission

Mucina, L. & Rutherford, M.C. (2006). *The vegetation of South Africa, Lesotho and Swaziland*. South African National Biodiversity Institute, Pretoria, South Africa

Muscutt, A.D., G.L., H., Bailey, S.W. & Davies, D.B. (1993). Buffer zones to improve water quality: a review of their potential use in UK agriculture. *Agriculture, Ecosystems and Environment* 45: 59–77

Nel, J.L., Driver, A., Strydom, N.A., Maherry, A.M., Peterson, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E.R. & Smith-Adao, L.B. (2011). *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources.* WRC Report No. TT 500/11. Water Research Commission, Pretoria, South Africa

OFC Consulting, (2020). Surface Water Management Plan for Dorstfontein East Mine – Updated 2020 Report

Postel, S. & Carpenter, S. (1997). Freshwater ecosystem services. In: Daily G (ed), *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington, D. C.

Rogers, F.E., Rogers, K.H. & Buzer, J.S. (1985). *Wetlands for wastewater treatment: with special reference to municipal wastewaters*. WITS University Press, Johannesburg, South Africa

Rountree, M.W., Malan, H.L. & Weston, B.C. (2013). *Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Vers.2.0).* WRC Report No. 1788/1/12. Water Research Commission, Pretoria, South Africa

Strategic Environmental Focus. (2015). Proposed Kekana and Wonderboom 132/22KVsubstation projects and associated 132 KV lines near Hammanskraal Project No. 505140

Soil Classification Working Group. (1991). *Soil classification. A taxonomic system for South Africa*. Department of Agricultural Development, Pretoria, South Africa

Soil Classification Working Group. (2018). *Soil classification. A natural and anthropogenic sytem for South Africa*. ARC- Institute for soil, Climat and Water, Pretoria.

Sustainable Drop Solutions. (2022). - Hydrogeological Assessment for Dorstfontein West Block A And B Underground Mining Expansion Project. REPORT NO.: 12-14102020

APPENDIX A – Methodology

Wetland Delineation

The report incorporated a desktop study, as well as field surveys, with site visits conducted during multiple seasons over several years. Additional data sources that were incorporated into the investigation for further reliability included:

- Google Earth images;
- 1:50 000 cadastral maps;
- ortho-rectified aerial photographs; and
- 5m contour data.

A pre-survey wetland delineation was performed in order to assist the field survey. Identified wetland areas during the field survey were marked digitally using GIS (changes in vegetation composition within wetlands as compared to surrounding non-wetland vegetation show up as a different hue on the orthophotos, thus allowing the identification of wetland areas). These potential wetland areas were confirmed or dismissed and delineation lines and boundaries were imposed accordingly after the field surveys.

The wetland delineation was based on the legislatively required methodology as described by Department of Water Affairs and Forestry (2005). The DWAF delineation guide uses four field indicators to confirm the presence of wetlands, namely:

- terrain unit indicator (i.e. an area in the landscape where water is likely to collect and a wetland to be present);
- soil form indicator (i.e. the soils of South Africa have been grouped into classes / forms according to characteristic diagnostic soil horizons and soil structure);
- soil wetness indicator (i.e. characteristics such as gleying or mottles resulting from prolonged saturation); and
- vegetation indicator (i.e. presence of plants adapted to or tolerant of saturated soils).

The wetland delineation guide makes use of indirect indicators of prolonged saturation by water, namely wetland plants (hydrophytes) and (hydromorphic) soils. The presence of these two indicators is indicative of an area that has sufficient saturation to classify the area as a wetland. Hydrophytes were recorded during the site visit and hydromorphic soils in the top 0.5 m of the profile were identified by taking cored soil samples with a bucket soil auger and Dutch clay auger (photographs of the soils were taken). Each auger point was marked with a handheld Global Positioning System (GPS) device (Figure 38).

Wetland Functionality

The methodology "Wet-EcoServices" (Kotze et al., 2008) was adapted and used to assess the different benefit values of the wetland units. A level one assessment, including a desktop study and a field assessment were performed to determine the wetland functional benefits between the different hydro-geomorphological types within the study area. Other documents and guidelines used are referenced accordingly. During the field survey, all possible wetlands and drainage lines identified from maps and aerial photos were visited on foot. Where feasible, cross sections were taken to determine the state and boundaries of the wetlands.

Following the field survey, the data was submitted to a GIS program for compilation of the map sets. Subsequently the field survey and desktop survey data were combined within a project report.

In order to gauge the Present Ecological State of various wetlands within the study area, a Level 2 Wet-Health assessment was applied in order to assign ecological categories to certain wetlands. Wet-Health (Macfarlane et al., 2008) is a tool which guides the rapid assessment of a wetland's environmental condition based on a site visit. This involves scoring a number of attributes connected to the geomorphology, hydrology and vegetation, and devising an overall score which gives a rating of environmental condition.

Wet-Health is useful when making decisions regarding wetland rehabilitation, as it identifies whether the wetland is beyond repair, whether rehabilitation would be beneficial, or whether intervention is unnecessary, as the wetland's functionality is still intact. Through this method, the cause of any wetland degradation is also identified, and this facilitates effective remediation of wetland damage. There is wide scope for the application of Wet-Health as it can also be used in assessing the Present Ecological State of wetlands and thereby assist in determining the Ecological Reserve as laid out under the National Water Act. Wet-Health offers two levels of assessment, one more rapid than the other.

For the assessments, an impact and indicator system were used. The wetland is first categorized into the different hydrogeomorphic (HGM) units and their associated catchments, and these are then assessed individually in terms of their hydrological, geomorphologic and vegetation health by examining the extent, intensity and magnitude of impacts, of activities such as grazing or draining. The extent of the impact is measured by estimating the proportion the wetland that is affected. The intensity of the impact is determined by looking at the amount of alteration that occurs in the wetland due to various activities. The magnitude is then calculated as the combination of the intensity and the extent of the impact and is translated into an impact score. This is rated on a scale of 1 to 10, which can be translated into six health classes (A to F – compatible with the EcoStatus categories used by DWAF, Table 19). Threats to the wetland and its overall vulnerability can also be assessed and expressed as a likely Trajectory of Change.

Determination of Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. As wetlands outside of the study area were only partially visited, there could easily be oversight as detailed studies are required to increase the confidence of the assessment which relied heavily on the experience of the author. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments, and the work conducted by Kotze et al. (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree et al., 2013). An example of the scoring sheet is attached as Table 20. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 21.

Table 12: Interpretation of scores for determining present ecological status (Kleynhans 1999)

Rating of Present Ecological State (Ecological Category)
CATEGORY A Score: 0-0.9; Unmodified, or approximates natural condition.
CATEGORY B Score: 1-1.9; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C Score: 2 – 3.9; Moderately modified, but with some loss of natural habitats.
CATEGORY D Score: 4 – 5.9; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E Score: 6 -7.9; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F Score: 8 - 10; Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

* If any of the attributes are rated <2, then the lowest rating for the attribute should be taken as indicative of the PES category and not the mean

Table 13: Example of scoring sheet for Ecological Importance and sensitivity

Ecological Importance	**Score (0-4)**	***Confidence (1-5)***	**Motivation**
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			

Table 14: Category of score for the Ecological Importance and Sensitivity

Rating	Explanation
Very low (0-1)	Rarely sensitive to changes in water quality/hydrological regime.
Low (1-2)	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate (2-3)	Some elements sensitive to changes in water quality/hydrological regime.
High (3-3.5)	Many elements sensitive to changes in water quality/ hydrological regime.
Very high (+3.5)	Very many elements sensitive to changes in water quality/ hydrological regime.

APPENDIX B – DWS Risk Assessment Matrix (DWS, 2023)

RISK ASSESSMENT MATRIX for Section 21 (c) and (i) Water Use activities - Version 2.0

Name of Assessor: Willem Lubbe

SACNASP Registration Number: 4750

Signature: 

Date: 10/04/2024

Risk to be scored for all relevant phases of the project (factoring in specified control measures). MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

Phase	Activity	Impact	Potentially affected watercourses			Intensity of Impact on Resource Quality					Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of impact	Significance (max = 100)	Risk Rating
			Name/s	PES	Ecological Importance	Abiotic Habitat (Drivers)			Biota (Responses)										
						Hydrology	Water Quality	Geomorph	Vegetation	Fauna									
CONSTRUCTION	<1> Site preparation and typical construction activities: Vegetation clearing, temporary access road	Decreased Water Quality, especially through increased sedimentation loads, but other potential sources as well. E.g. hydrocarbons	HGM 1	C	Moderate	1	1	D	1	D	2	1	1	4	3	12	40%	4.8	L
		<1b> Increased peak flow dicharges received by HGM 1	HGM 1	C	Moderate	D	D	D	1	1	2	1	1	4	3	12	20%	2.4	L
		<1c> Increased alien invasive vegetation infestation	HGM 1	C	Moderate	D	D	1	2	1	4	1	1	6	3	18	40%	7.2	L
OPERATIONAL	<1> Maintenance work Access road	<1a> Altered hydrological regime, access road concentrate sheet flow down towards wetland habitat	HGM 1	C	Moderate	1	1	D	1	1	2	1	1	4	3	12	20%	2.4	L
		<1b> Deteriorated water quality	HGM 1	C	Moderate	1	1	D	1	1	2	1	1	4	3	12	20%	2.4	L
		<1c> Spread of alien vegetation	HGM 1	C	Moderate	1	1	D	2	2	4	1	1	6	3	18	20%	3.6	L