September 2021

WATER COURSE DELINEATION AND ASSESSMENT:

Joubert, Investec, Portion 225, Portion 21, Portion 185, Portion 6 & 8 and Remainder 22, Lanseria

A report commissioned by

COSMOPOLITAN PROJECTS JOHANNESBURG (PTY) LTD

ENVIROGUARD ECOLOGICAL SERVICES CC
PO Box 703
Heidelberg
1438

Cell: 082 4641021
envguard@telkomsa.net

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The study was undertaken by Prof. LR Brown (PhD UP) & Mr T O' Donoghue (MSc UNISA). They are registered as a Professional Natural Scientists with the following details:

Prof LR Brown: Reg. No. 400075/98 (Botanical Science and Ecological Science).
Mr T.L. O' Donoghue Reg. No. 010184 (Ecological Science)

SPECIALIST	QUALIFICATION
Prof. L.R. Brown	PhD Terrestrial plant ecology MSc. Water ecology BSc Hons (Botany) BSc (Ed) (Botany, Zoology, Education) Wetland and Riparian Delineation *(DWAF Accredited Course)* Soil Classification and Wetland Delineation Short Course – TERRASOIL Science Wetland Legislation Course - Wetrest

Mr T.L. O' Donoghue	MSc Nature Conservation BTech Nature Conservation N.Dip Nature Conservation Wetland management & delineation course (DEM, Free State University)

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Factors limiting the quality of this study

A vegetation and faunal survey were conducted on 27 April 2021 and the watercourse assessment during a survey on 23 August 2021.

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INTRODUCTION

In order to prevent the destruction of any ecosystem, it is important that systematic planning and co-ordination of human activities and development should receive priority. This planning should include studies of the natural environment (soil, water, vegetation, animals and cultural / historical aspects). The planning and design of urban areas must therefore be done in such a way as to ensure that important ecosystem functions and services of the environment is maintained. Biodiversity must be protected to ensure the continued existence of plant and animal life in an area. It is therefore important that urban developers, landscapers and environmentalists together design development within urban areas. Before any development can take place it is important that all aspects of the environment is first assessed to identify areas of concern and inform the planning of the proposed development.

Wetlands and riparian zones are ecosystems (with specific plant and animal communities) that are associated with bodies of water or are dependent on permanent, seasonal or ephemeral surface/subsurface water. The vegetation of these areas is normally lusher than that of the surrounding terrestrial vegetation. These areas play an important role in channelling water, retention of water and release of water to adjacent ecosystems. These areas also support a unique floral and faunal component.

AIMS OF THE STUDY

This report aims to present a watercourse assessment for Lanseria (Joubert, Investec, Portion 225, Portion 21, Portion 185, Portion 6 & 8 and Remainder 22), Gauteng (hereafter referred to as the study area).

The objectives of this study were to:

- Delineate the watercourses present on the site.
- Assess the different watercourses present on the site.

STUDY AREA

Location

The study site is located north and south of the N14 Highway with Malibongwe Drive forming the eastern boundary. The western boundary in the northern section is formed by a perennial tributary that links up with another tributary which drains surface water from the surrounding areas and channels it towards the Crocodile River further north. The northern boundary borders onto small holdings and industrial developments. A wetland system and old farm dams occur towards the eastern boundary. Agricultural holdings occur along the western and southern boundaries of the southern section (Figure 1).

Figure 1. Locality the study area (Red lines) (Source: SANBI GIS, 2021)

Existing impacts on the site

- The site is not fenced and is located between various agricultural holdings and commercial/residential developments.
- Communal cattle graze the area throughout the year

METHODS

WETLANDS

The term “wetland” is a generic term for all the different kinds of habitats where the land is wet for some period of time each year, but not necessarily permanently wet. Wetlands are defined in the National Water Act (36 of 1998) 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 are found where the landform (topography) or geology slows down or obstructs the movement of water through the catchment, or where the groundwater surfaces causing the soil layers in the area to be temporarily, seasonally or permanently wet. This provides an environment where particular plants (hydrophytes) that are adapted to wet conditions tend to grow in abundance. The plants in turn affect the soil and hydrology by further slowing down the movement of water (e.g. reed beds) or by producing organic matter that may accumulate in the soil.

Wetlands are important because of the functions and values that they provide which benefit mankind. These benefits can be either direct or indirect benefits. Until very recently the benefits of wetlands to society were often not recognized, and many wetlands have been destroyed, or poorly managed. Wetland benefits refer to: "*those functions, products, attributes and services provided by the ecosystem that have values to humans in terms of worth, merit, quality or importance. These benefits may derive from outputs that can be consumed directly; indirect uses which arise from the functions or attributes occurring within the ecosystem; or possible future direct outputs or indirect uses*" (Howe et al., 1991 in Kotze et al., 2005).

The functioning of a wetland is also affected by other factors, many of which result from the activities of people. These include "off-site" factors which take place in the surrounding catchment (e.g. a change in land cover from natural grassland to a gum tree plantation which would decrease the amount of water reaching the wetland) and "on-site" factors which take place at the wetland (e.g. fire, draining, damming, etc.).

Humans have traditionally seen wetlands as wasteland areas and many of these sensitive ecosystems have as a result been transformed and developed. Due to the sensitive nature

of these systems as well as the different ecosystem functions they perform, it is important that wetlands are identified and assessed in any area where development is planned.

The classification system developed for the National Wetlands Inventory in South Africa is based on the principle of "hydro-geomorphic (HGM) units". HGM units take into consideration various factors that determine the nature and direction of water movement into, through and out of the wetland system. All together HGM units encompass three key elements (Kotze et al, 2005; USDA; 2011):

- *Landscape position*: This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment).
- *Dominant water source*: There are usually several sources such as surface water, precipitation, sub-surface water, springs, stream flow, etc.
- *Hydrodynamics:* This refers to the source and direction of water movement (this can be horizontal, vertical, unidirectional or bidirectional) (Figure 2).

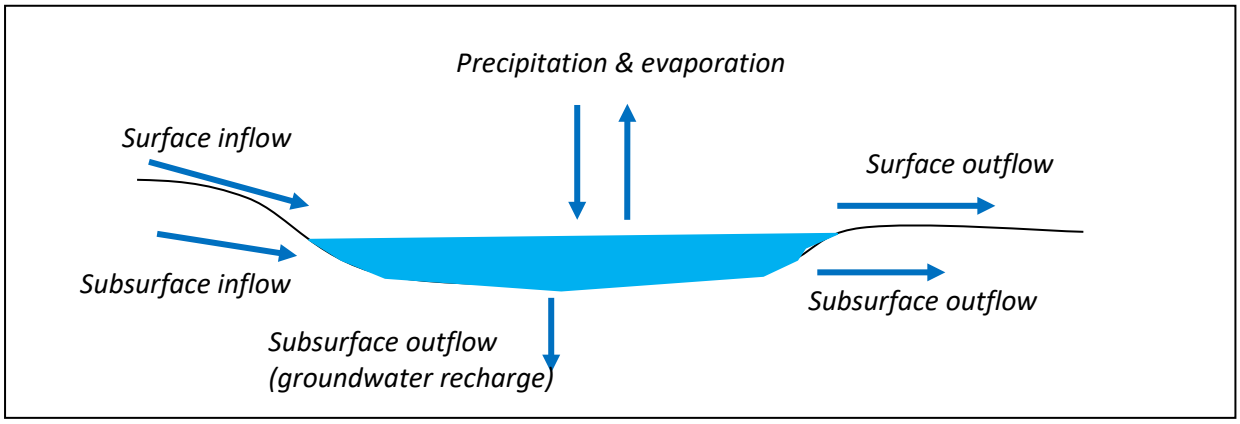


Figure 2. Water budget/movement in a wetland system (Adapted from USDA, 2011)

Dini, Cowan & Goodman (1998) classifies South African wetlands into the following classes:

- *Lacustrine*: Limnetic and Littoral (natural freshwater lakes).
- *Palustrine*: Flat, Slope, Valley Bottom, Floodplain (freshwater marshes, peatlands, springs, swamp forest, floodplains).
- *Endorheic* (permanent and seasonal pans).

For delineation purposes only, the wetland boundary is defined as the edge where the ***hydric indicators are encountered within the top 50cm or 500 mm of the surface***, but from a wetland management perspective consideration should extend beyond the boundaries to include the wetland catchment as a whole.

Terrain Unit Indicator:

Identifies those parts of the landscape where wetlands are likely to occur: Pans are usually concentrated in areas with an average slope of less than one degree and are characterised by a lack of integrated drainage. Inundation is usually seasonal or ephemeral. This indicator cannot be used for mapping but is useful for screening purposes.

Soil Form Indicator:

Particular forms of soil are associated with wetlands and display hydromorphic characteristics, and their presence at a site indicates that permanent or periodic (temporary or seasonal) saturation of the soil near the surface occurs. No comprehensive soil survey has been undertaken for the site.

Vegetation Indicator

The presence of indicator plant species or hydrophytes can be used to denote the presence of wetlands. This indicator is very useful as verification of the boundaries in undisturbed sites.

Soil wetness Indicator

Wetland soils can be permanently, seasonally or temporarily saturated. This normally results in anoxic (low oxygen) conditions in the saturated zone. Soil colour is markedly influenced by the oxidation statues of manganese and iron. Yellow, red and reddish-brown soil form under well-oxidised conditions and greyish colours when aeration is poorer. Under anoxic conditions, iron becomes soluble and can be leached out of the soil. Where the soil is permanently wet; the iron can all be dissolved out of the soil; resulting in a greyish or blueish colour. This is termed gleying. Consequently, it is possible to identify wetland areas on the basis of soil colour, while mottle hue and chroma initially increase and then decrease the more saturated the soils become.

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

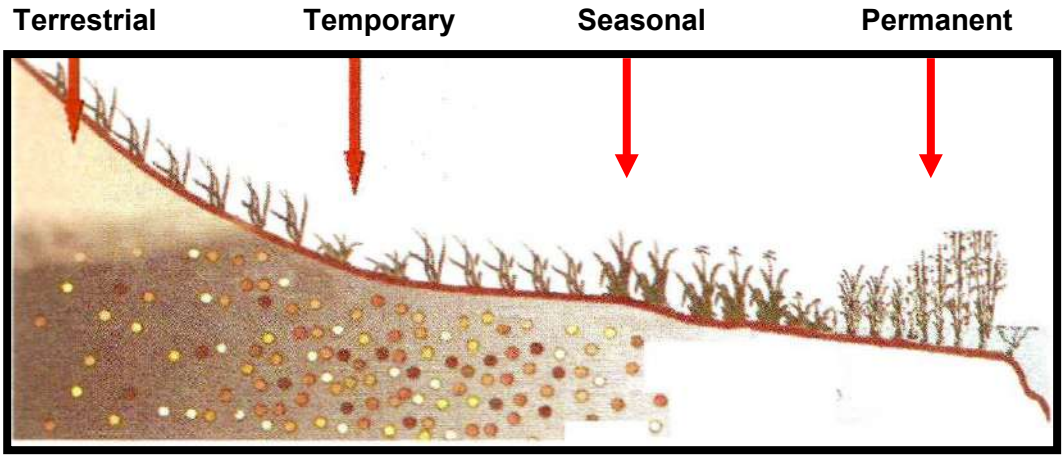


Figure 3. Cross section through a valley bottom wetland indicating how soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the permanent wet hydrological zone to the temporarily wet hydrological zone and eventually into the non-wetland or terrestrial zone (Department of Water Affairs and Forestry, 2003 as adapted by Kotze, 1996)

RIPARIAN ZONES

The word “riparian” is drawn from the Latin word “riparious” meaning “bank” (of the stream). Thus the “a riparian area” is simply the land adjacent to a body of water that is channelled or life on the bank of this body of water (Ilhardt *et al.* 2000).

A riparian zone refers to the interface between land and a river or stream (non-perennial, seasonal, occasional). The term “Riparian” is also the term used to refer to one of the fifteen biomes of the world. Plant species composition of these areas are different from that of the adjacent terrestrial systems as as well as that of the permanently wet or seasonally inundated vegetation areas of the river. These areas are separate ecosystems and not “buffers” as many people see these areas. They support a completely different set of functional characteristics and are large enough although sometimes narrow, to function on their own independently from other systems.

The number of functions that is part of an aquatic ecosystem and contributes to its functioning would decrease the further one moves away from the water. Thus, the probability of a function being part of the riparian system will change across the riparian zone moving toward the terrestrial zone IIlhardt *et al.* (2000).

River areas and associated floodplains are important since they channel water and also supply various terrestrial areas of water and nutrients. The vegetation around river systems present unique habitats that are different from the surrounding terrestrial areas and therefore have unique plant and animal species living in and utilising these areas. Furthermore, these systems are important from a water quality and quantity perspective and any degradation of these systems will negatively influence these aspects.

Humans also use these systems for recreational and economic purposes while sediment is naturally filtered by these water systems.

It is therefore important that these systems are properly managed and protected to ensure their and all other dependant ecosystems’ existence and prevent degradation that could lead to total ecosystem collapse.

Riparian zones are delineated by examining how the ecosystem function, species composition and topography changes with distance from the water. For the purposes of riparian zone delineation using plant species, we (re)define and utilize the following terms (adapted from MacKenzie & Rountree, 2007):

> **Obligate riparian**: these are species which are found almost exclusively in the riparian zone (> 90% probability). It is highly unlikely that they would occur outside the riparian zone and are regarded as indicators of wetness. Obligate riparian species are conservative as such i.e. an obligate will remain an obligate throughout all geographic regions and their occurrence would taper off from the water edge towards the terrestrial areas.

Preferential riparian: these are species that are preferentially, but not necessarily always found in the riparian zone (>75% probability). They may be found in terrestrial areas where moist conditions (e.g. indentation of soil with some moisture collection in the soil) occur. They will however, be more abundant closer to riparian areas. These species always indicate sites with increased moisture availability and are therefore good indicator species especially if abundant (a plot of species occurrence from the aquatic zone will peak and taper off predominantly within the riparian zone, but may extend beyond):

Facultative riparian: these species may occur in either riparian zones or the upland (>25% probability of occurrence in the riparian zone). They can tolerate a variety of environmental and moisture conditions in the environment. They are therefore not good national indicators, but rather circumstantial indicators depending on the region the study is conducted e.g. a species such as *Searsia pyroides* may not be an indicator of the riparian zone in perennial rivers in one region, but often is useful as an indicator of the riparian zone of ephemeral streams in another region.

Upland: these species are mostly terrestrial, and rarely occur in a riparian zone (<25% probability). They therefore characterize terrestrial landscapes that border onto riparian zones. Upland species usually occur in low-abundance in the upper parts of the riparian zone. An abundance of these species in the riparian zone may indicate altered/decreased flows and a subsequent “drying” out of the riparian zone.

FIELD SURVEYS & DATA ANALYSIS

Prior to the site visit, a desktop study was conducted of the wetland unit/s present on the site using 1:50 000 topographical maps, aerial images obtained from Google Earth and the SANBI BGIS Map Viewer (accessed March & August 2021).

Wetlands

A Dutch soil auger was used to extract the cores to a depth of 50cm. All soil samples were evaluated in hand for soil composition, colour, number, size and chroma of mottles as well as wetness, after which they were discarded. The location of each soil core was marked using a hand-held Garmin Colorado 300 GPS. Field verification was limited to the presence of hydric soils on the site as well as presence of hygrophytic and hydrophilic vegetation.

Soil auger samples were taken in transects that were laid parallel to each other in the study area. Soil samples were taken along transects radiating away from the visibly ‘wettest’ parts of the area at regular intervals.

Riparian areas

Surveys started at the edge of the water and continued in a transect outwards away from the water. All common obligates within the riparian area were identified and noted. Sample plots of 0.5 x 0.5 m were placed along the transect and all plant species identifiable noted. The riparian zone extends to where the plant obligates did not occur anymore. The greatest width where obligates occur was then used to delineate the riparian zone.

Terrestrial species normally decline as one moves towards the riparian zone. All nickpoints, down curves and peaks (indicator points) were noted and incorporated within the riparian zone. The riparian zone plays an important ecological role in providing habitat for various plant and animal species, diffusing and assimilating pollutants from the adjacent terrestrial areas. As such the riparian habitat is regarded as part of the aquatic buffer zone (Figure 4).

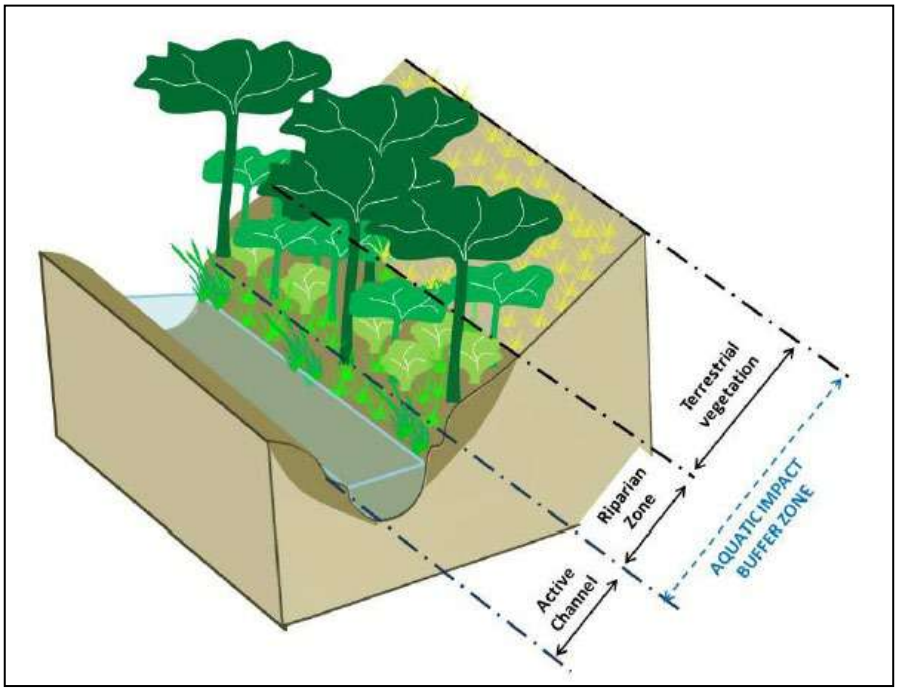


Figure 4. Schematic diagram of the riparian habitat (taken from Macfarland & Bredin, 2016)

The edge of the channel is used as the starting point from where the aquatic buffer zone is determined and zoned (Macfarland & Bedin, 2016.). For this study the riparian zone was determined and from there a buffer zone implemented.

Other characteristics also used in the delineation of the riparian zone included vegetation structure. There is normally a definite difference in vegetation structure between the riparian zone and the adjacent terrestrial vegetation areas. In most cases the riverine areas consist of larger woody species and a different species composition than that of the terrestrial zone.

Other aspects also measured include the channel width, river depth (estimation), retention time, and usage of the area.

Wetland assessment

Wetland health / Wetland Index of Habitat Integrity (IHI)

WET-Health and Wetland IHI assists in assessing the health of wetlands using indicators based on geomorphology, hydrology, water quality and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation.

The Wetland IHI is a tool that was developed to be able to assess and monitor floodplain and valley-bottom wetlands and provides a score on the Present Ecological State of of the wetland habitat. A Wetland IHI assessment was conducted as per the procedures in DWAF (2007).

The tool evaluates the intactness of the wetland and is determined by a score known as the Present Ecological Score (PES). The Present Ecological State (PES) refers to the current state or condition of a watercourse in terms of all its characteristics and reflects the change to the watercourse from its reference condition. The health assessments for the hydrology, geomorphology and vegetation components were then represented by the Present Ecological State (PES) categories. The PES categories are divided into six (A-F) units based on a gradient from “unmodified/natural” (Category A) to “severe/complete deviation from natural” (Category F) as depicted in Table 1.

Table 1. Present Ecological State categories used to define healt of water courses (adapted from Kleynhans, 1999).

Description	PES Score (%)	PES Category
Unmodified, natural.	**90-100**	**A**
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	**80-90**	**B**
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	**60-80**	**C**
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	**40-60**	**D**
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	**20-40**	**E**

Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	0-20	F

A summary of the change class, description and symbols used to evaluate wetland health are summarised in Table 2 below.

Table 2. Trajectory descriptions and symbols used to evaluate future direction of change to wetland health (Macfarlane et al, 2007).

Change Category	Description	Symbol
Improve	Condition is likely to improve over the over the next 5 years	(↑)
Remain stable	Condition is likely to remain stable over the next 5 years	(→)
Slowly deteriorate	Condition is likely to deteriorate slightly over the next 5 years	(↓)
Rapidly deteriorate	Substantial deterioration of condition is expected over the next 5 years	(↓↓)

Ecological Importance and Sensitivity

The **Ecological Importance and Sensitivity** (EIS) of a watercourse is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales, and both abiotic and biotic components of the system are taken into consideration. Sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The ecological importance and sensitivity categories are indicated in Table 3.

Table 3. Ecological Importance & Sensitivity Categories of Wetlands (DWAF, 1999)

EIS CATEGORIES	DESCRIPTION	RATING
LOW/MARGINAL	Not ecologically important and sensitive at any scale. The biodiversity of wetland is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers	>0 and <1
MODERATE	Ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	>1 and <2
HIGH	Ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	>2 and <3

EIS CATEGORIES	DESCRIPTION	RATING
VERY HIGH	Ecologically important and sensitive on a national (or even international) level. Biodiversity usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in rivers	>3 and <4

Wetland ecoservices

WET-EcoServices (Kotze *et al.* 2004) was used to assess the goods and services that the floodplain/stream provides. This tool provides guidelines for scoring the importance of different ecosystem services delivered by a wetland. The different services are then assessed based on existing knowledge and/or field assessment data. Each of fifteen different categories are assessed based on various characteristics (e.g. size of the wetland, pattern of flow through the wetland, social value and uses, etc.) that are relevant to the particular benefit.

Habitat integrity (Stream)

The Habitat Integrity (HI) evaluation is used to provide a degree of measure to which a stream or river has been modified from its natural state. In order to determine the HI a qualitative assessment is done using various anthropogenic and other factors that could potentially affect the ecosystem. The severity of each impact is ranked using six classes: 0 (no impact); 1-5 (small impact); 6-10 (moderate impact); 11-15 (large impact); 16-20 (serious impact); 21-25 (critical impact) (DWAF 1999).

The determination of the HI category is calculated as follows: Total of ratings/maximum valuesx100. The percentage obtained is deducted from 100 and the class determined from the HI category table (Table 4).

Table 4. Habitat Integrity for rivers & streams (DWAF, 1999)

CATEGORY	DESCRIPTION	SCORE (%)
A	Unmodified, natural	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged	60-79
D	Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive	20-39
F	Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat. In worst instances the basic ecosystem functions have been destroyed and changes are irreversible.	0

RESULTS OF WATERCOURSE ASSESSMENT

A total of three watercourses (stream, western wetland and eastern wetland) that is divided into four units, were identified and delineated for the study area (Figure 5):

1. Eastern wetland North
2. Eastern wetland south
3. Western stream
4. Western wetland

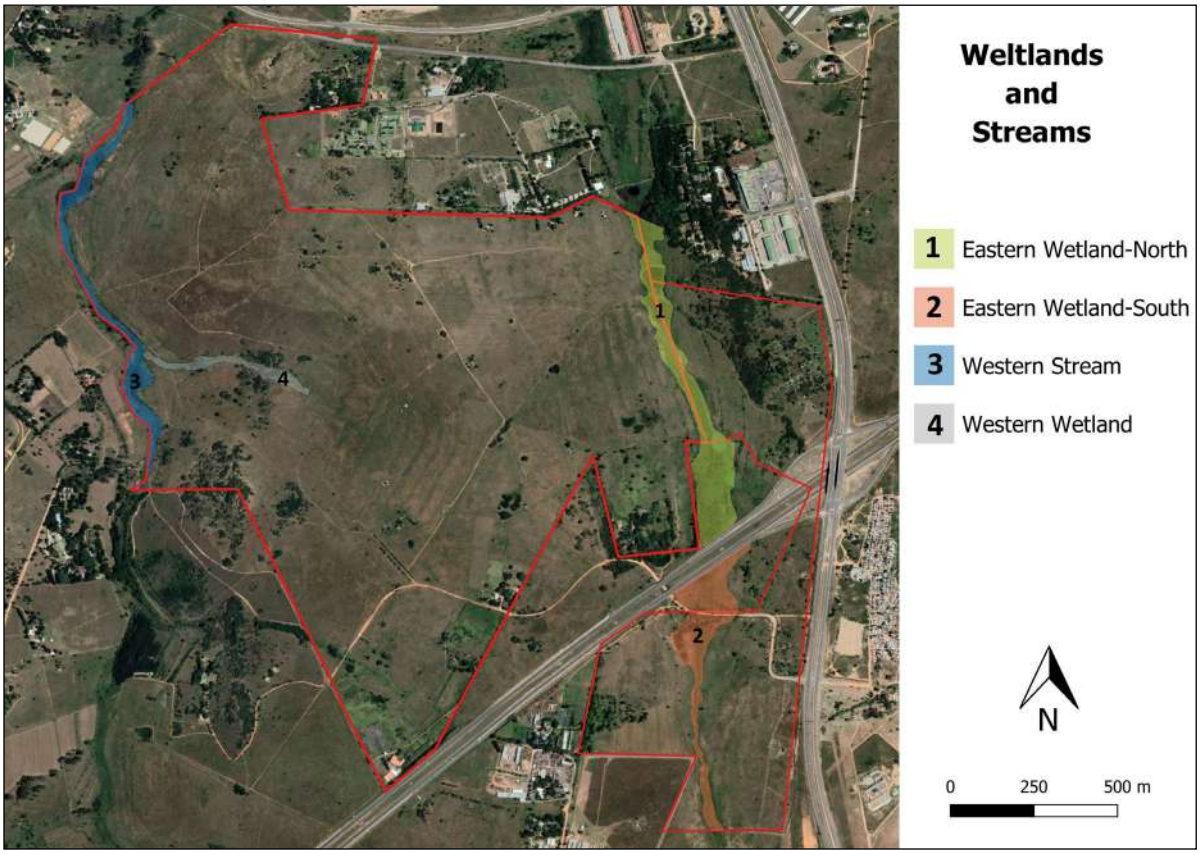


Figure 5. The four water courses identified and delineated on the study site.

VEGETATION

Eastern wetland north (Figure 6)

The wetland area is located along the far eastern boundary of the study area and comprises three artificial dams that are permanently wet. The soil is clayey with few rocks present. The area is grazed by local cattle while soil excavations have taken place in areas.

The vegetation has a patchy appearance with the grass *Pennisetum clandestinum* dominant on the dam walls, while the forb *Typha capensis* is prominent in the drainage channels and the forb *Cyperus textilis* dominant in the shallow standing water areas. This sedge was most probably planted in the area and normally occurs in the southern parts of the country. In the southern part of this unit a large dense bush clump consisting of the declared alien invader tree *Populus alba* is present and dominate this section of the wetland. The terrestrial area towards the west of the *Populus alba* clump has been infilled many years ago resulting in an abrupt steep edge along this section.

Land infill along the western boundary of the wetland with steep abrupt edge

Gleyed soil of the wetland (left); temporary wet soil with mottles (middle), and sandy soil of terrestrial area (right)

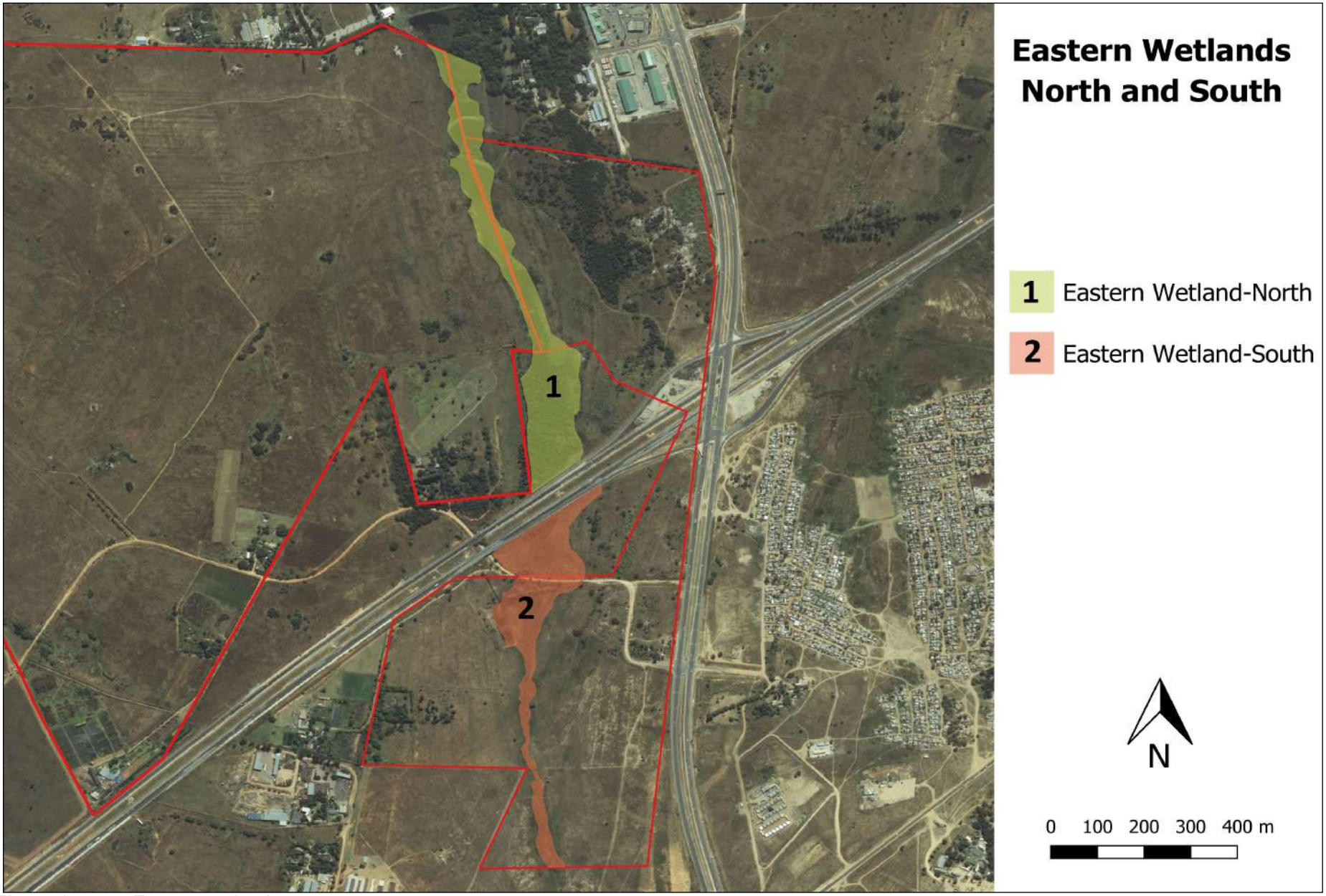
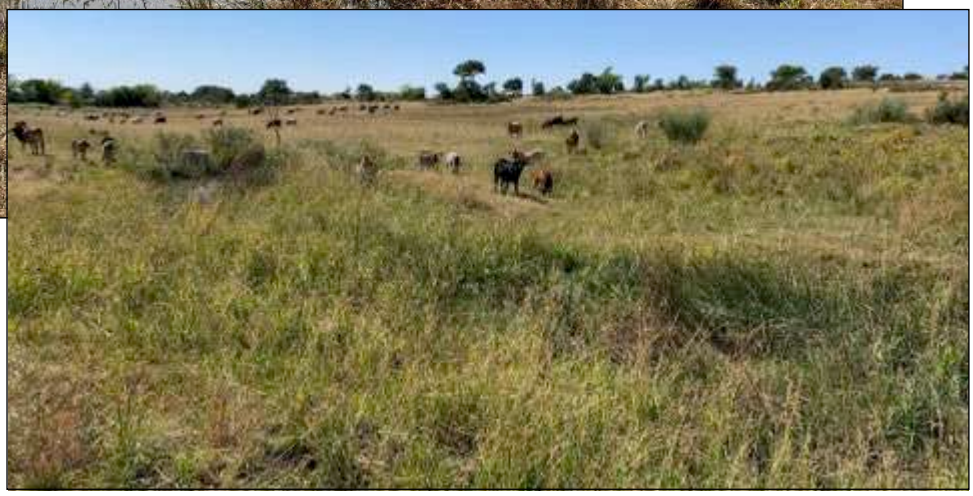


Figure 6. Eastern wetland systems

Eastern wetland south (Figure 6)



This wetland consists mostly of a narrow stream with two old but broken farm dams with dense poplar trees in the north. The herbaceous vegetation is dominant with the highest canopy cover. The area is grazed by cattle from the local community close to the site, while sections have been excavated.

Mottled soil of the temporary wet zone

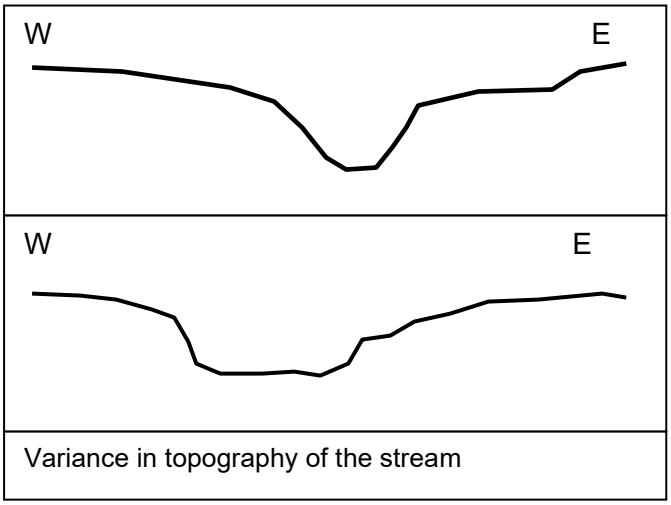
The vegetation is dominated by the grasses *Paspalum dilatatum* and *Paspalum urvillei,* while the forbs *Schoenoplectus corymbosus* and *Cyperus textilis* are prominent. The woody species vary from a high canopy cover of 40% locally to 5% overall and is characterised by the declared alien invader trees *Populus alba* and *Sesbania punicea*. Other species present include the grasses *Sporobolus africana, Hyparrhenia hirta* and the forbs *Verbena bonariensis, Schkuhria pinnata, Typha capensis* and *Berkheya setifera.*

Western stream (Figure 7)

The perennial stream forms a large part of the western boundary of the northern part of the study area. This area varies in vegetation composition and structure with large clumps of the declared alien invader trees *Populus alba* and *Eucalyptus camaldulensis* in and along the streambank in sections with wide to narrow stream areas where *Phragmites australis* and *Typha capensis* dominate. Some broken old farm dams are present along the stream. The shrub *Gymnosporia buxifolia* is prominent along the edge of the stream together with the forb *Artemisia afra* and the grass *Cymbopogon validus*. Various artificial berms are located along the embankment.

The embankment is mostly steep and varies in height between 1.8 and 2.5 m. The stream varies in width between 10 and 27 m.

The areas adjacent to the stream have a mild to moderate slope (1-6^0)



Variance in topography of the stream

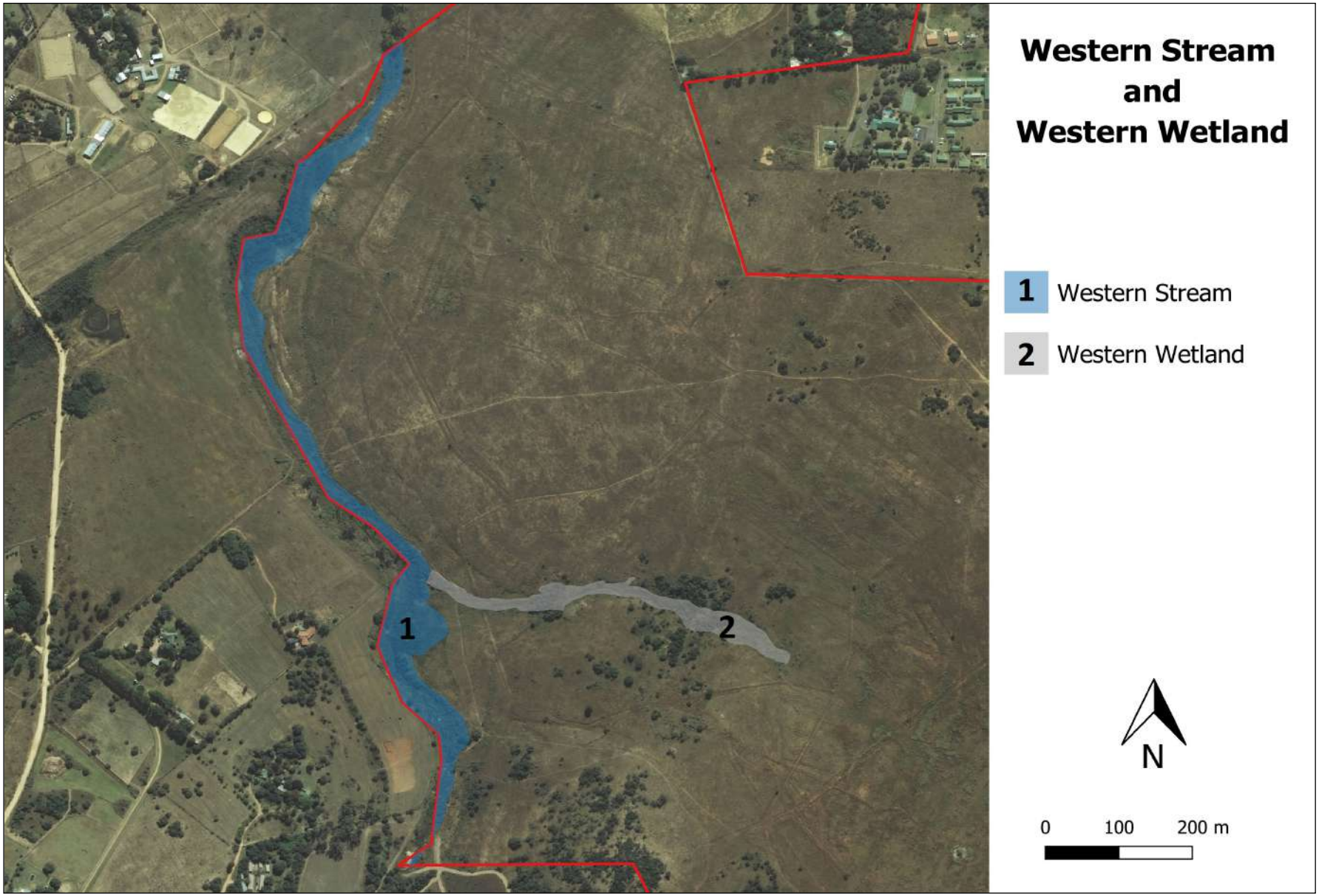


Figure 7. Western wetland systems

Western wetland (Figure 7)

This area is located in the central-western section of the study site and drains surface and ground water towards the perennial stream along the western boundary of the site. Topographically the area consists of a narrow and deep channel between steep rocky areas with more level areas lower down where water flows slower and where wetland conditions prevail. A seasonally moist wetland area as a result of an old broken farm dam is found on the upper lying area.

The vegetation composition and structure vary along the channel. The vegetation in the upper-lying section is characterised by the prominence of grasses and forbs such as *Eragrostis curvula, Brachiaria nigropedata, Cymbopogon validus, Bidens pilosa,* the alien invasive *Arundo donax,* and the woody shrub *Asparagus laricinus.* The vegetation of the lower-lying channel and wetland areas consists of medium-tall woody species with a high canopy cover that is dominated by the tree *Combretum erythrophyllum* with *Searsia lancea, Dombeya rotundifolia* and *Celtis africana* prominent. The reed *Phragmites australis* is prominent locally.

1. Eastern wetland north & Eastern wetland south

The Eastern wetland north and the Eastern wetland south form part of one large wetland ecosystem inside and outside the study area and have been evaluated as one unit.

Present Ecological Status (PES)

The results from the PES analysis for the wetland areas indicate it to be largely modified (PES class D – 52.8 %, Table 5). The wetland is regarded as largely modified with a change in ecosystem processes and resultant loss of natural habitat and biota. This can be ascribed to the grazing by cattle of the wetland that degraded the system, the invasion of the declared alien invader tree *Populus alba,* land infill along sections of the embankment, and soil excavation and resultant altering of the drainage channel.

The various agricultural and anthropogenic influences as listed above have negatively impacted the hydrological processes. The surface roughness around the wetland is still acceptable with moderate to good vegetation cover. The alien plant invasions and land infill in and around the wetland has changed the landscape and topography in areas.

Table 5. Present Ecological State (PES) of the Eastern wetland north & Eastern wetland south

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**2.5**		
Hydrology	1	100	2.6	*2.9*	**D**
Geomorphology	2	80	2.2	*2.3*	**D**
Water Quality	3	30	2.9	*1.5*	**D/E**
WETLAND LANDUSE ACTIVITIES:		**80**	**2.2**	***4.2***	
Vegetation Alteration Score	1	100	2.2	*4.2*	**D**
OVERALL SCORE:			**2.4**		
	PES %		**52.8**	*Confidence Rating*	
	PES Category		**D**	*1.9*	

Ecological Importance and Sensitivity (EIS)

The EIS and functions for the wetland was calculated using DWA guidelines and a model, as developed by M. Rountree, but not yet published. Information was used form the SIBIS and VEGMAP products. A mean score between 0 and 4 is obtained, with 0 as the lowest and 4 as the highest score (0-1 = Low to very low; >1-2 = Moderate; >2-3 = Medium-high: >3-4 = High to very high). The scores for the watercourse is indicated in table 6:

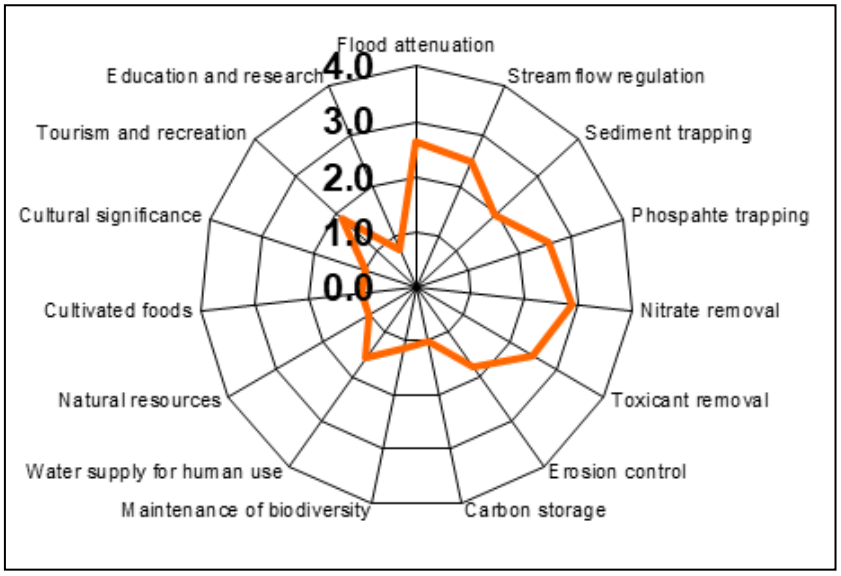
The entire watercourse obtained a score of 1.8 (Table 6) indicating the area to have a **moderate ecological sensitivity**. This is ascribed to the anthropogenic influences, alien invader plants, and the area being surrounded by the various developments that has affected it negatively over the years.

Table 6. EIS calculation of the Eastern wetland north & Eastern wetland south

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*
Biodiversity support	**2.00**	***5***
No red data species were found and no suitable habitat exists due to anthropogenic and agricultural influences.		
No unique species populations were found to be present due to habitat degradation.		
Bird species were observed along the edge and in the open water. The area do provide habitat for various animal species associated with water.		
Landscape scale	**2.4**	***5.00***
The area is easily accessible from both sides and due to the various anthropogenic influences not well protected.		
The wetland and embankment fall within the endangered Egoli Granite Grassland, however being wetland vegetation cannot be classified as such. Wetland vegetation is however important in stabilising embankments and as habitat for various species.		
The wetland is important in terms of its water channelling, storage and supply function since it channels water towards the Crocodile River, however the ecosystem in and around the wetland is degraded and mostly transformed due mostly to human impacts/activities.		
The wetland habitat is mostly homogeneous, consisting of various alien, weedy/pioneer and secondary successional species with a few climax grasses present.		
Sensitivity of the wetland	**1.00**	***3.67***
The water velocity in this wetland is slowed down due to the various dams as well as the dense alien vegetation in places together with old broken dam walls and thus nor sensitive to floods.		
The vegetation is well-established and provides some stabilisation. The system is generally not sensitive to floods. Most of the species present would easily survive during dry periods also.		
System already marginally influenced due to cattle using the area.		
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1.80**	***4.56***

Wetland ecoservices

The ecosystem services provided by this wetland are regarded as **low-moderate**. The wetlands play a role in phosphate, nitrate and flood attenuation (see diagram right). The area has a low-moderate stream flow function while it plays no role in the maintenance of biodiversity. These can all be described to the various factors as mentioned previously in this report.



2. Western stream

Present Ecological Status (PES)

The results from the PES analysis for the stream area (with associated wetland patches along and in the stream area) indicate it to be largely modified (PES class D – 57.2 %, Table 7). The stream is regarded as largely modified with a change in ecosystem processes and resultant loss of natural habitat and biota. This can be ascribed to adjacent land activities as well as the alien plants in and along the stream and embankment. In some areas there are medium-sized erosion gullies due to the removal of vegetation due to grazing and other activities.

The various anthropogenic influences as listed above have negatively impacted the hydrological processes. The alien plant species, artificial berms, and erosion gullies has changed the landscape and topography in areas.

Table 7. Present Ecological State (PES) of the western stream

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**2.4**	*Rating*	
Hydrology	1	100	2.5	*2.5*	**D**
Geomorphology	2	80	2.2	*2.6*	**D**
Water Quality	3	30	2.3	*1.0*	**D**
WETLAND LANDUSE ACTIVITIES:		**80**	**1.9**	***4.2***	
Vegetation Alteration Score	1	100	1.9	*4.2*	**C**
OVERALL SCORE:			**2.1**	*Confidence Rating*	
	PES %		**57.2**		
	PES Category		**D**	***1.8***	

Ecological Importance and Sensitivity (EIS)

The EIS and functions for the wetland was calculated using DWA guidelines and a model, as developed by M. Rountree, but not yet published. Information was used form the SIBIS and VEGMAP products. A mean score between 0 and 4 is obtained, with 0 as the lowest and 4 as the highest score (0-1 = Low to very low; >1-2 = Moderate; >2-3 = Medium-high: >3-4 = High to very high). The scores for the watercourse is indicated in table 8:

The entire watercourse obtained a score of 2.23 (Table 8) indicating the area to have a **medium ecological sensitivity**. This is ascribed to the stream area being somewhat degraded, but it is fulfilling an important role in water channelling and storage from the adjacent terrestrial areas.

Table 8. EIS calculation of the western stream

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*
Biodiversity support	**2.00**	***5***
No red data species were found and no suitable habitat exists due to anthropogenic and previous land-use influences.		
No unique species populations were found to be present due to the habitat being degraded and low in species richness.		
Bird species were observed in the alien trees and reeds. The area provides habitat for various animal species associated with water.		
Landscape scale	**2.5**	***5.00***
The area is accessible to people using it for horse riding, hikes etc. The habitat is mostly protected due to it being located between various properties.		
The stream/wetland and embankment fall within the endangered Egoli Granite Grassland, however being riverine vegetation cannot be classified as such. Riverine vegetation is however important in stabilising		

embankments and as habitat for various species.		
The stream is important in terms of its water channelling, storage and supply function since it channels water into the Crocodile River, however the ecosystem in and around the river is degraded and due to human impacts/activities.		
The riverine habitat is mostly homogeneous, but due to the different vegetation layers do provide some diversity of habitats. Various weedy/pioneer herbaceous species are present together with climax woody and secondary successional grasses.		
Sensitivity of the wetland	**2.20**	***3.67***
The stream is deeply incised, and the vegetation is typical of stream/river areas and therefore not particularly sensitive to floods. Signs of streambank erosion is however present indicating unstable conditions in sections during flood events.		
The vegetation is well-established and provides some stabilisation of the embankment although some signs of erosion has been observed due to floods. The system is therefore somewhat sensitive to floods.		
System is moderately influenced but seems to be in a moderately good condition in terms of water quality and pollution making it somewhat sensitive to pollution.		
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2.23**	***4.56***

Habitat Integrity for the Riverine system (HI)

The perennial spruit (embankment & instream) achieved an HI score of Class C (Table 7). This is a measure indication the degree to which a watercourse has been modified from its natural state. The HI score of C indicates the area to be moderately modified, but with the basic ecosystem functions predominantly unchanged.

Table 9. Habitat Integrity for the western stream

	RANK
Habitat integrity (instream)	**Western Spruit**
Water abstraction	5
Flow modification	12
Bed modification	14
Channel modification	15
Water quality	7
Inundation	3
Exotic fauna/flora	22
Rubbish dumping	1
INTEGRITY CLASS	**C**

3. Western wetland

Present Ecological Status (PES)

The results from the PES analysis for the wetland areas indicate it to be moderately modified (PES class C – 68.7 %, Table 10). The wetland is regarded mostly natural except for a few areas where degradation as a result of anthropogenic activities has taken place. There has been a moderate change in ecosystem processes and a moderate to low loss of natural habitats and the natural habitat has remained predominantly intact.

Table 10. Present Ecological State (PES) of the western wetland.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1.8**		
Hydrology	1	100	1.7	*2.4*	**C**
Geomorphology	2	80	1.9	*2.6*	**C**
Water Quality	3	30	2.3	*1.0*	**D**
WETLAND LANDUSE ACTIVITIES:		**80**	**1.2**	***3.7***	
Vegetation Alteration Score	1	100	1.2	*3.7*	**C**
OVERALL SCORE:			**1.6**	*Confidence Rating*	
	PES %		**68.7**		
	PES Category		**C**	*1.6*	

Ecological Importance and Sensitivity (EIS)

The EIS and functions for the wetland was calculated using DWA guidelines and a model, as developed by M. Rountree, but not yet published. Information was used form the SIBIS and VEGMAP products. A mean score between 0 and 4 is obtained, with 0 as the lowest and 4 as the highest score (0-1 = Low to very low; >1-2 = Moderate; >2-3 = Medium-high: >3-4 = High to very high). The scores for watercourse is indicated in table 6:

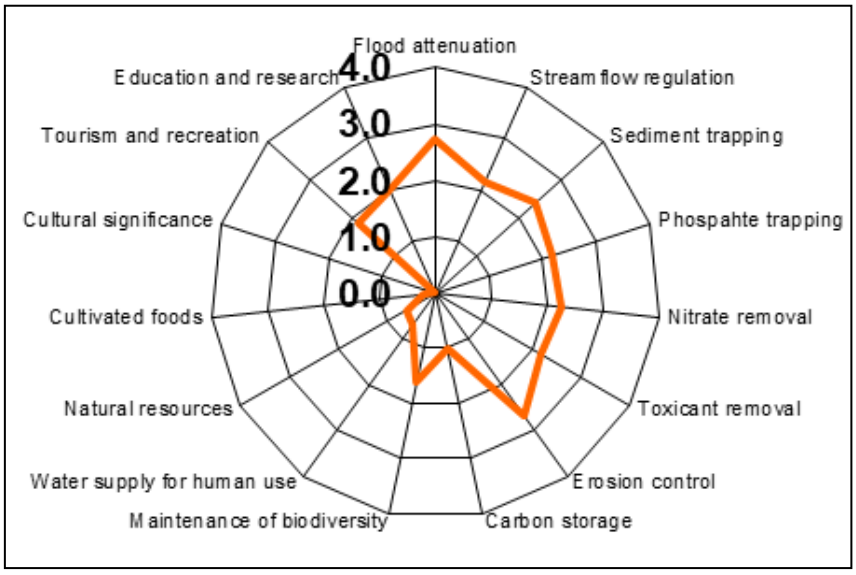
The entire watercourse obtained a score of 2.75 (Table 6) indicating the area to have a **medium-high (close to high) ecological sensitivity**. This is ascribed to the natural vegetation along especially the rocky areas on the embankment and the mostly stable embankment.

Table 11. EIS calculation of the western wetland.

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*
Biodiversity support	**3.00**	***5.00***
The orange listed geophyte *Hypoxis hemerocallidea* is present along the edge of the wetland, but no other such species were found		
The vegetation, apart from the top section around the old farm dam, is mostly natural while the steep rocky outcrops along the embankment comprises a variety of native species.		
Various bird species were observed as well as nests of Dikkkop. Various other species such as hare, guineafowl, ibis, snakes etc. were observed during the survey.		
Landscape scale	**2.75**	***5.00***
The area is mostly protected by due to the difficulty reaching it although an informal vagrant shed was found to be present with associated disturbance of the habitat.		
The stream/wetland and embankment fall within the endangered Egoli Granite Grassland, however being riverine vegetation cannot be classified as such.		
The wetland is important in terms of its water channelling, storage and supply function. It is however located in a small catchment with limited water storage function. It does play a role in flood attenuation.		
The different vegetation layers (woody, grass and forbs) provide some variety in terms of habitat that is utilised by various animal species.		
Sensitivity of the wetland	**2.50**	***4.00***
The wetland is mostly stable with good vegetation cover and various rocks that slows down the force of water.		
The vegetation is well-established and provides some stabilisation of the embankment. The system is adapted to wet and dry conditions.		
The catchment area and water are mostly unpolluted. Pollution could negatively influence the system.		
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2.75**	***4.67***

Wetland ecoservices

The ecosystem services provided by this wetland are regarded as **moderate**. The wetland plays a role in especially erosion control and flood attenuation whilst also playing a minor role in phosphate, nitrate and toxicant removal (see diagram right). The area has a low role in the maintenance of biodiversity and carbon storage.



ENVISAGED IMPACTS & MITIGATION OF DEVELOPMENT ON THE WETLANDS & STREAM SYSTEM

Construction activities in the area could potentially have several impacts on the surrounding environment and watercourses. Any development in a watercourse or its associated buffer area could potentially have a negative impact on the habitat, infiltration rates, runoff intensity of surface water run-off, and soil erosion. These are however considered to be highly unlikely especially if the mitigation measures are implemented. According to the WULA Risk Assessment sheet the Risk rating for all proposed activities is **low** after mitigation measures are implemented (Annexure 1 & 2). The following mitigation measures are recommended.

Impact **(Probability = low)**

Clearing of vegetation in or near the watercourse.

Mitigation

- No construction should be allowed within any of the watercourse areas.
- Prior to construction the watercourse areas should be fenced off along the buffer zone and designated as “no-go areas”.
- No vegetation clearing other than the removal of alien plant species must be allowed.

Impact **(Probability = low)**

Loss of habitat for terrestrial & aquatic animals.

Mitigation

- No construction should be allowed within any of the watercourse areas.
- Workers must be limited to areas under construction and access to natural undeveloped areas must be strictly regulated.
- No faunal species outside the construction area must be disturbed, trapped, hunted or killed during the construction phase.

Impact **(Probability = low)**

Changing of the quantity, quality and speed of water via surface water in the water systems.

Mitigation

- No construction should be allowed within any of the watercourse areas.
- Provision of adequate sanitation facilities away from the wetland/stream areas.
- No cleaning of equipment or washing of clothes must be allowed in or close to the watercourse areas.
- No maintenance of vehicles must be allowed close to the watercourse areas.
- Any fuel or oil leakages must be immediately reported to the ECO and contained to prevent it reaching the watercourse areas.
- No waste discharges must be allowed in or near the watercourse areas.

Impact **(Probability = low)**

Increased soil erosion, pollution and compaction of the channel/pan/stream areas. Clearing of vegetation for construction purposes will expose soil to the environment and heavy rainfall events could cause erosion. Large vehicles could compact the soil.

Mitigation

- The construction must preferably be conducted in the dry winter months where there is a smaller chance of heavy rains.
- No construction should be allowed within any of the watercourse areas.
- Runoff from the construction area must be managed to avoid erosion problems. Effective sediment traps should be installed where needed. Hay bales should be packed at the edge of the buffer zones of the various water courses to prevent soul erosion.
- Regular monitoring must be done to detect any form of soil erosion or pollution.

Impact **(Probability = low)**

Spread of alien plants into the ecosystem.

Mitigation

- All alien plants identified in the wetland/stream area should be controlled.
- All alien plants and weeds present on the construction site must be cleared and eradicated.

- Regular monitoring must be done to detect any form coppicing or re-establishment of such plants.

General

- No roads should be allowed to be constructed through the watercourse areas, except where they already exist.
- It is not envisaged that any construction will take place in or near the watercourses.

DISCUSSION & CONCLUSION

Watercourses are important ecosystems that should be conserved. Apart from these areas being aesthetically pleasing they provide a variety of ecosystem functions as well as various habitats for plant and animal species.

The watercourses of the study area comprise three large systems namely the **eastern wetland system** (consisting of a northern and southern section that are connected underneath the N4 highway), **the western spruit area** and the **western wetland area**. The eastern wetland system and the western spruit area are the most impacted by anthropogenic influences.

The Western stream is perennial and forms a long narrow section along the western boundary of the northern section of the study site and has been variously affected by agricultural activities along both sides in the past. As a result various declared alien invader trees (*Eucalyptus camaldulensis* and *Populus alba)* are present in other area are present in various locations where they form dense clumps, while other sections are dominated by the reed *Phragmites australis.* Old broken farm dams are present within the stream and erosion along the embankments are present in some areas. A berm has been built many years ago along the embankment, most probably when the area was actively used for agricultural purposes. This berm area is mostly dominated by the shrub *Gymnosporia buxifolia* and the medicinal forb *Artemisia afra*. As expected of areas that are subjected to various water levels throughout the year, various pioneer weedy species are also present. The area does have a water channeling and storage function and has achieved a medium Present Ecological Status (PES) and a moderate Habitat Integrity (HI) indicating that the area is moderately modified with some loss of habitat and ecosystem function, but with basic ecosystem functions predominantly unchanged

The Western wetland area was a wide drainage line within which al old farm dam was built to collect surface water from the surrounding areas. It then flows through a narrow channel through rocky outcrops before it flows slowly through the mostly level footslope area, where wetland conditions prevail, before flowing into the Western Spruit. This system is the most natural of all on the property and the only one where a protected plant (*Hypoxis hemerocallidea*) was found to be present. This wetland is perennial to at least seasonally moist and achieved the highest PES and EIS scores of the different watercourses on the

site indicating the system to be mostly natural with a moderate change in ecosystem processes and a moderate to low loss of natural habitats.

The Eastern wetland area occurs close to the eastern boundary of the study site and used to be a narrow wetland, however due to two artificial dams in the northern section the area has expanded and developed into a wider wetland system. The dam wall areas are overgrown with the alien invasive kikuyu grass (*Pennisetum clandestinum*). Soil excavation has taken place in the past within the channel and adjacent to it which has changed the waterflow through these areas. The large *Populus alba* forest areas in both the northern and the southern sections has displaced most of the native plant species and has dried up sections of the wetland. Cattle graze these areas on a regular basis and have trampled the channels in both sections. Land infill along its edges in the past has also negatively affected the ecosystem These areas are permanently wet and do provide habitat for various aquatic and insect species. This area is the most impacted by human actions and therefore achieved the lowest PES and EIS scores indicating it to be largely modified with a change in ecosystem processes and resultant loss of natural habitat and biota.

Despite some areas of the different water courses on the study site being degraded and impacted by anthropogenic influences (past and current), water systems fulfil important roles in the environment. Not only do they channel and store water, but they also play a role in the purification of polluted water, flood attenuation, and provide habitat for various plant and animal species with a variety of aquatic species dependant on these systems for their survival. The water systems on the study site, although some are impacted by human activities, are all functioning and provide various ecological functions. These systems should be managed to improve their condition that will enhance the ecological and conservation value even more.

It is therefore important that no development is allowed within these ecosystems and that a 32 m buffer zone (Figure 8) is implemented (as required by GDARD) around the edge of these system within which no development should be allowed.

All alien invasive plants within these systems should be controlled as prescribed by law.

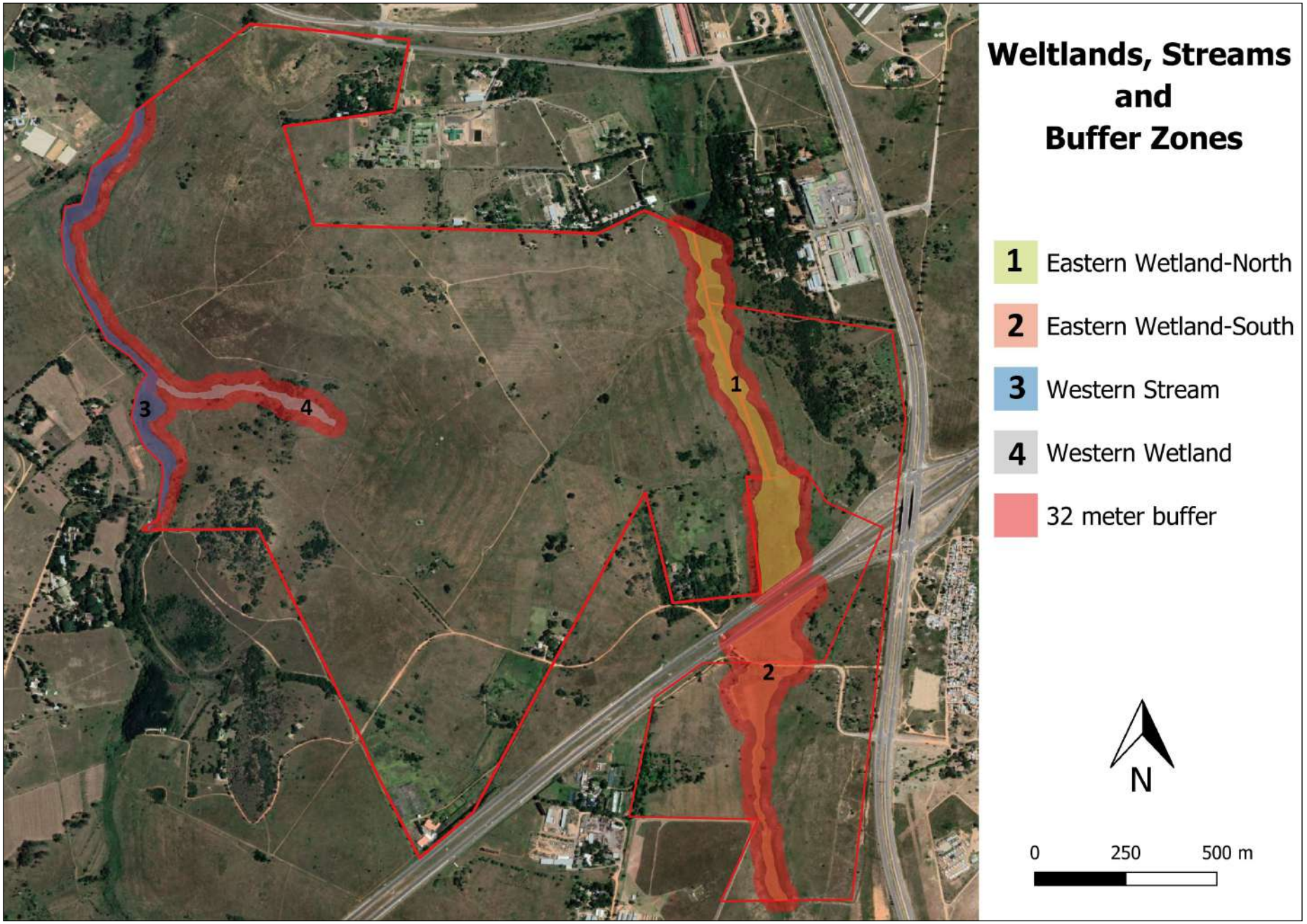


Figure 8. GDARD recommended 32 m buffer zone along the water courses of the study site.

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ANNEXURE 1: WULA Risk Matrix STREAM (western stream)

BEFORE MITIGATION

SK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocc			
SITE NAME	Lanseria western stream		
NAME and REGISTRATION No of SACNASP Professional member: ...	Prof LR Brown	Reg no.	400075/98

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

					Severity																
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	PES AND EIS OF WATERCOURSE
1	Construction		Vegetation clearance within stream	Erosion, loss of habitat & biodiversity	2	2	3	2	2.25	1	3	6.25	1	2	5	1	9	56.3	MODERATE	95	PES Class C (2.1); EIS=Low
			Alien vegetation encroachment		3	1	3	3	2.5	2	3	7.5	1	2	5	2	10	75.0	MODERATE	95	
			Loss of habitat for aquatic animals		2	1	3	3	2.25	2	2	6.25	1	1	5	1	8	50.0	LOW	95	
			Loss of biodiversity		2	1	1	2	1.5	2	2	5.5	1	2	5	1	9	49.5	LOW	95	
			Erosion of stream		3	2	2	2	2.25	2	2	6.25	1	1	5	2	9	56.3	MODERATE	95	
2	Operational Phase	Maintenance activities after construction	Vegetation clearance		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	PES Class C (2.1); EIS=Low
			Loss of vegetation/habitat		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	
			Erosion of stream		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	

AFTER MITIGATION

SK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocc			
SITE NAME	Lanseria western stream		
NAME and REGISTRATION No of SACNASP Professional member: ...	Prof LR Brown	Reg no.	400075/98

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

					Severity																		
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
1	Construction	`	Vegetation clearance within stream	Erosion, loss of habitat & biodiversity	1	1	2	2	1.5	1	1	3.5	1	1	5	1	8	28	LOW	95	See recommended mitigation measures in attached report		PES Class D (57.2%); EIS=Medium
			Alien vegetation encroachment		1	1	1	1	1	1	1	3	1	2	5	1	9	27	LOW	95			
			Loss of habitat for aquatic animals		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95			
			Loss of biodiversity		1	1	1	1	1	1	2	4	1	2	5	1	9	36	LOW	95			
			Erosion of drainage stream		1	1	2	2	1.5	1	1	3.5	1	1	5	1	8	28	LOW	95			
2	Operational Phase	Maintenance activities after construction	Vegetation clearance		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	See recommended mitigation measures in attached report		PES Class D (57.2%); EIS=Medium
			Loss of vegetation/habitat		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95			
			Erosion of drainage stream		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95			

ANNEXURE 2: WULA Risk Matrix WETLAND (western and eastern wetlands)

BEFORE MITIGATION

SK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocc			
SITE NAME	Lanseria eastern & western wetlands		
NAME and REGISTRATION No of SACNASP Professional member: ...	Prof LR Brown	Reg no.	400075/98

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

No.	Phases	Activity	Aspect	Impact	Severity																
					Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	PES AND EIS OF WATERCOURSE
1	Construction	`	Indigenous vegetation clearance within stream	Erosion, loss of habitat & biodiversity	3	2	3	2	2.5	1	3	6.5	1	2	5	1	9	58.5	MODERATE	95	Eastern wetlands: PES Class D (52.8%); EIS=Medium Western wetl PES Class C (68.7%); EIS = Med-high
			Alien vegetation encroachment		3	2	3	3	2.75	2	3	7.75	1	2	5	2	10	77.5	MODERATE	95	
			Loss of habitat for terrestrial and aquatic animals		2	2	3	3	2.5	2	2	6.5	1	1	5	1	8	52.0	LOW	95	
			Loss of biodiversity		2	2	2	3	2.25	2	2	6.25	1	2	5	1	9	56.3	MODERATE	95	
			Erosion of stream		3	2	2	2	2.25	2	2	6.25	1	1	5	2	9	56.3	MODERATE	95	
2	Operational Phase	Maintenance activities after construction	Vegetation clearance		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	Eastern wetlands: PES Class D (52.8%); EIS=Medium Western wetl PES Class C (68.7%); EIS = Med-high
			Loss of vegetation/habitat		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	
			Erosion of stream		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	

AFTER MITIGATION

SK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocc

SITE NAME	Lanseria eastern & western wetlands		
NAME and REGISTRATION No of SACNASP Professional member: ...	Prof LR Brown	**Reg no.**	400075/98

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

					Severity																	
No.	**Phases**	**Activity**	**Aspect**	**Impact**	**Flow Regime**	**Physico & Chemical (Water Quality)**	**Habitat (Geomorph + Vegetation)**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**Risk Rating**	**Confidence level**	**Control Measures**	**Borderline LOW MODERATE Rating**	**PES AND EIS OF WATERCOURSE**
1	Construction	`	Indigenous vegetation clearance within stream	Erosion, loss of habitat & biodiversity	1	1	2	2	1.5	1	1	3.5	1	1	5	1	8	28	LOW	95	See recommended mitigation measures in attached report		Eastern wetlands: PES Class D (52.8%); EIS=Medium Western wetl PES Class C (68.7%); EIS = Med-high
			Alien vegetation encroachment		1	1	1	1	1	1	1	3	1	2	5	1	9	27	LOW	95			
			Loss of habitat for terrestrial and aquatic animals		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95			
			Loss of biodiversity		1	1	1	1	1	1	2	4	1	2	5	1	9	36	LOW	95			
			Erosion of drainage stream		1	1	2	2	1.5	1	1	3.5	1	1	5	1	8	28	LOW	95			
2	Operational Phase	Maintenance activities after construction	Vegetation clearance		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95	See recommended mitigation measures in attached report		Eastern wetlands: PES Class D (52.8%); EIS=Medium Western wetl PES Class C (68.7%); EIS = Med-high
			Loss of vegetation/habitat		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95			
			Erosion of drainage stream		1	1	1	1	1	1	1	3	1	1	5	1	8	24	LOW	95			