WETLAND DELINEATION:

PROPOSED ALLUVIAL DIAMOND MINE AND ASSOCIATED INFRASTRUCTURE: SAMARA PTY LTD PROSPECTING PROJECT, NORTHERN CAPE PROVINCE

Commissioned by:	Written by:
	Nyamoki Consulting Pty Ltd

November 2020

CONTENTS

List of Figures

List of Tables

CONDITIONS RELATING TO THIS REPORT

Declaration of interest

Nyamoki Pty (Ltd) has no vested interest in the property studied nor is it affiliated with any other person/body involved with the property and/or proposed development. Nyamoki Consulting Africa Pty (Ltd) is not a subsidiary, legally or financially of the proponent.

The study was undertaken by Mr Tshuxekani Maluleke, he is a registered Natural Scientists with the following details:

Mr Maluleke: Reg. No. 120501

Qualifications

SPECIALIST	QUALIFICATION
Mr Tshuxekani Maluleke	MSc Environmental Sciences BSc Hons Zoology Bsc Hons Animal, Plant and Environmental Sciences

Indemnity

Although Nyamoki Consulting Pty (Ltd) exercises due care and diligence in rendering services and preparing documents, the client takes full responsibility for this report and its implementation in terms of the National Environmental Management Act of 1998, and exempt Nyamoki Consulting Africa Pty (Ltd) and its associates and their sub-contractors from any legal responsibility based on the timing of the assessment, the result and the duration thereof, which has an influence on the credibility and accuracy of this report. Nyamoki Consulting Africa Pty (Ltd) accepts no liability, and the client, by receiving this document, indemnifies Nyamoki Consulting Africa Pty (Ltd) and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Nyamoki Consulting Africa (Pty) Ltd and by the use of the information contained in this report.

Background to the study

A wetland delineation study was conducted on the entire footprint of the proposed Samara Diamond alluvial and associated infrastructure Prospecting Right at Sydney on Vaal near Barkley West Town in Northern Cape, to determine the presence, and extent of wetland habitat for the proposed development of the area. The study area is a residential area that is highly developed, with some farming and mining within the vicinity of the project.

A single site visit was undertaken during a single visit (29 July 2020). The site was recently burned, and it is the dry season and thus the bulk of the plant species could not be identified. The wetland was delineated according to DWS guidelines and procedures.

Terms of reference

Nyamoki Consulting Africa Pty (Ltd) was requested to conduct a wetland delineation of the wetland present on the study site. This report includes the delineation and also provides an assessment on the ecological state of these areas**.**

APPROVED BY:

Tshuxekani Maluleke, Candi.Nat. Sci (MSc, Environ. Sci) Wetland Specialist

Date: 12 November 2020

1. INTRODUCTION

Nyamoki Consulting (Pty) Ltd has been appointed to conduct a wetland delineation for the proposed Samara Diamond Alluvial and associated activities Prospecting Right project along the Vaal River at Sydney on Vaal near Barkley West Town in Northern Cape Province of South Africa. The investigation has been undertaken to form part of the Environmental Impact assessment (EIA), associated management plan (EMP) as well as the Integrated Water Use License Application (IWULA), to be submitted to the Department of Water and Sanitation (DWS).

Figure 1: Locality Map

1.1 Wetland functions and values

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 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 (Table 1). 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.).

Table 1: Direct and indirect wetland benefits (Kotze et al., 2005)

INDIRECT BENEFITS	DIRECT BENEFITS
Hydrological Benefits include: • Water Purification • Sustained stream flow • Flood reduction • Ground water recharge/discharge • Erosion control **Biodiversity Conservation**- Integrity and irreplaceability **Chemical Cycling**	• Water Supply • Provision of harvestable resources (reeds etc.) • Socio-cultural significance • Tourism and recreation • Education and research

Their flat and wide nature assists in reducing the velocity of the flow, because of reduced gravitation and spreading of the concentrated channel flow over a wider area. This causes sediment to settle down, thereby purifying the water from sediment, but also of other pollutants adsorbed to the sediments, e.g. bacteria and viruses. The flatness of the surface area also promotes contact between water and sediments because of the shallow nature of the water column, leading to high levels of sediment/soil-water exchanges. The shallow nature also promotes exposure of bacteria and viruses to solar radiation, which assists in the elimination of these from wetland waters (Seidel, 1970; Rogers, 1983 in Kotze et al., 1994).

The shallow oxygenated surface water promotes the occurrence of aerobic/anaerobic processes by maximising the aerobic/anaerobic interface where denitrification can occur (Hemond and Benoit, 1988; Hammer, 1992 in Kotze et al., 1994). The flat and wide nature of palustrine floodplain-type wetlands is responsible for the greater retention time of these systems relative to the river or channel flow. One of the most important mechanisms for bacterial removal by wetlands is simply detention while natural die-back occurs. Pathogenic micro-organisms found in sewage effluent generally cannot survive for long periods of time outside the host organisms (Hemond and Benoit, 1988 in Kotze et al., 1994).

1.2 Types of wetlands

There are many different types of wetlands; and a number of classification systems have been developed to try to describe these different types. One system which has been developed for inland wetland systems is based on the hydrogeomorphic (HGM) characteristics of wetlands (Marneweck and Batchelor, 2002; Kotze et al., 2005) (Figure 1). This approach follows that used by the US Environmental Protection Agency, and this classification system has been included as part of a proposed wetland classification system for South African wetlands by Ewart-Smith et al (2006).

Wetlands can be classified by methods that range from the use of commonly recognized vegetation or cover types, to systems based on hydrology, geomorphology, or some combination of the two. The classification presented here is based on the hydrogeomorphic functions of wetlands. There are three basic properties that are used to provide insight into wetland functions.

This hydrogeomorphic classification system classifies wetlands according to their form (geomorph- characteristics) and the way in which water moves in, through and out of the wetland system (hydro- characteristics). The classification system recognises 5 generic palustrine wetland types:

- Pans and depressions (incl. lakes);
- Seepage wetlands;

- Un-channelled valley bottoms;
- Channelled valley bottoms; and
- Floodplains

Different wetlands perform different functions in the landscape.

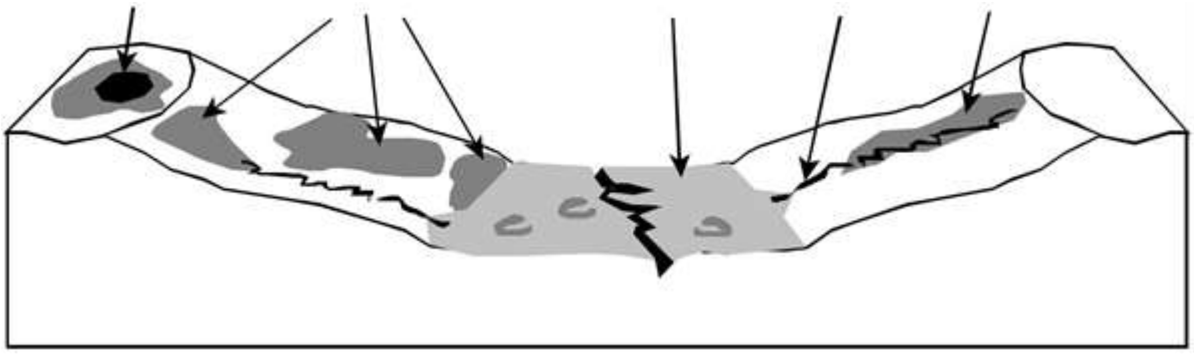

Figure 2: This hydrogeomorphic (HGM) classification is an easy classification system for wetlands which can be applied at desktop level. Additionally it has strong links to the hydrological functions, since wetlands are grouped by hydrological characteristics; and it therefore provides insight into the likely functional importance (role in the landscape) that the wetland type is likely to play (Marnewick and Batchelor, 2002; Kotze et al., 2005).

1.3 Hydrological Zones

As mentioned previously, because of the landscape in which wetlands usually occur, the hydrological regime is not constant throughout the entire wetland. Consider a typical floodplain wetland located within a valley bottom. Depressions could be present within this valley bottom wetland of which the soil surface is below the water table; they are therefore permanently saturated (wet even in the dry winter months). As one moves from these depressions towards the surrounding upland, the general trend will be to move along an incline from the valley bottom towards the foot slopes of the catchment.

Flooding of the perimeter areas of the floodplain will therefore be dependent on the extent of flooding (volume of water per unit of time). During high runoff events, these areas will be flooded, and conversely, during low runoff events they will not be flooded. Consequently the period of flooding, which affects the development of reduced soil conditions, will also be shorter than for the lower lying areas. It can be concluded that within this wetland there exists a hydrological gradient ranging from permanent saturation at its deepest end, to periodic saturation at its shallowest end. At some point within this hydrological gradient the average period of saturation of the soil will be insufficient for this area to develop reduced soil conditions, and to therefore be classified as a wetland.

There are thus regions which range from those which remain permanently flooded and/or saturated for the entire year (permanently saturated) to those which are flooded and/or saturated for 5-11 months of the year (seasonally saturated), or saturated at or close to the soil surface for 1-5 months (temporarily saturated) in the year, but still long enough to develop reduced soil conditions. These areas of different duration of reduced soil conditions are referred to as hydrological zones. Depending on the hydrology, a wetland can possess all three hydrological zones (permanent, seasonal and temporary), any two of them, or only one.

The hydrological zones are recognised by the presence of redoximorphic features within the soil matrix, but are distinguished from one another by the relationships in which they occur. The redox concentrations (mottles: the red, yellow and black spots) are close to the soil surface in the seasonal and temporary wet zones of the wetland, while they are much deeper in the soil profile in the non-wetland area. These mottles are absent or far fewer in the permanent wet area due to these areas being mostly, void of oxygen (because of the relatively permanent presence of water) so that oxidation of the colourless Fe^{2+} to Fe^{3+} does not occur as readily as in the temporarily and seasonally wet soils.

The significance of reduction and the resulting redox concentrations and redox depletions in defining a wetland is that it is only once the soil of a piece of land displays these redoximorphic features within the upper 500mm, that it is classified as being a wetland.

In practice it is not easy to identify the subtype as the contribution of groundwater to wetlands is difficult to determine. However, it is important to recognize the existence of the different water transfer mechanisms as they affect various aspects of the wetland ecology (Table 2).

Table 2: The three landscape locations and their associated hydrological subtypes.

Landscape location	Subtype based on water transfer Mechanism
Hillslope wetlands	Surface water-fed Surface and groundwater-fed Groundwater-fed
Valley bottom wetlands	Surface water-fed Surface and groundwater-fed Groundwater-fed
Depression wetlands	Surface water-fed

	Surface and groundwater-fed Groundwater-fed

(a) Permanent Wet Zone

Of any of the zones, the permanent wet areas have the greatest potential to decrease the velocity of flow due to the high friction value of the vegetation typically associated with this zone (also, due to the flat nature of palustrine type wetlands, they naturally decrease the velocity of flow, even in the absence of vegetation). Due to the permanent wet nature of the soils, it is mostly anaerobic. Although the wetland plants provide substantial surface area for the attachment of microbes, both above-ground and below-ground, due to the aerobic rhizosphere around roots, this process is not as significant in this zone as it is in the seasonal wet zone which is marked by dry (aerobic) and wet (anaerobic) cycles. Because of the longer prevalence of anaerobic conditions, water purification functions associated with organic matter are more efficient in the permanent wet zone than in the other zones. The prolonged anaerobic conditions of the permanent wet zone promoted flood attenuation and regulation more so than the seasonal wet zone due to conditions (anaerobic) promoting the aggregations of organic material.

(b) Seasonal Wet Zone

Due to the seasonal nature of flooding, aerobic and anaerobic conditions are more favourable for performing water purification functions than in the permanent zone. The seasonal zone is therefore the most important location for water purifying processes dependant on an aerobic/anaerobic environment. Although the frictional value of the seasonal wet zone is not as high as that of the permanent wet zone, it is still sufficient in most cases, depending on the ratio of inflow and surface area, to decrease the velocity sufficiently enough for all water purifying processes to take place (due to the flat nature of palustrine type wetlands, they naturally decrease the velocity of flow, even in the absence of vegetation).

The seasonal wet zone is usually characterised by having a lower organic content than the permanent wet zone due to more oxygen, which promoted the decay of organic material. Processes associated with organic matter are therefore not as efficient in the seasonal wet zone as in the permanent wet zone, but still contribute significantly towards water purification through these processes. The contribution of organic soils in withholding water, thereby performing a flood attenuation and regulation function, is less so than in the case of the permanent wet zones where there is usually a thicker layer of organic material due to the anaerobic conditions which is more characteristic of the permanent wet zone than of the seasonal wet zone.

(c) Temporary Wet Zone

The temporary wet zone is the transitional zone between the wetland and the surrounding dry land. Because of the limited surface area, the limited water volumes they receive, absence of significant aerobic/anaerobic conditions, limited organic material (due to relative short periods of anaerobic conditions) and average plant productivity, temporary wet areas do not contribute significantly to the hydrological functions, e.g. water purification, typically associated with palustrine floodplain type wetlands. Temporary wet areas are, however, more capable of performing hydrological functions than the surrounding dry land and could represent important sites for these functions where no other, or very little of the other, more capable hydrological units occur.

2. OBJECTIVES OF THE STUDY

Nyamoki Consulting (Pty) Ltd, an independent company was requested to undertake an assessment of wetlands. The activities for this assessment include the following:

- Desktop review of local, regional and national databases and plans.
- Document the legislative and regulatory context, including limits and standards.
- Delineation of the watercourses (including wetlands) within the site and within 500m of boundary of the site, based on methodologies accepted by the DWS, using aspects such as soil morphological characteristics, vegetation types and wetness.
- Mapping of watercourses (including wetlands).
- Watercourse (and wetland) classification.
- Assessment of the integrated habitat integrity (IHA).
- Assess watercourse services provided by the resources within the site.
- Identification of potential species of conservation concern.
- On site assessment of biota-specific water quality, for parameters including pH, conductivity, dissolved oxygen and temperature.
- Assess the Ecological Importance and Sensitivity (EIS) and Present Ecological State (PES).
- Determine watercourse drivers (hydrology, water quality, sediment balance and the geomorphological regime) and watercourse receptors (habitat and biota).
- Delineation of buffer zones / regulation zones around the watercourses.
- Identify potential impact issues and risks to be assessed during the impact assessment and reporting phase and matters that could affect the project layout and design and selection of project alternatives.

3. STUDY AREA

The site is in along the Vaal River at Sydney on Vaal near Barkley West Town in Northern Cape Province of South Africa(Figure 3).The study site development has mining history, and thus previous mining past activities have completely transformed the natural habitat of the area and created a present day environment characterised by alien invasive species, weeds and a patchy distribution of secondary grassland vegetation elements

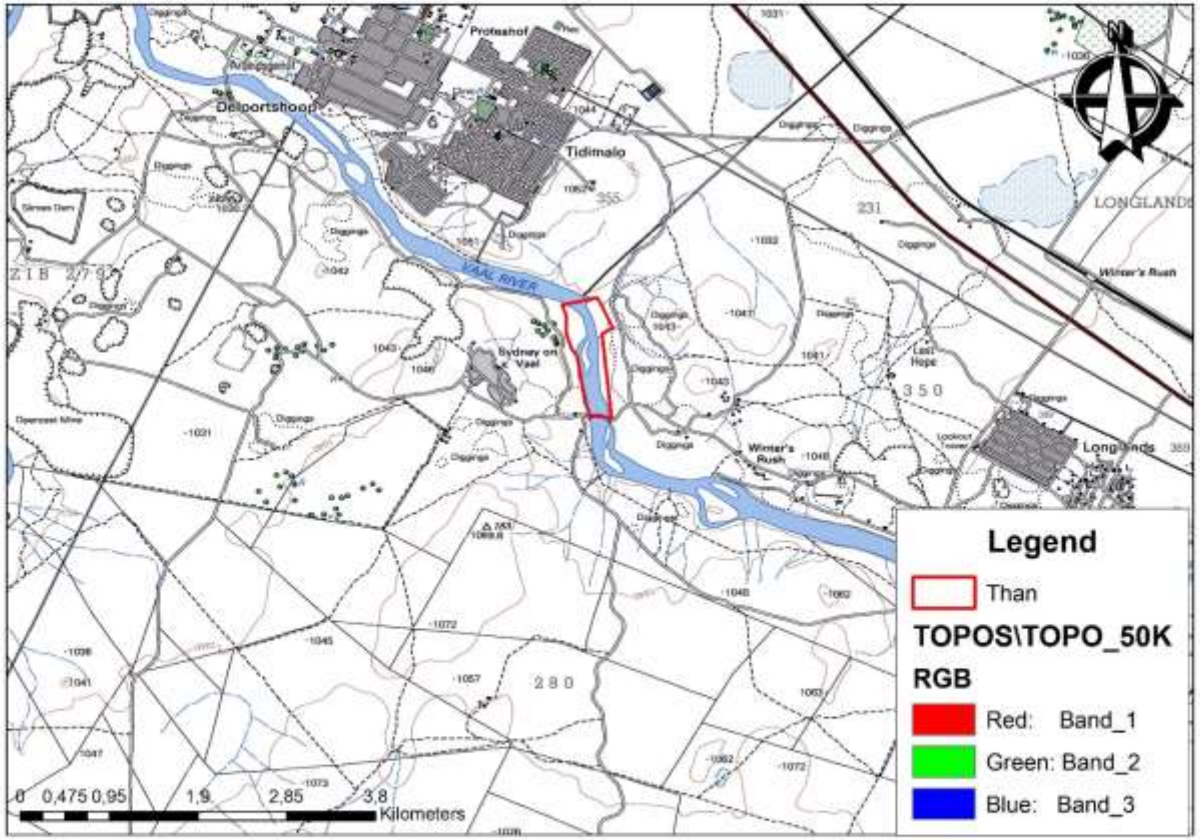

Figure 3: Locality map

The study site is located within the Lower Vaal Water Management Area (WMA=20) (Figure 5).

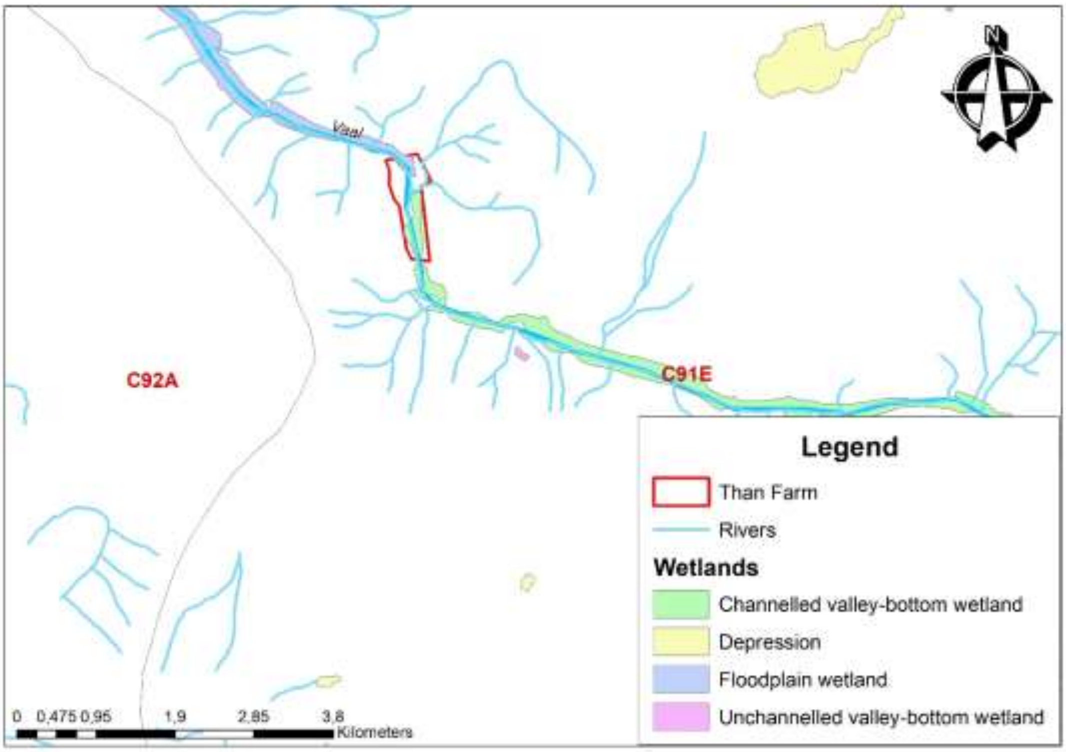

Figure 4: Wetland catchment area

4. METHODS

4.1 Wetland delineation

A visual reconnaissance of the area was undertaken before surveying commenced. Maps and Google Earth™ images were studied in order to determine the position of possible wetlands and/or riparian zones in the study area. All possible wetlands and water courses were subsequently surveyed in order to determine the delineation thereof. The method described by (DWAF, 2005 and 2008). The DWAF guidelines contain a number of stipulations relating to the protection of wetlands and the undertaking of wetland assessments. The guidelines state that a wetland delineation procedure must identify the outer edge of the temporary zone of the wetland, which marks the boundary between the wetland and adjacent terrestrial areas and is that part of the wetland that remains flooded or saturated close to the soil surface for only a few weeks in the year, but long enough to develop anaerobic conditions and determine the nature of the plants growing in the soil.

The guidelines also state that locating the outer edge of the temporary zone must make use of four specific indicators including the terrain unit indicator, the soil form indicator, the soil wetness indicator and the vegetative indicator. In addition the wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive in a sensitivity map.

The guidelines stipulate buffers to be delineated around the boundary of a wetland; the wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive and a 30m buffer delineated around the edge of the wetland in which no development must be allowed to occur.

For the purposes of this investigation a wetland was defined according to the definition in the National Water Act (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 in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

Wetland delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the department of Water Affairs and Forestry (DWAF, 2005). The method for identification and delineation uses four indicators to indicate/flag the presence of riparian areas and wetlands. These four indicators are:

- Terrain Unit (Location in the landscape)
- Soil form (typical wetland soil forms)
- Vegetation (indicator species or hydrophytes) and
- Soil wetness (evidence of hydric conditions)

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.

(a) 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 (e.g. desktop screening assessment of where development is proposed in or alongside a valley bottom wetland or river). 1:50 000 topographic maps were used to generate digital base maps onto which the boundaries of the wetland can be delineated using Arcview 9.2. The terrain unit indicator is used for indicating the likely presence of wetlands, but not for delineation purposes.

(b) 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. Soils forms are also only indicators of possible wetland presence: i.e. on its own it is not sufficient information to rely on for wetland verification. The exceptions are the Katspruit, Champagne, Willowbrook and Rensburg soil forms which are mostly associated with permanent wetlands. No comprehensive soil survey has been undertaken for the site.

(c) 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 condition is the primary criterion that signifies waterlogged conditions. These conditions manifest itself through plant communities that can tolerate hydromorphic soils. These plants are hydrophytes that are adapted to stresses imposed on plants through temporary or permanent waterlogged conditions.

(d) Soil wetness Indicator

This indicator refers to the colour of soil component is often the most diagnostic indicator of hydromorphic soils. Iron is what gives soil its red-brown colour; the reddish colour originates from iron-oxide (rust) – iron and oxygen. 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. Prolonged periods of water saturation producing gleysation, where grey and blue mottles are form and are a condition in which hydrophilic plants flourish. Soil that are gleyed or organic soils indicate permanently saturated zones. Where the soil is only saturated on a seasonal basis (at least 3 months per year); the gleying may not be extensive. Instead, due to alternating periods of iron being dissolved and then oxidised, a mottled appearance develops in the soil. 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 (Table 3 & Figure 6).

Table 3: Relationship between degree of wetness (wetland zone) and vegetation (adapted from Kotze et al., 1994)

Degree wetness			
	Temporary	**Seasonal**	**Permanent/ Semi-permanent**
Soil Depth (0cm-50cm)	Few/no mottles Non-sulphuric	Many mottles Seldom sulphuric	Few / no mottles Often sulphuric
Vegetation	Predominantly sedges and grasses	Predominantly sedges and grasses	Predominantly reeds and sedges

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).

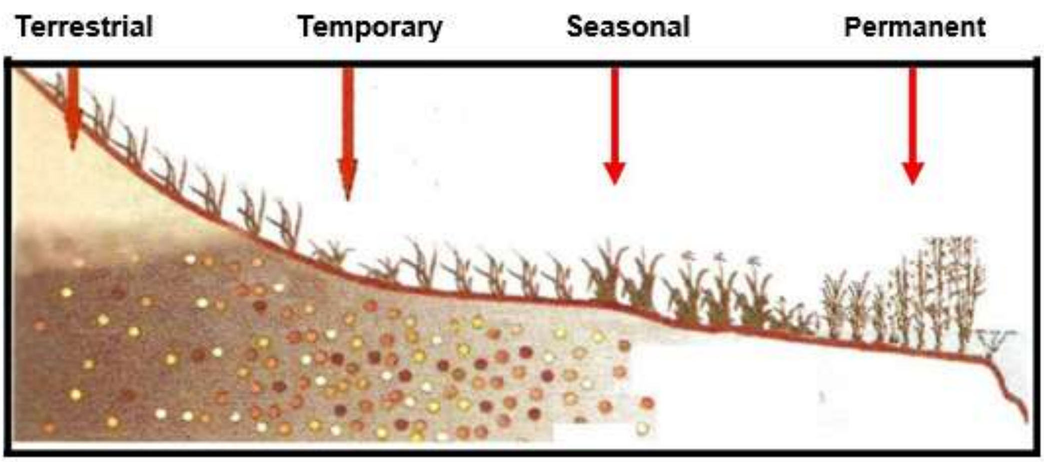

Figure 5: Cross section through a valley bottom wetland indicating how soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the permanent wet hydrological zone to the temporarily wet hydrological zone and eventually into the non-wetland or terrestrial zone (Department of Water Affairs and Forestry, 2003 as adapted by Kotze, 1996)

4.2 FIELD SURVEY

The site is disturbed to different degrees, which include permanent and reversible damage to the wetland area within the site. Historic impacts include the mining and pollution.. The result has been low vegetation surface areas with little to no biodiversity cover or topsoil in many areas. As a result the identification of typical wetland indicators in the form of hydrophytes and hydromorphic soils were restricted on the site.

A Dutch soil auger was used to extract the cores to a depth of 50cm (Figure 6). 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.

Figure 6:Clay soil onsite indiactive of wetalnd presence

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. Soil auger samples were restricted to the immediate site.

4.3 Wetland assessment

4.3.1 Present Ecological Status

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 results from such an assessment are compared to the standard DWAF A-F ecological categories (Table 4) from where the PES/Habitat integrity of the wetland can be determined. The values give an indication of the alterations that have occurred in the wetland system.

Table 4: Present Ecological status categories of wetlands (adapted from kleynhans, 1996 & 1999)

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

4.3.2 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 5.

Table 5: Ecological Importance & Sensitivity Categories of Wetlands

EIS Categories	Description
Low/marginal	Not ecologically important and sensitive at any scale. Biodiversity ubiquitous and not sensitive to flow and habitat modifications (Wetlands: play an insignificant role in moderating water quality & quantity)
Moderate	Ecologically important & sensitive on provincial/local scale. Biodiversity not usually sensitive to flow & habitat modifications. (Wetlands: play a small role in moderating water quantity & quality)
High	Ecologically important & sensitive and important. Biodiversity may be sensitive to flow & habitat modifications. (Wetlands: Play a role in moderating water quantity & quality)
Very high	Ecologically important & sensitive on a national (or even international) level. Biodiversity usually very sensitive to flow & habitat modifications. (Wetlands: play a major role in moderating water quantity & quality)

4.3.3 Wetland Eco services

WET-EcoServices (Kotze et al. 2004) was used to assess the goods and services that the floodplain 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.

5. RESULTS

5.1 Wetland delineation

Figure 7: General Representation of the wetland on site.

The proposed project is located within 500m of the Vaal River, the river is regarded as a National Freshwater Priority Area by the SANBI. It can be classified in terms of its hydro-geomorphic characteristics, as a **river (FEPA)** that receives both surface and subsurface water input , the delineated river displays a gradient of wetness across its width. Hydrophytes species and terrestrial species dominate the drier portion of the river banks , while obligated hydrophytes occur in the wetter areas.

The river is surrounded by the Kimberly Thornveld vegetation type (Figure 8), which is characterised by Plains often slightly irregular with well-developed tree layer with *Acacia erioloba*, *A. tortilis*, *A. karroo* and *Boscia albitrunca* and well-developed shrub layer with occasional dense stands of *Tarchonanthus camphoratus* and *A. mellifera*. Grass layer open with much uncovered soil. The vegetation of the central wet to moist portion of the valley bottom wetland (permanently wet area) is dominated by a homogeneous stand of the obligate hydrophytes.

Figure 8: Kimberly Thornveld Vegetation Type onsite.

The The edge and adjacent areas of the wetland remains largely bare, however in some cases isolated patches of *Cynodon dactylon* (Couch Grass), *Nidorella hottentotica* and *Conyza podocephala* are present (Figure 9). A large number of declared alien invasive species are also present along the edge and around the   the wetland   and pose a huge risk to the larger environment .

Figure 9: Signs of human disturnbace onsite.

5.2 Site Hydrology

The study area's water balance was not greatly influenced by climate imbalance between average evaporation and rainfall as the Vaal River receives high return flows from factories and irrigated areas upstream of the study area. However, caution should be exercised to prevent flooding of infrastructure during the opening of weirs upstream and also during heavy rainfall on the Vaal River system (Nyamoki,2020).

5.3 Wetland assessment

5.3.1 Present ecological status (PES)

Table 6 (Kleynhans 1999). It should however be noted that if a score of less than 2 is attributed to any impact, the lowest rating is used to attribute PES class and not the mean.

Table 6: PES classes (from Kleynhans 1999) indicating the interpretation of the mean scores to rate the PES category.

		WITHIN GENERALLY ACCEPTABLE RANGE
Category	**Score**	**Description**
A	>4	Unmodified, or approximates natural condition and/or represents a natural condition due to successful rehabilitation process/program(s) which has occurred and/or are in the process of occurring.
B	>3 and 4	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged
C	>2 and 3	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	2	Largely modified. A large loss of natural habitats and basic Ecosystem functions has occurred.
		OUTSIDE GENERAL ACCEPTABLE RANGE
E	>0 and 2	Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive
F	0	Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat

The results from the PES analysis indicate the river to be in PES class E (Table 7) indicating that it is seriously modified with losses of natural habitats and ecosystem functions. This can be ascribed to the effect of the polluted water flowing through the study site and the disturbance next to the study site, the destruction of the natural vegetation and the introduction of alien vegetation along the edge and the rest of the study area, especially along across the river.

Table 7: PES calculation for the riverine wetland.

Criteria and attributes	Relevance	Score	Confidence
	Hydrological		
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	2	4
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	2	4
	Water Quality		
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland	1	4
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	2	4
	Hydraulic/Geomorphic		
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	3	4
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or changes wetland habitat directly or through changes in inundation patterns.	1	4
	Biota		
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and	2	5

	loss of wetland functions.		
Indigenous Vegetation Removal	Direct destruction of habitat through any human activities affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	1	5
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	1	5
Alien fauna	Presence of alien fauna affecting faunal community structure.	2	4
Overutilisation of biota	Overgrazing, Over-fishing, etc	4	4
Mean		**1.91**	**4.3**
Class		**E**	

5.3.2 Ecological Importance and Sensitivity (EIS)

The EIS and functions were calculated using the new draft DWA guidelines and 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. No classification of the scores is given.

The Vaal river has an Ecological Importance and Sensitivity (EIS) score of 3 (Table 8). This is a value between 0 and 4, with 0 being very low and 4 very high. The river therefore has a medium EIS score. It is regarded as being ecologically important or sensitive with a low biodiversity though it plays a role in moderating water quality and quantity.

Table 8: EIS calculation of the river

ECOLOGICAL IMPORTANCE AND SENSITIVI TY	Score (0-4)	*Confidence (1-5)*	Motivation
Biodiversity support	**0.66**	*4*	
Presence of Red Data species	**0.00**	*4.00*	No known red data or protected species observed on site.
Populations of unique species	**0.00**	*4.00*	No unique plant or animal populations were observed.
Migration/breeding/feeding sites	**2.00**	*4.00*	Though a few bird species were observed, few nests were present..
Landscape scale	**1.00**	*4.80*	
Protection status of the wetland	**1.00**	*5.00*	The wetland and surrounding area has been exposed to

			various industrial and housing developments surrounding the area.
Protection status of the vegetation type	**1.00**	*5.00*	The wetland is not located in an endangered vegetation type. Although dominated by *Phragmites* it is very homogeneous as a result of the polluted state of the water. The vegetation surrounding the wetland is mostly pioneer and alien invasive species with few indigenous species present.
Regional context of the ecological integrity	**1.00**	*5.00*	The wetland is in PES class E due to the large scale degradation of the surrounding areas as well as the wetland area itself.
Size and rarity of the wetland type/s present	**4.00**	*4.00*	The wetland is not particularly rare and has no vulnerable ecosystem present.
Diversity of habitat types	**1.00**	*5.00*	The wetland has a low species diversity as well as habitat diversity. The wetland is dominated by a homogeneous stand of *Phragmites* australis

5.3.3 Wetland ecoservices

WET-EcoServices (Kotze et al. 2004) was used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision-making. Overall the riverine wetland has a low-moderate ecosystem services (spider diagram right). It has a low species richness and biodiversity due to the destruction of the natural vegetation and resultant loss of habitat for insects and amphibians. However, the wetland plays a role in terms of sediment trapping, toxicant and phosphate removal, and erosion control (Figure 9).

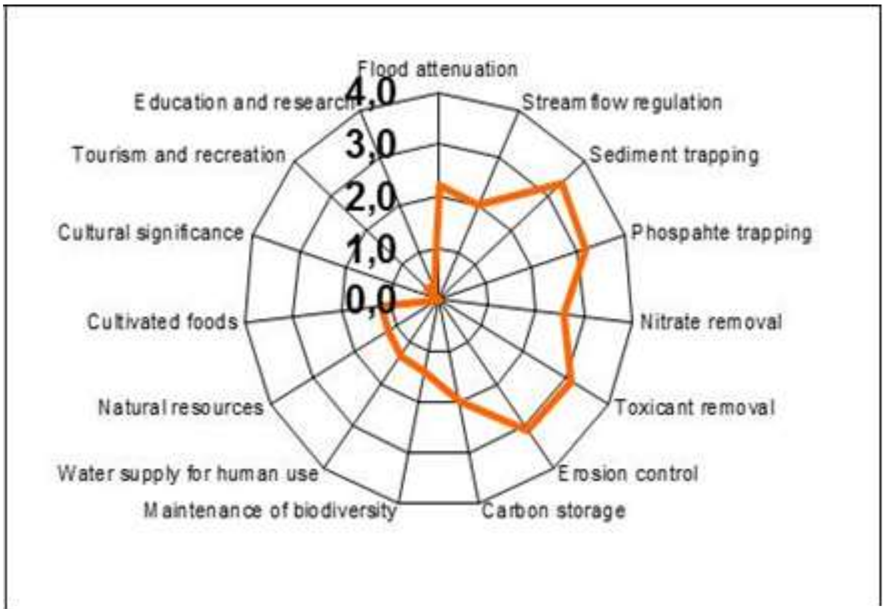

Figure 10: Eco services

6. RECOMMENDATIONS

- Limit all activities within the demarcated areas.
- Include environmental awareness aspects into the site induction program to ensure all construction staff are aware of the location and importance of wetland habitats.
- Establish emergency response measures and a clearly defined chain of communication to rapidly deal with any unforeseen impacts to wetlands, e.g. spills.
- No stockpiling of material may take place within the wetland areas and temporary construction camps and infrastructure should also be located outside the wetland footprint.
- Regular cleaning up of the wetland areas should be undertaken to remove litter.
- Design and implement a construction stormwater management plan that aims to minimise the concentration of flow and increase in flow velocity, as well as minimising sediment transport off site.
- Where practically possible, the major earthworks should be undertaken during the dry season (roughly from April to August) to limit erosion due to rainfall runoff.
- Store and handle potentially polluting substances and waste in designated, bunded facilities.
- Waste should be regularly removed from the construction site by suitably equipped and qualified operators and disposed of in approved facilities.
- Locate temporary waste and hazardous substance storage facilities a minimum of 100m from any wetland edge.
- Keep sufficient quantities of spill clean-up materials on site.

7. DISCUSSION

The study area falls within the Lower Vaal water management area (WMA ID=20). The proposed project is located along the Vaal River, The local catchment is characterised by mined areas and agricultural activities. The areas around the River on the study site have been highly disturbed by historic mining activities, with the result that little topsoil and organic material remain. Sedimentation has been taking place. Consequently, topsoil with signs of wetness and organic material are present in along the riverbanks.

The vegetation is homogeneous comprising grass species and patches of Acacia species with a few other species present in the river. The biodiversity and species composition of the total area is low with a **low-moderate ecosystem functioning**. The degradation that has taken place is of such a scale that the damage is considered to be reversible.

8. CONCLUSION

The ecological significance of the river should be viewed in the context of the overall level of functionality of the river, which is thought to be medium, and in the context of the hydrological ‘connectivity’ of the river, which has resulted from significant historical modification and thus transformation of the ecosystem. It is important to note that the Vaal River catchment contains South Africa's economic heartland, the Pretoria-Witwatersrand-Vereeniging complex. Although the catchment only produces eight per cent of the mean annual runoff of the country it has the highest concentration of urban, industrial, mining and power generation development in South Africa, and thus it important to protect this river.

It must also be remembered that wetlands are protected under the National Water Act, and that the Act does not discriminate between degraded and non-degraded wetlands in terms of their importance. It is therefore recommended that extra caution be taken when prospecting. All alien invasive vegetation along the river banks must be removed and eradicated from the property boundary.

9. REFERENCES

ACOCKS, J.P.H. 1988. Third Edition. Veld Types of South Africa. Memoirs of the Botanical Survey of South Africa No. 57, Botanical Research Institute, RSA

BREEN, C.M. (ED.). 1997. How Wet is a Wetland? – An Introduction to Understanding Wetland Hydrology, Soils and Landforms, Wetland-Use Booklet 2, Share-Net, Wildlife Society of South Africa

BROMILOW, C. 2001. Problem plants of South Africa. Briza Publications, Pretoria.

COLLINS, N.B. 2005. Wetlands: The basics and some more. Free State Department of Tourism, Environmental and Economic Affairs.

(DWAF) DEPARTMENT OF WATER AFFAIRS AND FORESTRY. 2003. A Practical field procedure for identification and delineation of wetlands and riparian areas, Final Draft.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (2003). National Water resource Strategy (Final Draft). DWAF. Pretoria. South Africa.

DEPARTMENT OF WATER AFFAIRS AND FORESTRY (1998). National Water Act; Act No.36 of 1998. South Africa.

ENVIROGUARD ECOLOGICAL SERVICES. 2010. Wetland delineation for remaining extent of Portion 7 of the Farm Mooifontein 141 IR Gauteng Province. Unpublished report.

(DWAF) DEPARTMENT OF WATER AFFAIRS AND FORESTRY. (2005). A practical field procedure for the identification and delineation of wetlands and riparian areas. DWAF, Pretoria, South Africa.

HENDERSON, L. (2001). Alien weeds and invasive plants – A complete guide to declared weeds and invaders in South Africa. Plant Protection Research Institute, Agricultural Research Council Handbook No 12. Pretoria.

LOW, A. B. AND REBELO, A. G. (EDS) (1998). Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs & Tourism, Pretoria.

KOTZE, D.C., KLUG, J.R., HUGHES, J.C. AND BREEN, C.M., 1996. Improved criteria for classifying hydromorphic soils in South Africa. S.Afr. J. Plant and Soil, 13(3)

KOTZE, D.C., MARNEWECK, G.C. Draft document 1999: Guidelines for delineating the wetland boundary and zones within a wetland under the South African Water Act.

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S., AND COLLINS, N.B., 2005. WET-EcoServices - A technique for rapidly assessing ecosystem services supplied by wetlands, Draft unpublished report.

MUCINA, L AND RUTHERFORD, M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. SANBI, Pretoria.

SOIL CLASSIFICATION WORKING GROUP. 1991. Soil Classification: a taxonomic system for South Africa. Memoirs of the Agricultural Natural Resources of South Africa, No 15,

VAN OUDTSHOORN, F. (1999). Guide to grasses of southern Africa. Briza Publications, Pretoria.