THE PROPOSED EXPANSION OF BUSHVELD VAMETCO MINE OPERATIONS IN BRITS WITHIN THE JURISDICTION OF MADIBENG LOCAL MUNICIPALITY IN NORTH WEST PROVINCE:

Wetland and Riparian Impact Assessment

Prepared for:

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Prepared by:

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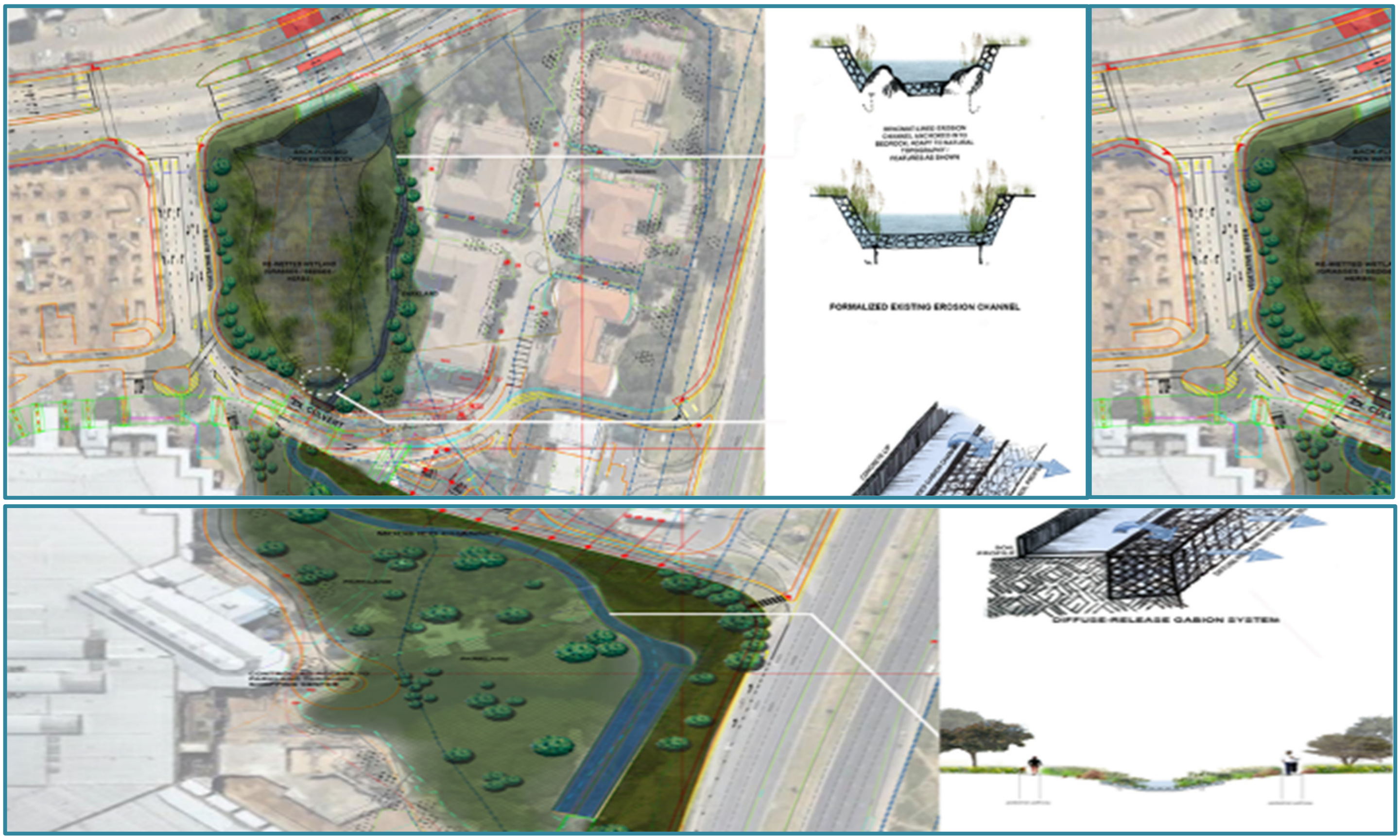

October 2020

Declaration of Independence by Specialist

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

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

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Wetland Specialist
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26/10/2020

Date

EXECUTIVE SUMMARY

Nsovo Environmental Consulting was contracted to conduct an Environmental Impact Assessment (EIA) on for the Bushveld Vametco Alloys (Pty) Ltd Production Expansion Project. Bushveld Vametco Holdings proposes expanding its mining operations to increase production capacity from 3000 to 5000 metric tons and eventually 10000 metric tons in the future. The project will take place within their authorised Mining Right (MR) area and will entail the following activities:

- The expansion of the existing slimes dam towards the east of the mine to cater for additional slimes waste;
- The expansion of the magnetite dump to the north and south of the mine;
- The construction of the two Pollution Control Dams (PCDs) for the proposed magnetite dump expansion and existing plant to accommodate the return or polluted water;
- Development of the new Return Water Dam (RWD) to accommodate return/polluted water from the proposed and existing slimes dams as well as to accommodate stormwater within the mine;
- Construction of a Barren Dam (BD) to store barren and mother liquor solution; and
- Development of a new Waste Rock Dump (WRD) to reduce load and haul distance and facilitate easy backfill.

Subsequently, WaterMakers was appointed by Nsovo Environmental Consulting as independent specialists to conduct the relevant wetland-related studies in order to facilitate the required environmental authorisation and water use licence processes. The present study represents the wetland and riparian impact assessment of the study and aims to inform responsible decision making with regards to the project. In order to enable an adequate description of potential wetland habitat and so as to ensure that the wetland study conducted is applicable for both an Environmental Authorisation as well as a Water Use Licence Application, the following approach was to be undertaken:

- Desktop assessment;
- Site assessment for Identification and delineation of wetland habitat;
- Classification of identified wetland habitat;
- Identification of wetland goods and services by means of the Wet-EcoServices approach;
- Determination of the Present Ecological State of identified wetlands by means of the Wet-Health approach;
- Determination of the Ecological Importance and Sensitivity of identified wetlands; and
- Impact assessment with mitigation measures

One hydro-geomorphic units (HGM), comprising one HGM type, a channelled valley bottom wetland was delineated and classified within the study area and within 500m surrounding the study area. In addition several riparian watercourses were also delineated within and surrounding the study area.

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

Combined area weighted Wet-Health results indicated that the valley bottom wetland within the study area have been moderately altered as a result of changes in water inputs (derived from its catchment) and water retention and distribution patterns within the wetlands units, as well as vegetation changes within the wetlands and surrounding catchments due to historic and current anthropogenic impacts. Riparian habitat were assessed for their Present Ecological Status through applying a Level 3 VEGRAI assessment which indicated that riparian habitat were moderately to seriously impacted due to changes in water inputs (derived from its catchment) and water retention and distribution patterns within the riparian habitat itself.

The valley bottom wetland, HGM 1, was regarded as having a moderate Hydrological and Functional Importance as a result of the relatively moderately intact nature and various important ecosystem services it provide. The moderate Ecological Importance and Sensitivity assigned too HGM 1 can be attributed to the relatively intact hydrological and geomorphological nature associated with the wetland and its associated catchment. Direct human benefits were associated with the provision of natural resources as well as grazing opportunities afforded by wetland habitat within the study area, especially by providing a higher general moisture regime compared to the terrestrial habitat. Collectively, the valley bottom system play an important role in contributing to good water quality and quantity to the downstream environment, more specifically the Crocodile River. All riparian habitat was also considered sensitive due to the important functions it could potentially provide.

The impact assessment identified surface water pollution including sedimentation as well as increased erosion, loss of wetland and riparian functionality and decreased downstream water quality as the major potential impacts during the construction and operational phase. Several general and specific mitigation measures were proposed in order to reduce negative impacts and incorporate some potentially positive impacts from the proposed development following the application of the mitigation hierarchy. Some of the most pertinent recommendations include:

- Particular care must be taken on the eastern periphery where the existing clean water diversion channel is situated within the proposed footprint of the new Waste Rock Dump. The existing clean water diversion channel must be redirected west of the proposed new waste rock dump. Alternatively, if contours permit, the clean water diversion channel could also be re-routed around the eastern periphery of the proposed Waster Rock Dump. Further, a diffuse release gabion channel must be constructed on contour on the downstream end of the clean water diversion channel in order to ensure that channelisation of the valley bottom wetland (HGM 1) is not promoted. Some soft channel rehabilitation intervention is also recommended just downstream from the release point as part of the installation of the diffuse release channel.
- The clean and dirty water separation infrastructure should be audited by a surface hydrologist to ensure that adequate clean and dirty separation infrastructure is in place for the mining complex.
- An appropriate wetland and riparian monitoring program must be implemented prior to the start of the construction phase;

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ACRONYMS

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

1. INTRODUCTION

1.1 Project Description

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1.2 Scope of Work

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

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

A site visit to the area to be affected by the proposed activity was undertaken on the 27th and 28th of June 2019. A detailed description of the methodology used to address the above Terms of Reference is provided in Appendix A.

1.3 Assumptions and Limitations

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

- In order to obtain definitive data regarding the biodiversity, hydrology and functioning of particular wetlands, studies should ideally be conducted over a number of seasons and over a number of years. The current study relied on information gained during a single field survey conducted during a single season, desktop information for the area, as well as professional judgment and experience;
- Wetland and riparian areas within transformed landscapes, such as urban and/or agricultural settings, or mining areas with existing infrastructure, are often affected by disturbances that restrict the use of available wetland indicators, such as hydrophytic vegetation or soil indicators (e.g. as a result of dense stands of alien vegetation, dumping, sedimentation, infrastructure encroachment and infilling). As such, wetland and riparian delineations as provided are based on indicators where available and the author's interpretation of the current extent and nature of the wetlands and riparian areas associated with the proposed activity;
- Vertic soils are notoriously difficult for augering soil profiles, it is especially the presence of a deeper lying G-horison that is not easily observable and often contains diffuse boundaries. Further, the vegetation adapted to the high smectitic properties and high base status associated with the vertic soils makes for very little differentiation between wetland and terrestrial habitat, especially if there were disturbances such as overutilization of the veld, as is the case within the study area.
- Wetland and riparian assessments are based on a selection of available techniques that have been developed through the Department of Water and Sanitation (DWS). These methods are, however, largely qualitative in nature with associated limitations due to the range of interdisciplinary aspects that have to be taken into consideration. Current and historic anthropogenic disturbance within and surrounding the study area has resulted in soil profile disturbances as well as successional changes in species composition in relation to its original /expected benchmark condition;
- Delineations of wetland areas were largely dependent on the extrapolation of field indicator data obtained during field surveys, 5m contour data for the study area, and from interpretation of geo-referenced orthophotos and satellite imagery as well as historic aerial imagery data sets received from the National Department of Rural Development and Land Reform. As such, inherent ortho-rectification errors associated with data capture and transfer to electronic format are likely to decrease the accuracy of wetland boundaries in many instances; and
- Wetlands outside of the study area boundary was extrapolated using aerial imagery, although some sampling was done outside of the study boundaries in order to confirm findings and better interpret hydropedological characterisation of the study area.
- The full extent of wetlands and riparian further away than 500m from the study area were not fully delineated.

2. GENERAL CHARACTERISTICS

2.1 Location

The study area is situated approximately 5km west of Ga-Rankuwa and approximately 10km East-northeast from the town of Brits. The approximate centre co-ordinates for the study area are 25°34'40.53"S and 27°53'16.77"E (Figure 1).

2.2 Biophysical Attributes

2.2.1 Climate

According to Mucina & Rutherford (2006), the daily winter temperatures in July fluctuate on average between 1°C and 16°C. Incidence of frost is frequent which helps grasslands to persist. The study area receives summer rainfall with very dry winters. The Mean Annual Precipitation is between about 600mm to 700mm. Frost is frequent in winter and mean monthly maximum and minimum temperatures for Brits are around 35.3ºC and -3.3ºC for January and June respectively (Mucina & Rutherford, 2006).

2.2.2 Historic vegetation overview

The study site is situated within the Marikana Thornveld Biome of South Africa (Rutherford & Westfall, 1994), which occurs in the North-West and Gauteng provinces. The vegetation consists of open *Acacia karoo* woodland occurring in valleys and slightly undulating plains and some low hills. Shrubs tend to be denser along drainage lines and rocky outcrops. According to Mucina and Rutherford (2006), this vegetation type is regarded as Endangered with less than 1% statutorily conserved and much of its area transformed by cultivation of crops and urban development. Alien invasive plants also occur in localised high densities especially along drainage lines and wetland areas.

2.2.3 Geology

The lithology of the study are situated within the Bushveld Complex and more specifically within the Rustenburg Layered Suite with intrusive rocks comprising of Bierkraal Magnetite Gabbro and the Pyramid Gabbro-norite dominating the study area and surroundings (Figure 2). The Gabbro's weather to form well structured soils such as the Vertics found within the study area.

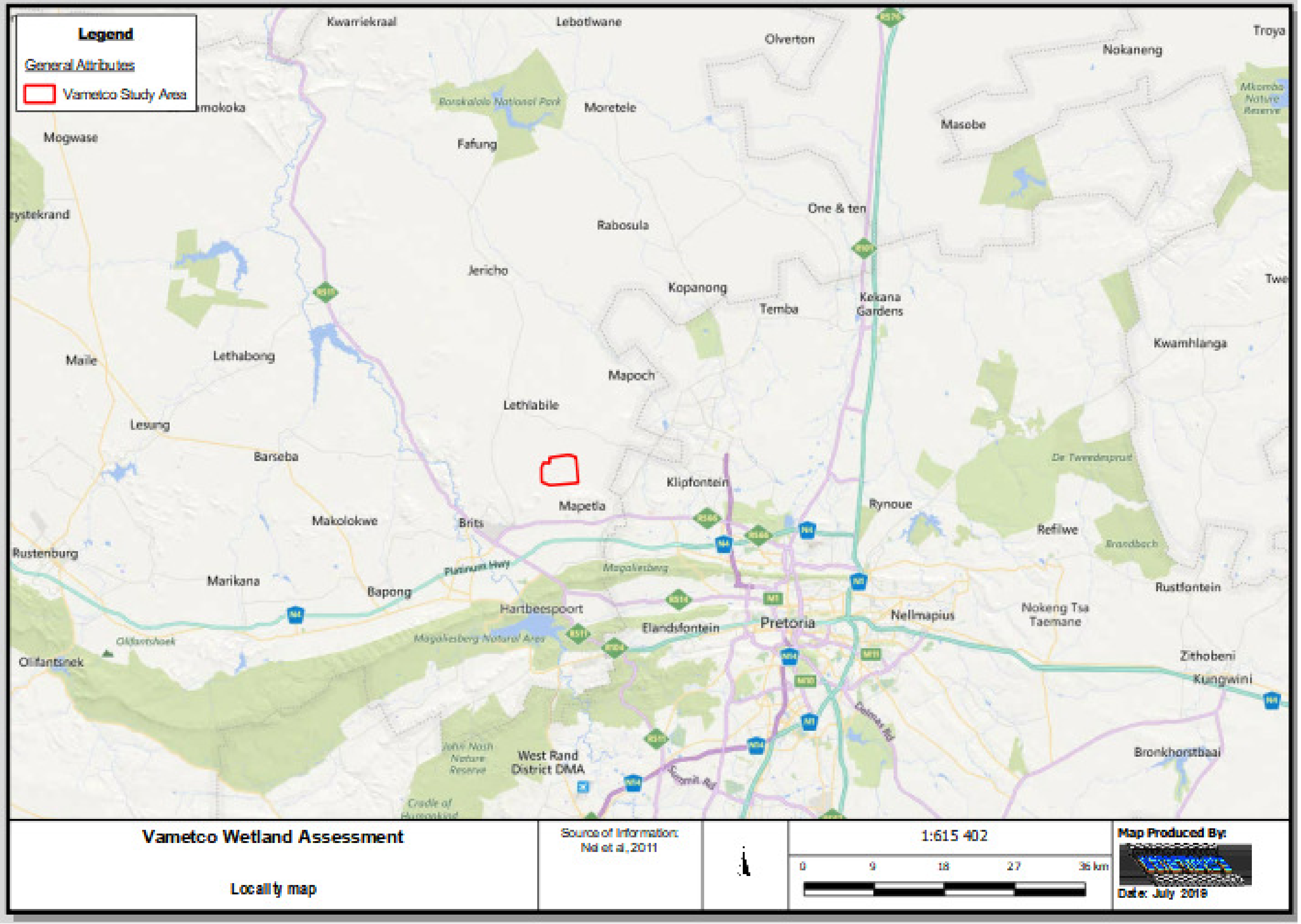


Figure 1: Locality map for the study area

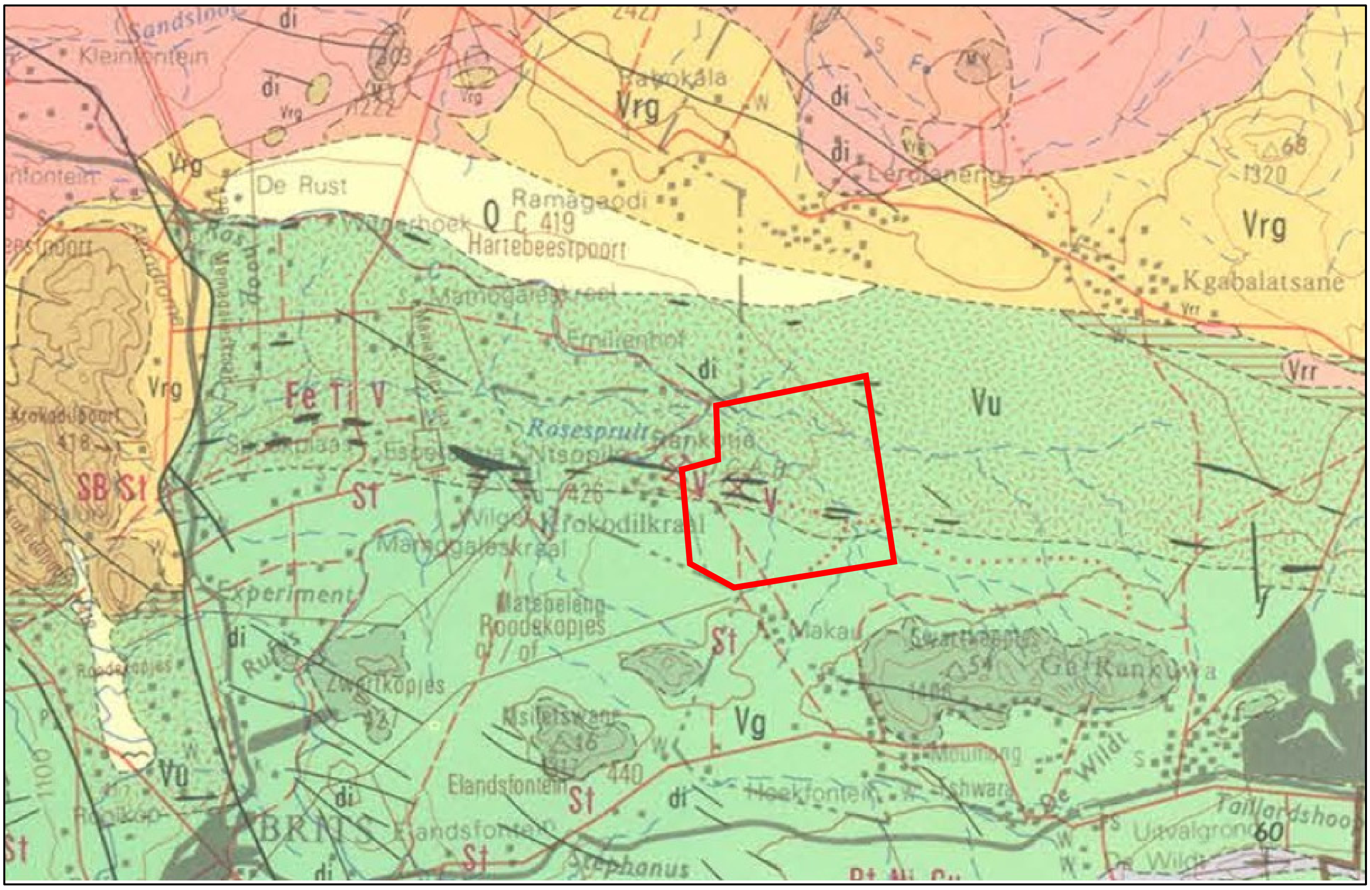


Figure 2: Geology of the study area (2526 Rustenburg 1:250 000; Department of Mines – Geological Survey) with the approximate study area indicate by red polygon of the map inset

2.2.4 Associated Aquatic Ecosystems and Drainage

The NWRS-1 (National Water Resource Strategy, Version 1) originally established 19 Water Management Areas (WMA) within South Africa and proposed the establishment of the 19 Catchment Management Agencies to correspond to these areas. In rethinking the management model and based on viability assessments with respect to water resources management, available funding, capacity, skills and expertise in regulation and oversight, as well as to improve integrated water systems management, the original 19 designated WMAs have been consolidated into nine WMAs. The site falls into Quaternary catchment A21J of the Crocodile (West) and Marico Water Management Area, within the Bushveld Basin Ecoregion (Kleynhans *et al*., 2007). Surface water on the site drains in a western direction, towards the Crocodile River, which is located several kilometres downstream from the study site.

2.2.5 National Freshwater Ecosystem Priority Areas

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

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

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

Based on current outputs of the NFEPA project (Nel et al., 2011; Figure 3), no FEPA wetlands or wetland clusters were located within the study area or within several kilometres from the stusy area. (Figure 3).

2.2.6 Wetland Vegetation Group

According to Nel et al. (2011), the study area falls within the Central Bushveld Group 2 wetland vegetation group. According to Macfarlane et al. (2014), the Central Bushveld Group 2 wetland vegetation group is regarded as being Vulnerable (Macfarlane et al., 2014).

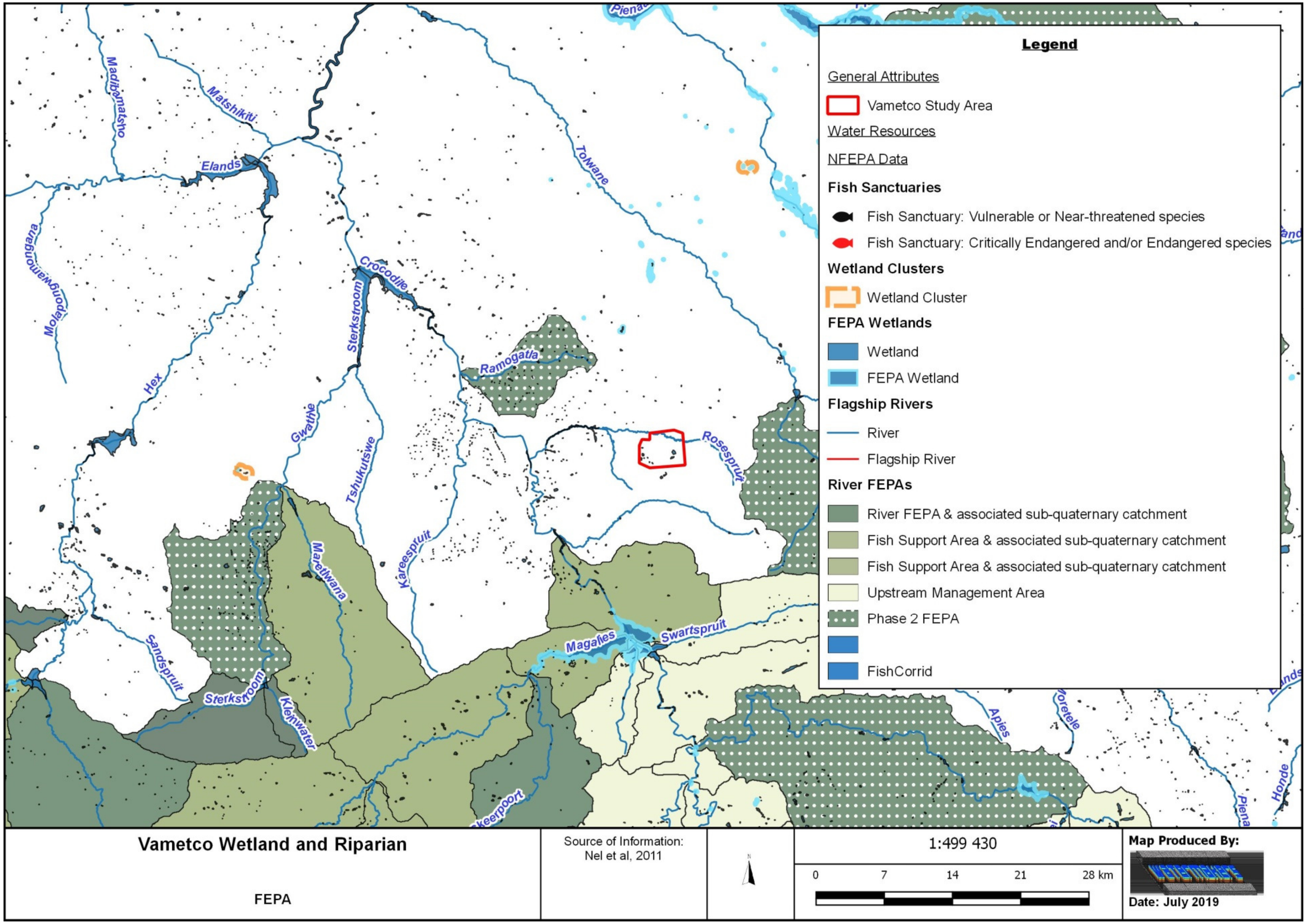


Figure 3: NFEPA map indicating closest FEPA features in relation to the study area

3. ASSOCIATED WETLANDS

3.1 Wetland soils

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

The traversed catenas within the study area were dominated by vertic soils. The soil forms identified and associated with the study area were the Arcadia and Rensburg soil forms both of which are associated with black, strongly structured, vertic clay topsoil horizons which have the capacity to swell in the wet state and shrink in the dry state due to the presence of a high content of smectitic clays. The Rensburg soil form is regarded as a hydric soil form and is the result of seasonal wetting and drying cycles. The Rensburg soil form has a gleyed sub-horizon which is present at variable depths ranging on average from a depth of 25cm up to more than a metre in the study area.

North of the study area as well as a section on the periphery on the very north eastern section of the study area different catenas then the dominant vertices of the study area were discovered. These comprised the Magudu, Swartland and Sepane soil forms. The Magudu and the Swartland soil forms are regarded as terrestrial soil forms whereas the Sepane soil form is regarded as a hydric soil form according to DWAF (2005). However, the Sepane soil form observed just north of the study area were not regarded as a hydric soil form as the signs of wetness were deeper than 1,5m from the soil surface. The Sepane soil form along with the more complex catena and other light signs of wetness in especially subsoils discovered north of the study site are likely indicative of lateral and return flows that is landscape driven. From a hydropedological perspective the area north of the study area were therefore consider more important in terms of lateral subsurface flows than compared to the vertic dominated soils and cantenas associated with the bulk of the study area.

According to the DWAF (2005), soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence due to the fact that soil wetness indicators remain in wetland soils in most instances, even if they are degraded or desiccated. It is important to note that the presence or absence of redoximorphic features within the upper 500mm of the soil profile alone is sufficient to identify the soil as being hydric (a wetland soil), or non-hydric (non-wetland soil) (Collins, 2005). Redoximorphic features were present within soil profiles of the disturbed valley bottom wetland as well as within the hillslope seepage wetland including black, orange and red mottles and rhizospheres (Figure 5).

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

- **A reduced matrix** - i.e. an *in situ* low chroma (soil colour), resulting from the absence of Fe^{3+} ions which are characterised by "grey" colours of the soil matrix (Figure 4).
- **Redox depletions** - the "grey" (low chroma) bodies within the soil where Fe - Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur.
- **Redox concentrations** - Accumulation of iron and manganese oxides (also called mottles). These can occur as:
    - Concretions - harder, regular shaped bodies;
    - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours (Figure 5); and,
    - Pore linings – zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognised as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres

Further, precipitates (white concretions) were in general observed more frequently along drainage lines than within terrestrial habitats.

Figure 4: Reduced matrix (grey) observable within the valley bottom position of the study area.

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

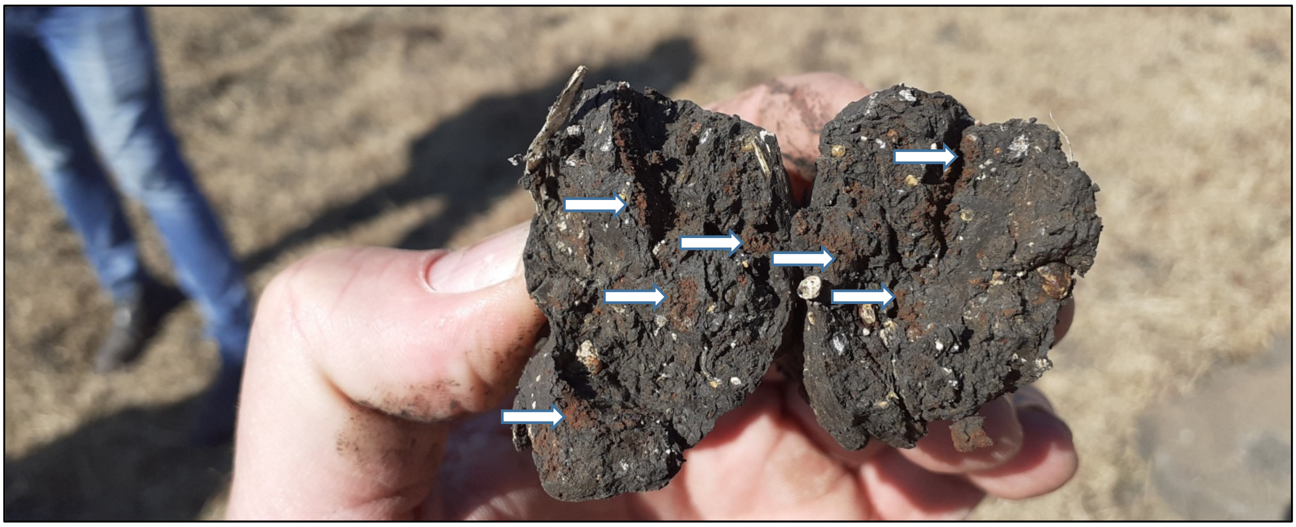


Figure 5: Red mottles indicated with white arrows, an example of redox concentrations (accumulation of iron), within the valley bottom position of the study area. Also note the small white precipitates throughout the matrix

3.2 Wetland Vegetation

According to the Department of Water Affairs and Forestry (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act (Act 36 of 1998). Using vegetation as a primary wetland indicator however, requires undisturbed conditions (Department of Water Affairs and Forestry, 2005). A cautionary approach must therefore be taken as vegetation alone cannot be used to delineate a wetland, as several species, while common in wetlands, can occur extensively outside of wetlands. When examining plants within a wetland, a distinction between hydrophilic (vegetation adapted to life in saturated conditions) and upland species must be kept in mind.

There is typically a well-defined 'wetness' gradient that occurs from the centre of a wetland to its edge that is characterized by a change in species composition between hydrophilic plants that dominate within the wetland to upland species that dominate on the edges of, and outside the wetland (Department of Water Affairs and Forestry, 2005). It is important to identify the vegetative indicators which determine the three wetness zones (temporary, seasonal and permanent) which characterize wetlands. Each zone is characterized by different plant species which are uniquely suited to the soil wetness within that zone. However, the wetness gradient within the study area is not that well defined as a result of the dominance of the vertic soils with high base status and smectitic properties. Further, intensive historic grazing regimes has also encrypted the wetness gradient further through negative successional changes as evident by the the dominance of the indigenous invasive *Dichrostachys cinerea.*

Areas identified within the study area with seasonal to permanent zonation and associated wetter subsoils contained hydrophylic plants such as *Typha capensis, Persicaria lapathifolia, Persicaria* sp., *Phragmites australis*, as well as *Hemarthria altissima.* The only other hydrophilic species that was noted within the study area were *Imperata cylindrica.*

Several preferential drainage lines did not exhibit redoximorphic signs, however, several of these drainage lines did exhibit intermittent signs of alluvium and more vigorous growth forms compared to terrestrial habitat and were therefore considered to be riparian habitat. Although most species considered to be riparian could also be found within the terrestrial habitat, species like *Searsia pyroides* seemed to be more abundant in addition to having a more vigorous growth form compared to counterparts growing n terrestrial habitat (Figure 6).

Figure 6: Riparian 2 habitat along the banks of a preferential flow path that is now cut off from its original catchment due to mining activities in the area

3.3 Delineated Wetland Areas

According to the National Water Act (Act no 36 of 1998), a wetland is defined as, "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*." Wetlands typically occur on the interface between aquatic and terrestrial habitats and therefore display a gradient of wetness – from permanent, to seasonal, to temporary zones of wetness - which is represented in their plant species composition, as well as their soil characteristics. It is important to take cognisance of the fact that not all wetlands have visible surface water. An area which has a high water table at or just below the surface of the soil is as much a wetland as a pan that only contains water for a few weeks during the year.

Hydrophytes and hydric soils are subsequently used as the two main wetland indicators. The presence of these two indicators is symptomatic of an area that has sufficient saturation to classify the area as a wetland. Terrain unit, which is another indicator of wetland areas, refers to the land unit in which the wetland is found.

In practice all indicators should be used in any wetland assessment/delineation exercise, the presence of redoximorphic features being most important, with the other indicators being confirmatory. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland and to delineate the boundary of a wetland. According to Department of Water Affairs and Forestry (2005), the more wetland indicators that are present the higher the confidence of the delineation. In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where indicators are no longer present. Classification for the purpose of the current project therefore focused on classifying watercourses according to the most dominant hydrological and geomorphological drivers, especially in terms of relating potential impacts of the potential development on especially the watercourses associated with the study area. Wetland boundaries determined within the study area focused on identifying terrain units, soil forms, redoximorphic signs, perceived organic content and the presence of vegetation species that are adapted to saturated conditions. Riparian habitat was typically delineated where riparian elements dominated a preferential flow path with a lack redoximorphic signs.

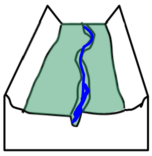
One hydro-geomorphic units (HGM), comprising one HGM type, a channelled valley bottom wetland was delineated and classified within the study area and within 500m surrounding the study area (Figure 7). In addition several riparian watercourses were also delineated within and surrounding the study area.

HGM units encompass three key elements (Kotze *et al.*, 2005):

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

Table 1 describes the characteristics that form the basis for the classification of the HGM units within the study area. The disturbance caused by anthropogenic impacts and resulting successional vegetation changes made the use of vegetation indicators complex in various circumstances, especially on the temporary boundaries of wetlands. Therefore, identifying wetland features on site was primarily done by identifying terrain unit, soil forms and soil wetness features such as the presence of mottling, a gleyed matrix and/or Fe and Mg concretions. However, vegetation indicators did confirm to delineated boundaries and wetness zonation in some instances. Further, the exact extent of hydrological features could not always be determined due to subtle landscape gradients combined with various disturbances and high degree of transformation (including mining and areas that has been topographically manipulated)

Table 1: Wetland hydro-geomorphic types typically supporting inland wetlands in South Africa within the vicinity of the study area (adapted from Kotze et al., 2008)

Hydro-geomorphic types	**Description**	**Source of water maintaining the wetland[1]**	
		Surface	**Sub-surface**
Valley bottom with a channel 	Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/ ***

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

Water source: * Contribution usually small

*** Contribution usually large

*/ *** Contribution may be small or important depending on the local circumstances

 Wetland

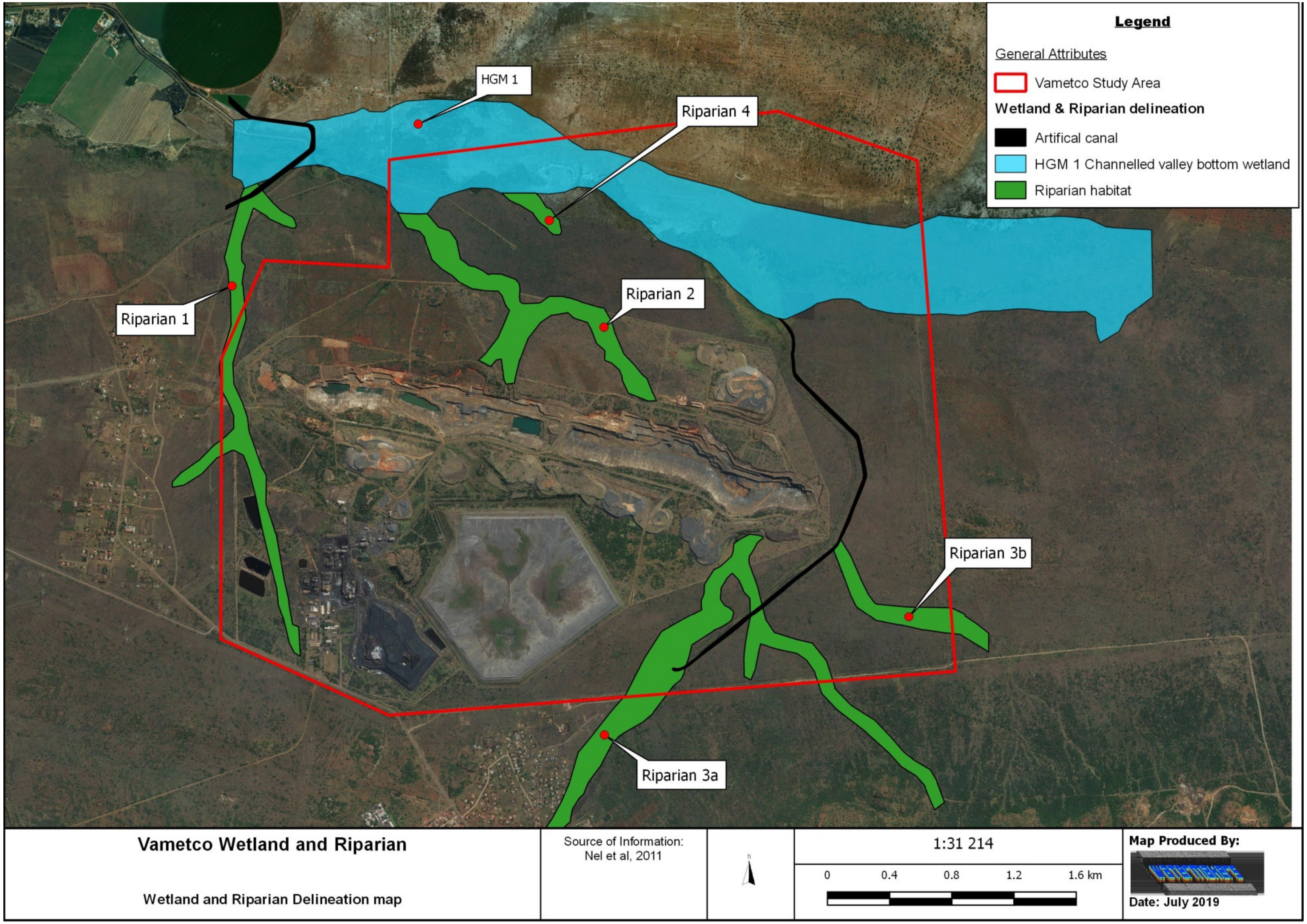


Figure 7: Delineated wetlands and riparian habitat within the study area and within 500m from the study area

3.4 Functional and Present Ecological State Assessment

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

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

Table 2: Potential wetland services and functions in study area

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

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

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

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

Rating: 0 Benefit unlikely to be provided to any significant extent

\+ Benefit likely to be present at least to some degree

++ Benefit very likely to be present (and often supplied to a high level)

Each wetland's ability to contribute to ecosystem services within the study area is also dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. Present Ecological State scores were determined for wetlands within the study area using Wet-Health Level 2 assessment. Through the use of a scoring system, the perceived departure of elements of each particular system from the "natural-state" was determined (current state versus anticipated future rehabilitated state). The following elements were considered in the assessment:

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

For the purpose of the present assessment, the determined Present Ecological State and wetland ecosystem services provided by wetlands within the study area are discussed in more detail below.

3.4.1 Channelled valley-bottom Wetland (HGM 1)

HGM 1 received its highest ecosystem services scores from the Wet-EcoServices assessment for flood attenuation, sediment trapping, erosion control, maintenance of biodiversity, carbon storage and the provision of natural resources (Figure 13, Figure 14). The relatively relaxed gradient associated with the valley bottom wetland would allow for high levels of sediment deposition. Stream channel input will be spread diffusely across the wetlands even in low flows, resulting in extensive areas of the wetlands remaining saturated and tending to have higher levels of soil organic matter. During flow events shallow water pools are present which would promote sunlight penetration, contributing to the photodegradation of certain toxicants. In addition there are also several farm dams with shallow water sections which would also further facilitate photodegradation processes.

The valley bottom wetlands occupied a relatively wide area with a relaxed gradient that would have played a significant role in flood attenuation. However, phosphate retention levels would of likely been lower than in floodplains because a certain amount of phosphate may be re-mobilized under prolonged anaerobic conditions (Cronk and Siobhan Fennessy, 2001; Keddy, 2002).

The valley bottom wetlands are potentially supported by subsurface water flows including a lateral seepage component from the adjacent hillslope to the north as well as return flows via the vadose zone which would enhance the wetlands importance for stream flow regulation albeit to a small extent. Some nitrate and toxicant removal potential would be expected, particularly from the water being delivered from the adjacent hillslopes as well as a few open water bodies present (The Federal Interagency Stream Restoration Working Group, 1998). From a biodiversity perspective, a species of conservation concern was observed during the field survey, and the potential exist that more may be present despite the majority of the wetland being intensely utilised for grazing. Further, the valley bottom network serves as a movement corridor for fauna to connect large terrestrial grassland and wetland habitat to each other. People were also noticed to abstract water from open wells and dammed areas for utilisation.

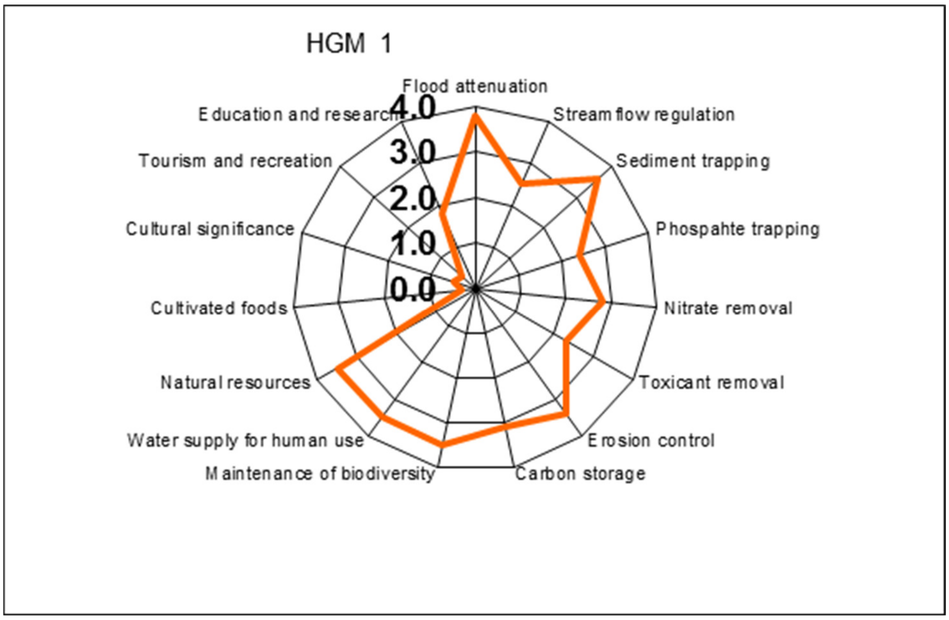


Figure 8: Radar diagrams depicting ecosystem services for HGM 1

Historic and current impacts on the wetland in combination with land use changes in sections of the surrounding catchment resulted in some geomorphological, hydrological and vegetation changes within the valley bottom wetland. Impact on the hydrology of the valley bottom wetland could potentially include some channel incision within reaches of the watercourse as a result of semi and urban developments within especially the upper catchment of the watercourse (suburbs of Ga-Rankuwa).

From a geomorphological perspective, the highest impact calculated within the valley bottom wetland were related to altered runoff characteristics, albeit not significant. Further impacting features with regards to the geomorphology included the presence of roads (excavations and infill), and some limited erosional features, although their magnitude of impact were determined to be limited in several instances due to the average gully width in relation to the width of the wetlands.

Due to the nature of historic and current land uses within the catchment, species composition within the wetlands is expected to have changed relative to the perceived natural condition of the wetlands, especially as a result of overgrazing practices. This was also evident in the supporting recharge areas which were dominated by natural veld that has been overgrazed.

Based on the assessment of the individual drivers of the wetlands, the Present Ecological State for HGM 1 was determined to be representative of a Category C (moderately modified), (Table 4).

Table 4: Wet-Health scores for HGM 1

HGM Unit	Hydrology	Geomorphology	Vegetation	PES category
HGM 1	3.0	2.0	6.9	**C (3.7)**

3.4.2 Riparian Habitat

The PES of the riparian zones was assessed using the Riparian Vegetation Response Assessment Index (VEGRAI) level 3 (Kleynhans et al., 2007). Riparian vegetation areas were divided into two sub-zones which included marginal and non-marginal zones. Recognition of the different zones is important given that riparian vegetation distribution and species composition varies in different sub-zones, which has implications for flow-related impacts. Since all VEGRAI assessments are relative to the natural unmodified conditions (reference state) it is necessary and important to define and describe the reference state for the study area (Kleynhans et al., 2007). This was done (in part) before going into the field, using historic aerial imagery, present and historic species distributions, general vegetation descriptions of the study area, knowledge of the area and comparison of the study area characteristics to other comparable sections of the stream that might be in a better state. According to Kleynhans et al. (2007), the reference (and present state) is quantified on site; the assessor reconstructs and quantifies the reference state from the present state by understanding how visible impacts have caused the vegetation to change and respond.

Impacts on riparian vegetation at the site are then described and rated. Kleynhans et al. (2007) further states that it is important to distinguish between a visible / known impact (such as flow manipulation) and the response of riparian vegetation to other impacts such as erosion and sedimentation, alien invasive species and pollution. If there is no response to riparian vegetation, the impact is noted but not rated since it has no visible / known effect. These impacts are then rated as per a scale from 0 (No Impact) to 5 (Critical Impact). Once the riparian zone and sub- zones have been delineated, the reference and present states have been described and quantified (basal cover is used) and species description for the study area has been compiled, the VEGRAI metrics were rated and qualified. The riparian ecological integrity was assessed using the spreadsheet tool that is composed of a series of metrics and metric groups, each of which was rated in the field with the guidance of data collection sheets. The metrics in VEGRAI describe the following attributes associated with both the woody and non-woody components of the lower and upper zones of the riparian area:

- Removal of the riparian vegetation;
- Invasion by alien invasive species;
- Flow modification; and
- Impacts on water quality.

Results from the lower and upper zones of the riparian vegetation were then combined and weighted with a value that reflects the perceived importance of that criterion in determining habitat integrity, allowing this to be numerically expressed in relation to the perceived benchmark. The score is then placed into one of six classes.

These findings of the VEGRAI vegetation assessment revealed that riparian habitat (Riparian 1) on the western periphery of the study area was seriously modified as a result of historic topographic manipulation, building of dams and changes in the associated catchment (E class) (Table 5). Riparian 2 was considered to be largely modified as a result of being cut off from its upstream hydrological support (Riparian 3a and 3b) through the establishment of the mine several decades ago and resultant changes that ensued thereafter (especially impacting on water quantity) . Riparian 3a and 3b has been cut-off from its downstream section Riparian 2 as discussed above as well as through a municipal channel that was constructed, originating in the vicinity of the sewage works. Water quality is likely to be severely affected as a result of poor discharge quality water from the sewage works and algal blooms that were observed. Riparian area 4 is relatively still intact with the largest impact being overgrazing as per all other riparian units.

Table 5: VEGRAI score for the riparian vegetation calculated for the study area

COMPONENT	Riparian 1	Riparian 2	Riparian 3a	Riparian 3b	Riparian 4
Level 3 VEGRAI (%)	25.8%	47.2%	58,4%	68,0%	72,9%
VEGRAI EC	E	D	D	C	C
Category	Seriously modified	Largely modified	Largely modified	Moderately modified	Moderately modified
Average Confidence	1,6	1,0	1,4	1,3	1,2
Marginal	19.3	54,4	49,6	67,2	71,9
Non-Marginal	32.4	40.1	67.3	68,8	73,9

Riparian functions have both on-site and off-site effects, some of which may be expressed as goods and services available to society (Table 3). For example, functions related to hydrology and sediment dynamics include storage of surface water and sediment, which reduces damage from floodwaters downstream from the riparian area. Similarly, the function of cycling and accumulating chemical constituents has been measured in a number of studies on nitrogen and phosphorus cycling (Anon, 2002). These studies have shown that nutrients are intercepted, to varying degrees, as runoff passes through managed and natural riparian zones. The societal benefit is the buffering effect of pollutant removal, a service that has been a major motivation for protecting and managing riparian areas.

The hydrologic, nutrient cycling, and habitat/food web functions of riparian areas correspond to goods and services such as support of biodiversity, flood peak reduction, and removal of pollutants from runoff (Anon, 2002). Except for support of biodiversity, some of the environmental services of riparian areas can be provided by technologies, such as reservoirs for flood peak reduction and wastewater treatment plants for pollutant removal. However, these substitutions are directed at single functions rather than the multiple functions that riparian areas carry out simultaneously and with little direct costs to society (Anon, 2002).

Table 6: Functions of riparian areas and their relationship to environmental services (Anon, 2002)

Examples of functions	Indicators that functions exist
Hydrology and Sediment Dynamics	
Stores surface water over the short term	Floodplain connected to stream channel
Maintains a high-water table	Presence of flood-tolerant and drought intolerant plant species
Accumulates and transports sediments	Riffle-pool sequences, point bars, and other features
Biogeochemistry and Nutrient Cycling	
Produces organic carbon	A balanced biotic community

Contributes to overall biodiversity	High species richness of plants and animals
Cycles and accumulates chemical constituents	Good chemical and biotic indicators
Sequesters carbon in soil	Organic-rich soils (marginal zone)
Habitat and Food Web Maintenance	
Maintains streamside vegetation	Presence of shade-producing canopy
Supports characteristic terrestrial vertebrate populations	Appropriate species having access to riparian area
Supports characteristic aquatic vertebrate populations	Migrations and population maintenance of fish

According to Anon (2002), the effects of functions sometimes are expressed off-site as well. Indicators are often used to evaluate whether or not a function exists, and are commonly used as shortcuts for evaluating the condition of riparian areas. The functions listed in Table 7 are examples only and are not comprehensive.

Table 7: Examples of on-site and off-site riparian functions in terms of goods and services valued by society (modified from NRC, 1995)

On-site or off-site Effects of Functions	Goods and Services Valued by Society
Attenuates downstream flood peaks	Reduces damage from floodwaters (Daily, 1997)
Maintains vegetation structure in arid climates	Contributes to regional biodiversity through habitat (e.g., forest canopy) provision (Szaro, 1991; Ohmart, 1996; James et al., 2001)
Contributes to fluvial geomorphology	Creates predictable yet dynamic channel and floodplain dynamics (Beschta et al., 1987a; Klingeman et al., 1999)
Provides energy to maintain aquatic and terrestrial food webs	Supports populations of organisms (Gregory et al., 1991; Meyer and Wallace, 2001)
Provides reservoirs for genetic diversity	Contributes to biocomplexity (Szaro, 1991; Naiman and Rogers, 1997; Pollock et al., 1998)
Intercepts nutrients and toxicants from runoff	Removes pollutants from runoff (Bhowmilk et al., 1980; Peterjohn and Correll, 1984)
Contributes to nutrient retention and to sequestration of carbon dioxide from the atmosphere	Potentially ameliorates global warming (Van Cleve et al., 1991)
Provides shade to stream during warm season	Creates habitat for fish dependant on colder water (Beschta et al., 1987b; McCullough, 1999)
Allows daily movements to annual migrations	Supplies objects for bird watching, wildlife enjoyment,and game hunting (Green and Tunstall, 1992; Flather and Cordell, 1995)
Allows migratory fish to complete life cycles	Provides fish for food and recreation (Nehlsen et al, 1991; Naiman et al., 2000)

Anon (2002) further states that riparian areas, in proportion to their area within a watershed, perform more biologically productive functions than do uplands (terrestrial habitat). Riparian areas provide a wide range of functions such as microclimate modification and shade, bank stabilization and modification of sedimentation processes, contributions of organic litter and large wood to aquatic systems, nutrient retention and cycling, wildlife habitat, and general food-web support for a wide range of aquatic and terrestrial organisms. Thus, even though they occupy only a small proportion of the total land base in most watersheds, they are uniquely positioned between the aquatic and terrestrial ecosystems to provide a wide range of functions critical for many aquatic and terrestrial species, for maintenance of water quality, for aesthetics, for the production of goods and services, and for a wide range of social and cultural values (Anon, 2002). Because riparian areas are located at the convergence of terrestrial and aquatic ecosystems, they are regional hot spots of biodiversity and often exhibit high rates of biological productivity in marked contrast to the larger landscape. This is particularly dramatic in arid regions, as evidenced by the high number of plant and animal species that find crucial habitats along watercourses and washes. Riparian areas provide connectivity at all spatial and temporal scales, helping maintain landscape biodiversity by countering the negative ecological effects of habitat fragmentation (Anon, 2002).

Despite the large anthropogenic impacts that occurred within and surrounding the study area, some of the potential functions of the riparian habitat in the vicinity of the study area included:

- sediment trapping;
- nutrient trapping;
- bank stabilization and bank maintenance;
- flow energy dissipation;
- maintenance of biotic diversity; and
- primary production.

Despite the current Ecological condition associated with the vegetation of the riparian habitat, all riparian habitat within and surrounding the study area was designated as sensitive as a result of the high ecological and functional values attributed to riparian areas in general, legal regulations and requirements as well as the potential increase in ecological services that could be provided through rehabilitation of the riparian vegetation within the study area.

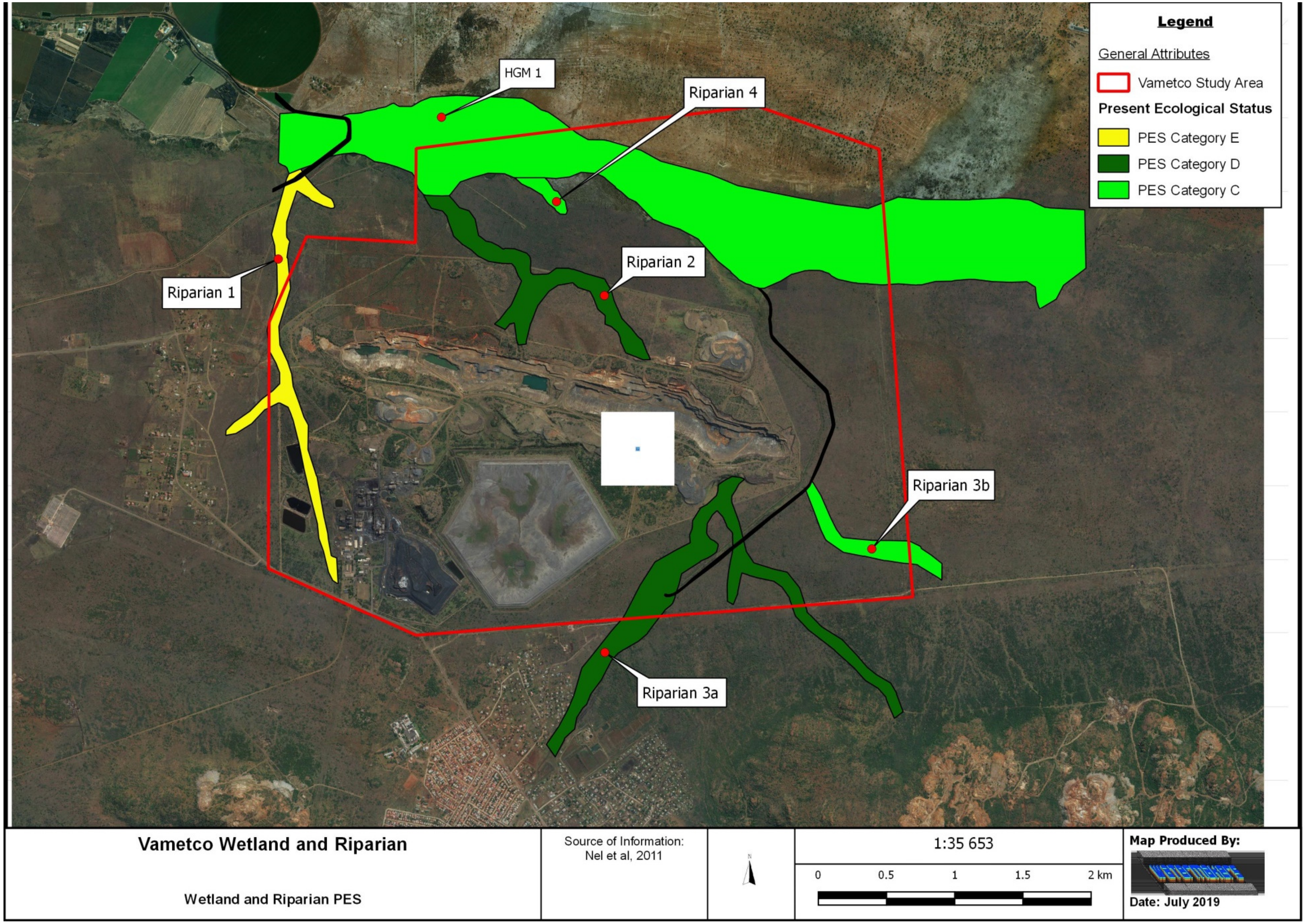


Figure 9: Present Ecological Status for wetlands within the study area and within 500m

3.5 Ecological Importance and Sensitivity

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

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

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

Water resources which have high values for one or more of these criteria may thus be prioritised and managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), hydrological functional importance (where water resources provide critical functions upon which people may be dependent, such as water quality improvement) or their role in providing direct human benefits (Rountree et al., 2013). Ecological Importance and Sensitivity results for wetlands identified to be associated with the study area are listed in Table 8.

Table 8: Ecological Importance and Sensitivity scores for wetland complexes

Wetland	Parameter	Rating (0 -4)	Confidence (1 – 5)
HGM 1	Ecological Importance & Sensitivity	Moderate (2.6)	Low (1.2)
	Hydrological / Functional Importance	Moderate (2.9)	Moderate (2.1)
	Direct Human Benefits	Moderate (2.3)	Moderate (2.0)

The valley bottom wetland, HGM 1, was regarded as having a moderate Hydrological and Functional Importance as a result of the relatively moderately intact nature and various important ecosystem services it provide. The moderate Ecological Importance and Sensitivity assigned too HGM 1 can be attributed to the relatively intact hydrological and geomorphological nature associated with the wetland and its associated catchment. Direct human benefits were associated with the provision of natural resources as well as grazing opportunities afforded by wetland habitat within the study area, especially by providing a higher general moisture regime compared to the terrestrial habitat. Collectively, the valley bottom system play an important role in contributing to good water quality and quantity to the downstream environment, more specifically the Crocodile River.

All of the riparian habitat was also considered sensitive due to the important functions it could potentially provide.

4. ASSESSMENT OF IMPACTS

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

4.1 Impact Assessment Methodology

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

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

Nature of the Impact
This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.
Extent of the Impact
A description of whether the impact will be local, limited to the study area and its immediate surroundings, regional, or on a national scale.
Duration of the Impact
This provides an indication of whether the lifespan of the impact would be short term (0-5 years), medium term (6-10 years), long term (>10 years) or permanent.
Intensity
This indicates the degree to which the impact would change the conditions or quality of the environment. This was qualified as low, medium or high.
Probability of Occurrence
This describes the probability of the impact actually occurring. This is rated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any prevention measures).
Degree of Confidence
This describes the degree of confidence for the predicted impact based on the available information and level of knowledge and expertise. It has been divided into low, medium or high.

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

Significance = (Magnitude + Duration + Scale) x Probability
The maximum potential value for significance of an impact is 100 points. Environmental impacts can thus be rated as high, medium or low significance on the following basis:

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

Table 9 illustrates the scale used to determine the overall ranking.

Table 9: Scale used to determine significance ranking

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

The impacts posed by the proposed Vametco expansion have been assessed using the SANBI 2012 mitigation hierarchy tool which entails the following four aspects and also also described on Figure 4:

1. Avoid or Prevent;
2. Minimise;
3. Rehabilitate; and
4. Offset.

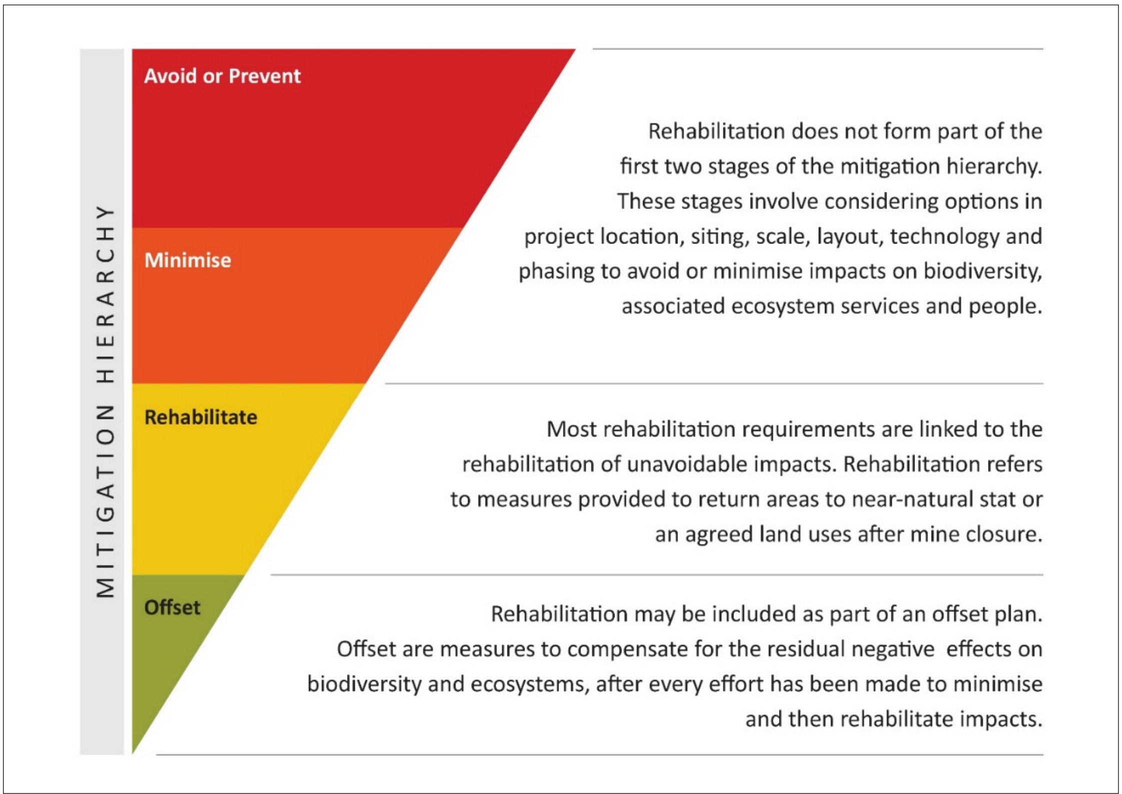


Figure 10: Mitigation hierarchy (SANBI, 2012)

4.2 Impact Assessment

Possible impacts and their sources associated with the proposed activities are provided in Table 9 (operational phase, including the expansion of the mine) and Table 10 (decommissioning phase). Some of the impacts are relevant during more than one phase and has therefore only been described once under the initial phase. Vametco has identified the need to expand its mining operations in order to increase the mine production while ensuring environmental sustainability and management. The aim of the proposed expansion is to increase production capacity from 3000 to 10000 metric tons in future. In order to achieve the aforementioned aim, the project will entail the undertaking of the following activities (Figure 9):

- The expansion of the existing slimes dam towards the east of the mine to cater for additional slimes waste.
- The expansion of the magnetite dump to the north and south of the mine.
- The construction of the two Pollution Control Dams (PCDs) for the proposed magnetite dump expansion and existing plant to accommodate return or polluted water; and
- Development of the new return water dam to accommodate return/polluted water from the proposed and existing slimes dams as well as to accommodate stormwater within the mine.

Table 10: Possible additional impacts arising during the construction and operational phase

Possible impact	Source of impact
Destruction of wetlands and or riparian habitat	Destruction of hydric soils, hydrophytic vegetation and changes to hillslope hydrology.
Sedimentation of wetland and increased erosion	Runoff from construction activities associated with clearing of natural vegetation and earthworks related activities
Pollution of water resources	Mobilisation of sediments, excavations removal and disturbances to vegetation, mobilisation of mineral and metal compounds. Contamination of recharge, interflow and responsive zones. Discharge of polluted water. Lack of clean and dirty water separation

Table 5: Potential impacts during the Decommissioning Phase of the proposed project

Possible Risks	Source of the Risk
Loss of wetland function	Pollution from decant. Poor rehabilitation.
Decreased downstream water quality	Pollution from decant Poor rehabilitation.

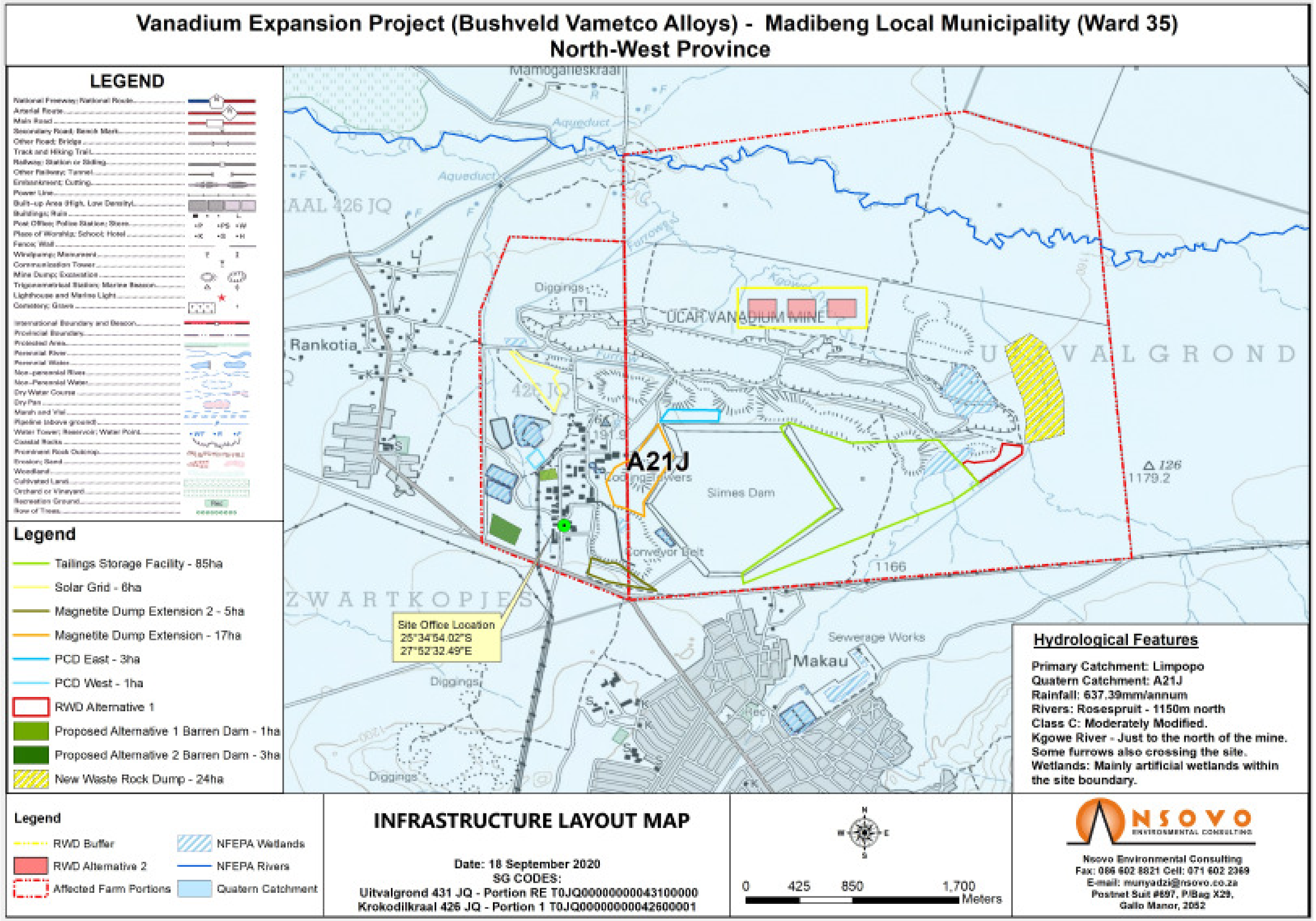


Figure 11: Infrastructure lay-out for the mine, plant and associated infrastructure.

Construction and Operational Phase

Destruction and degradation of wetlands

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	Local (2)	Permanent (5)	Moderate (6)	Medium (3)	Medium (48)	Moderate
With mitigation measures	Local (2)	Medium term (3)	Low (4)	Low (2)	Low (18)	Moderate

Description of Impact

The footprint of new infrastructure and the expansion of the mine could infringe on or destroy wetland habitats if care is not taken to ensure that all construction activities takes place within the existing mining footprint and outside of functioning watercourses. Particular care must be taken on the eastern periphery where the existing clean water diversion channel is situated within the proposed footprint of the new Waste Rock Dump. The existing clean water diversion channel must be redirected west of the proposed new waste rock dump (Figure 12). Alternatively, if contours permit, the clean water diversion channel could also be re-routed around the eastern periphery of the proposed Waster Rock Dump. Further, a diffuse release gabion channel must be constructed on contour on the downstream end of the clean water diversion channel in order to ensure that channelisation of the valley bottom wetland (HGM 1) is not promoted (Figure 12). Some soft channel rehabilitation intervention is also recommended just downstream from the release point as part of the installation of the diffuse release channel.

Appropriate berms should be installed along the clean water diversion channel in order to ensure that the clean water channel is not contaminated during large return precipitation events and or accidental spillages. It must be ensured that no construction activities, polluted water or increased loads of sedimentation negatively impact on the clean water diversion channel which support freshwater ecosystems downstream.

The extension off the tailings storage facility will directly impact on Riparian 3a as the footprint will be situated on a remnant section of the riparian habitat (Riparian 3a is already diverted through the diversion channel east of the mining area). The diversion channels western end just south of the mine will have to be upgraded (extension of diversion channel and or through installing a diversion berm) to ensure that all clean water are diverted via the diversion channel east around the mine (Figure 12; Figure 13). Further, the removal of natural vegetation and riparian soils could lead to the degradation of the downstream wetland areas through the initiation of erosion processes and increased runoff of sediment into watercourses particularly during times of high rainfall. No wetlands are situated within the proposed expansion footprint.

Mitigation Measures

- A detailed local topographical survey must be completed in order to inform an effective clean water diversion strategy likely through a cut-off trench and berm for Riparian 3a.

- All soils within the footprint of the mining area must be appropriately separated and stored.
- Avoid mining activities in the wetland areas identified as far as possible through proper planning, demarcation and appropriate environmental training;
- If there are any changes to the proposed mining expansion lay-out a wetland ecologist should re-evaluate potential impacts and mitigation measures
- A wetland specialist must be appointed to guide engineers for the detailed designs if lay-out plans change to include water course crossings which is not currently proposed;
- Management has the responsibility to inform members of staff of the need to be vigilant against any practice that will have a harmful effect on wetlands;
- Any proclaimed weed or alien species that germinate during the operational period shall be cleared by hand before flowering;
- The construction of surface stormwater drainage systems during the operational phase must be done in a manner that would protect the quality and quantity of the downstream system;
- Caution must be taken to ensure building materials are not dumped or stored within the proximity of the delineated wetlands;
- Emergency plans must be in place in case of spillages into wetland systems.
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimized, and be surrounded by bunds. It should also only be stored for the minimum amount of time necessary;
- Erosion control of all banks must take place so as to reduce erosion and sedimentation into wetland areas;
- Littering and contamination of water sources during mining activities must be mitigated by effective camp management; and
- All construction materials including fuels and oil should be stored in a demarcated area that is contained within a bunded impermeable surface to avoid spread of any contamination (outside of wetlands)

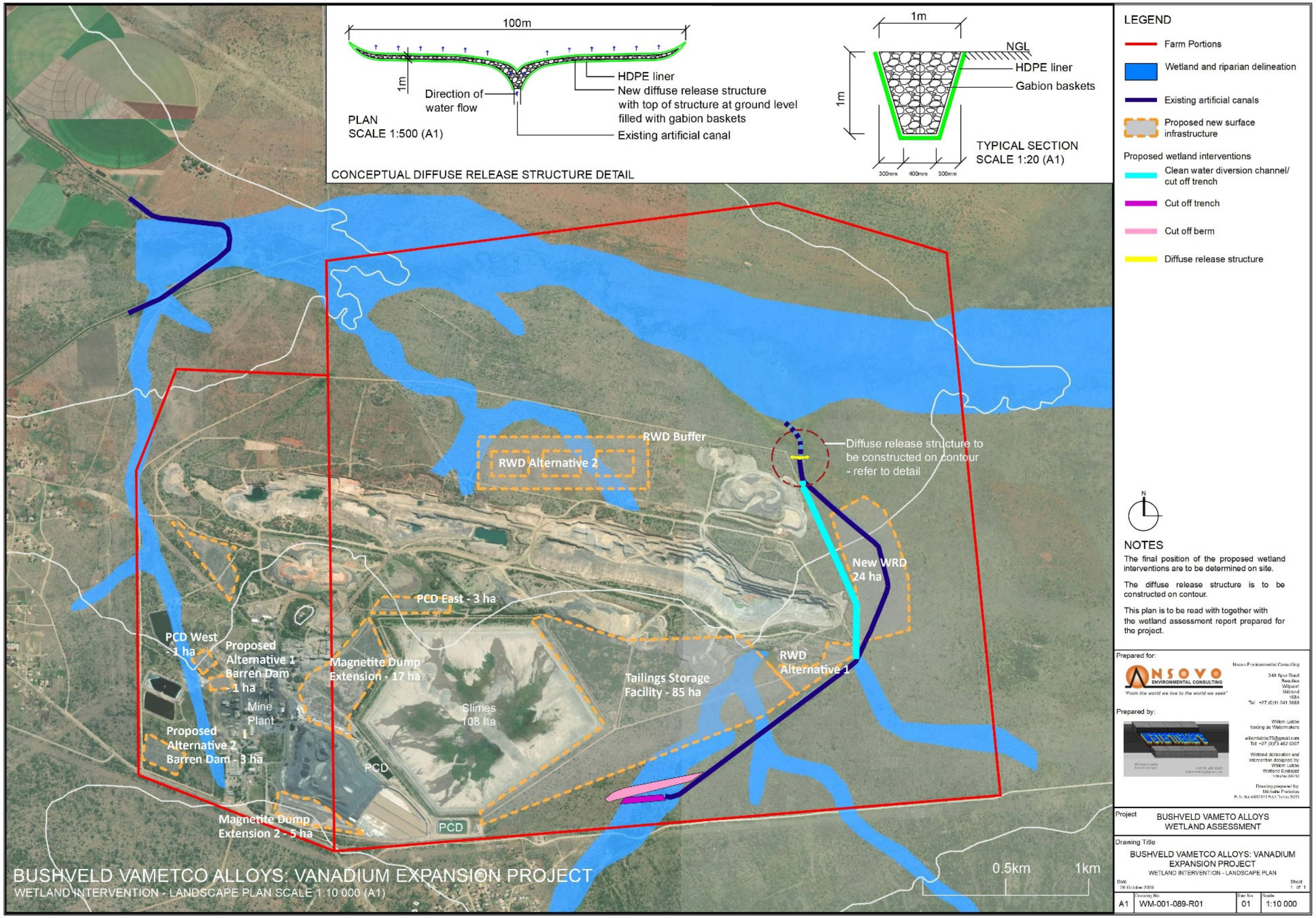


Figure 12: Proposed lay-out and mitigation measures

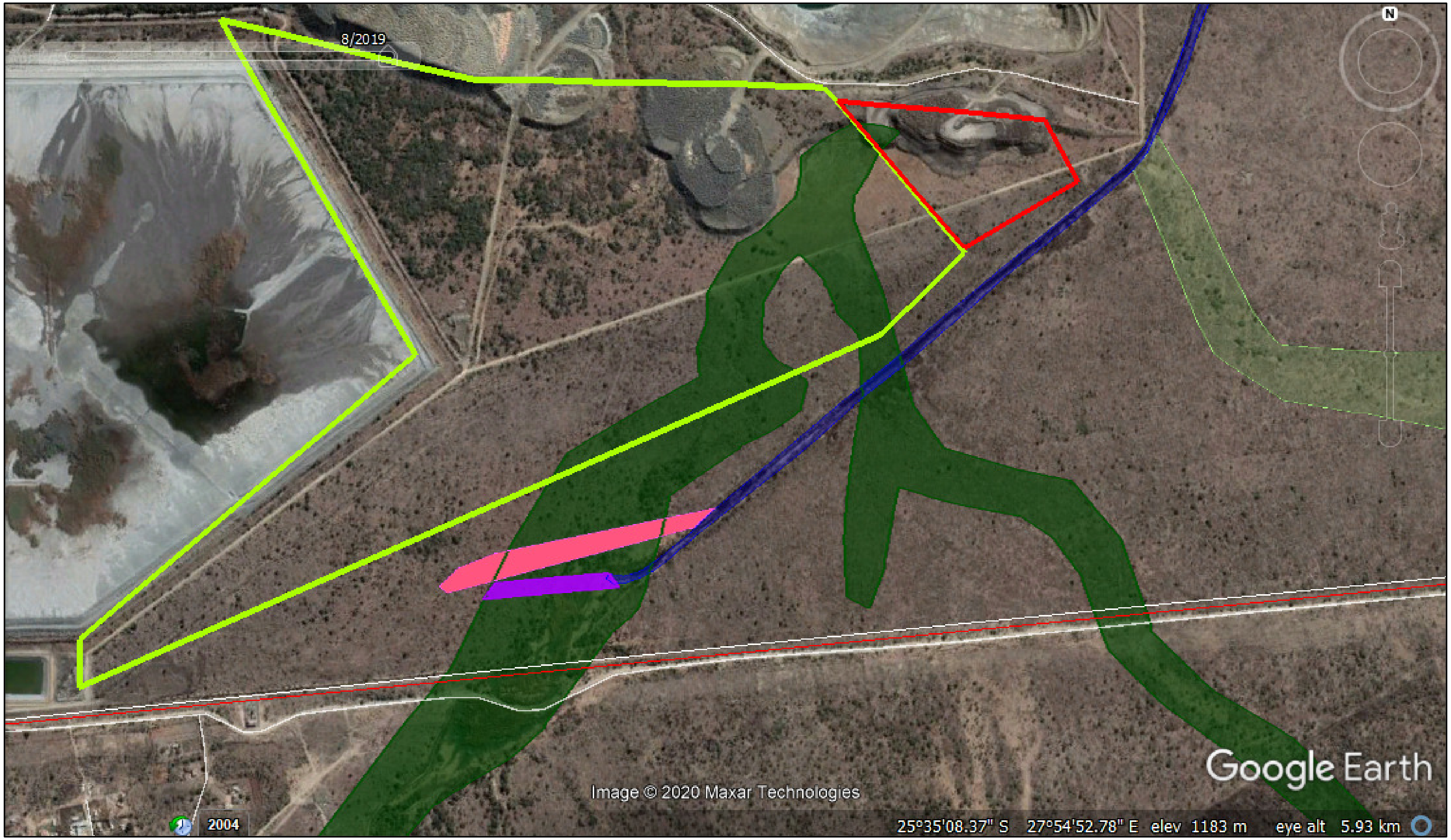


Figure 13: Cut-off trench (purple) and / or diversion berm (pink) in order to divert clean water run-off via the existing cut-off trench (dark blue)

Sedimentation of wetlands and increased erosion

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	Local (2)	Permanent (5)	Moderate (6)	Medium (3)	Medium (48)	Moderate
With mitigation measures	Local (2)	Medium term (3)	Low (4)	Low (2)	Low (18)	Moderate

Description of Impact

The clearing of natural vegetation and the stripping of topsoil will result in increased runoff of sediment from the site into watercourses associated with the study area. This is particularly so during times of high rainfall and high winds. Water flowing down trenches and access roads, as well as movement of vehicles and personnel, could cause additional erosion processes and sediment to accumulate within the wetland areas. The potential siltation of the wetland system would alter geomorphologic functioning, the movement of water through the system (hydrological functioning) as well as having an impact on water quality within the resource. In addition, hardened surfaces and bare areas are likely to increase surface run off velocities and peak flows received by wetlands.

From a watercourse perspective there is no significant differences between Barren Dam Alternative 1 and Barren Dam Alternative 2. Proximity to Riparian 1 and required mitigation measures is also similar for both alternatives. Care must be taken during the construction of the Barren Dam does not cause any sedimentation and pollution downstream wetlands via Riparian 1. in order to ensure sedimentation to Riparian 1 habitat is minimised, Environmental Control Officers should be pertinent on the control of sedimentation sources and ensure adequate sediment control and barriers are in place (e.g. silt screens, sandbags, swales, haybales etc.)

Some soft channel rehabilitation intervention is also recommended just downstream from the release point as part of the installation of the diffuse release channel. Soft rehabilitation measures must be implemented to halt channel development and increase sediment capture functionality of HGM 1 just downstream of the outflow of the diffuse release mechanism

Mitigation Measures

- A phased planned approach must be taken when construction is initiated. Areas must only be stripped directly prior to construction and only expose soils to erosion for the minimum period necessary. Where possible, re-vegetation of areas must be implemented as soon as possible;
- The clean and dirty water separation infrastructure should be audited by a surface hydrologist to ensure that adequate clean and dirty separation infrastructure is in place for the mining complex. This should include a review whether Riparian 1, Riparian 3a and Riparian 3b are adequately diverted. Erosion control and stormwater infrastructure must form the basis of the initial construction activities, prior to production related construction activities;
- Topsoil and subsoil must be stockpiled separately in low heaps;
- Erosion must not be allowed to develop on a large scale before effecting repairs;
- A wetland monitoring program should be initiated before the start of the construction phase. The Environmental Control Officer should be briefed by a wetland specialist on specific monitoring issues.

An inspection of clean and dirty water separation infrastructure and stormwater infrastructure needs to take place after each large rain event. Appropriate mitigation needs to be implemented after consultation with relevant specialist if any problems are detected;

- Make use of existing roads and tracks where feasible rather than creating new routes through vegetated areas;
- Vegetation and soil must be retained in position for as long as and wherever possible, and only removed immediately ahead of construction / earthworks in that area (DWAF, 2005). Topographical profiling and revegetation must take place as soon as a section is completed;
- Runoff from roads must be managed to avoid erosion and pollution problems;
- All areas susceptible to erosion must be protected (e.g. silt screens, sandbags, swales, haybales etc.) and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and or work areas;
- Areas exposed to erosion due to construction should be vegetated with appropriate species naturally occurring in the area; and
- Surface water or storm water must not be allowed to concentrate, or flow down cut or fill slopes without erosion protection measures being put in place.

Pollution of water resources

	Scale	Duration	Magnitude	Probability of occurrence	Significance	Confidence
Without mitigation measures	Local (2)	Permanent (5)	Moderate (6)	Medium (3)	Medium (48)	Moderate
With mitigation measures	Local (2)	Medium term (3)	Low (4)	Low (2)	Low (18)	Moderate

<u>Description of Impact</u>

Hydrocarbon-based fuels or lubricants spilled from construction vehicles, construction materials that are not properly stockpiled, and litter deposited by construction workers may be washed into the surface water bodies. Slag spillages or material containing high levels of metals or potentially harmful minerals, the mobilisation of sediments, excavations, removal and disturbances to vegetation, could have various negative impacts on wetlands and their associated functionality.

Should appropriate toilet facilities not be provided for construction workers at the construction crew camps, the potential exists for surface water resources and surroundings to be contaminated by raw sewage. The utilisation of the water courses for disposal of water used for washing will decrease the abundance and diversity of aquatic macro-invertebrates inhabiting the section of the wetlands and freshwater ecosystems downstream. Contaminated runoff from concrete mixing and sediment release as well as hydrocarbon spillages may lead to the infiltration of pollutants into recharge, interflow or responsive soils with potential negative impacts on freshwater ecosystems downstream.

Mitigation Measures

- An emergency response plan must be implemented to clean and remediate any potential harmful spillages as soon as they happen in order to harmful derivative materials from being washed into watercourses through either surface or hydropedological pathways.
- Construction vehicles are to be maintained in good working order so as to reduce the probability of leakage of fuels and lubricants;
- Emergency plans and infrastructure to deal with spillages (especially hydro-carbon spillages) must be in place, this should include mobile response units to deal with spillages in the field;
- A walled concrete platform, dedicated store with adequate flooring or bermed area should be used to accommodate chemicals such as fuel, oil, paint, herbicide and insecticides, as appropriate, in well-ventilated areas;
- Storage of potentially hazardous materials should be above any 100-year flood line, or as agreed with the Environmental Control Officer. These materials include fuel, oil, cement, bitumen etc.;
- Surface water draining off contaminated areas containing oil and petrol would need to be channelled towards a sump which will separate these chemicals and oils;
- All construction materials liable to spillage are to be stored in appropriate structures with impermeable flooring;
- Portable septic toilets are to be provided and maintained for construction crews. Maintenance must include their removal without sewage spillage;
- Under no circumstances may ablutions occur outside of the provided facilities;
- No uncontrolled discharges from the construction crew camps to any surface water resources shall be permitted. Any discharge points need to be approved by the relevant authority;
- In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water Affairs must be informed immediately;
- Store all litter carefully so it cannot be washed or blown into any of the water courses within the study area;
- Provide bins for construction workers and staff at appropriate locations, particularly where food is consumed;
- The construction site should be cleaned daily and litter removed; and
- Conduct ongoing staff awareness programs so as to reinforce the need to avoid littering.

Decommissioning phase

Decreased downstream water quality.

	Scale	Duration	Magnitude	Probability of occurrence	Significance
Without mitigation measures	Local (2)	Permanent (5)	Moderate (6)	Medium (3)	Medium (48)
With mitigation measures	Local (2)	Medium term (3)	Low (4)	Low (2)	Low (18)

Description of Impact

Discard and plant facilities working with metals after a number of years often emanate polluted seepage through surface and or hydropedological pathways to deliver pollutants into the downstream watercourses.

Mitigation Measures:

A geohydrological and hydropedological assessments should consider potential future impacts associated with the existing and proposed developments. Other measures include:

- An appropriate wetland and riparian monitoring program must be implemented prior to the start of the construction phase;
- Appropriate wetland rehabilitation design and implementation must ensure that wetland functionality is enhanced with respect to the area affected by the clean water diversion channel and associated channelisation that has taken place;
- The re-release of clean water from clean and dirty water separation infrastructure must be diffused and not reach the wetland as concentrated flows where it will have serious negative impacts on the valley-bottom wetland soils. The stormwater plan must include adequate attenuation facilities to ensure that peak flows do not cause negative impacts on wetlands. More specifically as a guideline:
  - Post development flows for frequent, average every afternoon type storm event 6 mm over 2 hours, will not exceed pre development flows.
  - Post development velocities associated with the 1:5 year return event storm will be within 25% of predevelopment velocities.

5. CONCLUSION AND RECOMMENDATIONS

One hydro-geomorphic units (HGM), comprising one HGM type, a channelled valley bottom wetland was delineated and classified within the study area and within 500m surrounding the study area. In addition several riparian watercourses were also delineated within and surrounding the study area.

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

Combined area weighted Wet-Health results indicated that the valley bottom wetland within the study area have been moderately altered as a result of changes in water inputs (derived from its catchment) and water retention and distribution patterns within the wetlands units, as well as vegetation changes within the wetlands and surrounding catchments due to historic and current anthropogenic impacts. Riparian habitat were assessed for their Present Ecological Status through applying a Level 3 VEGRAI assessment which indicated that riparian habitat were moderately to seriously impacted due to changes in water inputs (derived from its catchment) and water retention and distribution patterns within the riparian habitat itself.

The valley bottom wetland, HGM 1, was regarded as having a moderate Hydrological and Functional Importance as a result of the relatively moderately intact nature and various important ecosystem services it provide. The moderate Ecological Importance and Sensitivity assigned too HGM 1 can be attributed to the relatively intact hydrological and geomorphological nature associated with the wetland and its associated catchment. Direct human benefits were associated with the provision of natural resources as well as grazing opportunities afforded by wetland habitat within the study area, especially by providing a higher general moisture regime compared to the terrestrial habitat. Collectively, the valley bottom system play an important role in contributing to good water quality and quantity to the downstream environment, more specifically the Crocodile River. All riparian habitat was also considered sensitive due to the important functions it could potentially provide.

The impact assessment identified surface water pollution including sedimentation as well as increased erosion, loss of wetland and riparian functionality and decreased downstream water quality as the major potential impacts during the construction and operational phase. Several general and specific mitigation measures were proposed in order to reduce negative impacts and incorporate some potentially positive impacts from the proposed development following the application of the mitigation hierarchy. Some of the most pertinent recommendations include:

- Particular care must be taken on the eastern periphery where the existing clean water diversion channel is situated within the proposed footprint of the new Waste Rock Dump. The existing clean water diversion channel must be redirected west of the proposed new waste rock dump. Alternatively, if contours permit, the clean water diversion channel could also be re-routed around the eastern periphery of the proposed Waster Rock Dump. Further, a diffuse release gabion channel must be constructed on contour on the downstream end of the clean water diversion channel in order to ensure that channelisation of the valley bottom wetland (HGM 1) is not promoted (Figure 12). Some soft channel rehabilitation intervention is also recommended just downstream from the release point as part of the installation of the diffuse release channel.

- The clean and dirty water separation infrastructure should be audited by a surface hydrologist to ensure that adequate clean and dirty separation infrastructure is in place for the mining complex.
- An appropriate wetland and riparian monitoring program must be implemented prior to the start of the construction phase;

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APPENDIX A – Methodology

Wetland Delineation

The report incorporated a desktop study, as well as field surveys, with site visits conducted during February 2019. Additional data sources that were incorporated into the investigation for further reliability included:

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

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

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

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

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

Wetland Functionality

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

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

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

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

Determination of Ecological Importance and Sensitivity

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

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

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

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

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

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

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

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