PROPOSED REHABILITATION OF A SECTION OF THE EXISTING ROAD D684, AND THE PROPOSED CONSTRUCTION OF A NEW ACCESS ROAD TO LINK THE R104 AND THE D684, NEAR THE SIKHULULIWE VILLAGE, SITUATED 28KM EAST OF MIDDELBURG IN THE MPUMALANGA PROVINCE.

Surface Water Ecosystems Ecological, Delineation and Impact Surveys

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DECLARATION

PROJECT: Proposed rehabilitation of a section of the existing road D684, and the proposed construction of a new access road to link the R104 and the D684, near the Sikhululiwe Village, situated 28km east of Middelburg in the Mpumalanga Province: Surface Water Ecosystems Ecological Report

This report has been prepared according to the requirements of the Environmental Impact Assessments Regulations (GNR 982) in Government Gazette 38282 of 4 December 2014, and DWAF (2008) Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas. We (the undersigned) declare the findings of this report free from influence or prejudice.

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DISCLAIMER, ASSUMPTIONS AND LIMITATIONS

The findings of the survey provided within this report, together with the results and general observations, and the conclusions and recommendations provided upon completion of the survey are based on the best scientific and professional knowledge of the field specialists. This is also dependent on the data and resources available at the time. The report is based on survey and assessment techniques that are limited by time and budgetary constraints relevant to the type and level of investigation undertaken.

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ABBREVIATIONS, ACRONYMS AND DEFINITIONS

TERM	EXPLANATION
DARDLEA	Mpumalanga Department of Agriculture, Rural Development, Land and Environmental Affairs.
DFFE	Department of Forestry, Fisheries and the Environment.
DHSWS	Department of Human Settlements, Water and Sanitation.
DWAF	Department of Water and Forestry. An outdated an unofficial name for the present DHSWS but which remains relevant for literature and policy referrals.
DWS	Department of Water and Sanitation. An outdated an unofficial name for the present DHSWS but which remains relevant for literature and policy referrals.
ECO	Environmental Control Officer. A suitably qualified person appointed to oversee the construction procedures to ensure environmental compliance (also sometimes referred to as the Environmental Compliance Officer).
EIA	Environmental Impact Assessment.
Facultative wetland species	Floral species that occur in wetlands or the outer skirts of wetland units where soils are seasonally saturated or waterlogged.
Ferrolysis	A chemical process that occurs within hydromorphic soils associated with wetland conditions where the cyclic precipitation and dissolution of iron (and other minerals) within the soils due to oxidation induced by a seasonally fluctuating water table induces metal nodule formation. This is useful as an indication of wetland conditions.
GIS	Geographic Information System.
GPS	Global Positioning System.
HGM	Hydrogeomorphic. A referral to the type of wetland unit that is dependent on topographical, geomorphological and hydrological characteristics.
Hydromorphic	Refers to soils that show the physical and chemical indications of being waterlogged for a prolonged period within a year (i.e. wetland soils).
Hydrophytic	Floral species specifically adapted to grow within water inundated (saturated) soils or water
Hypoxic	A state of oxygen deprivation.
IHI	Index of Habitat Integrity
I&AP	Interested and Affected Party.
NFEPA	National Freshwater Ecosystem Priority Areas. A national inventory and description of the surface water ecosystem units of South Africa.
PES	Present Ecological State. A term used to describe the overall ecological condition of the ecological feature described
Pioneer species	A floral species that is typically the first to colonize a disturbed area as part of the plant succession process. Characteristically hardy to sustain harsh environmental conditions, it then provides more favourable conditions for other floral species to establish.
SANBI	South African National Biodiversity Institute.
SFI	Soil Form Indicator. In confirming wetland conditions, chemical processes within the soil within 500 mm of the surface are identified and utilised to confirm the occurrence of a wetland unit.
SWI	Soil Wetness Indicator. In confirming the potential occurrence of a wetland unit, the degree of soil wetness to a depth of 500 mm is used as one of the confirmation indicators of wetland conditions.
TUI	Terrain Unit Indicator. In confirming the potential occurrence of a wetland unit, the terrain (valley bottom, depression, etc.) provides an indication of where topographical features could support wetland conditions and is often the first step to delineating a wetland unit.
VI	Vegetation Indicator. Wetland soils, depending on their period of prolonged saturation, support a particular floral species community structure. Due to facultative adaptation to levels of soil saturation, floral species within wetland soils tend to only occur within particular zones of the wetland (i.e. temporary, seasonal or permanent zones). The identification of the zones and the floral species communities associated with each is a useful tool when delineating the boundaries of a wetland unit.
Wetland-IHI	Wetland Index of Habitat Integrity.

EXECUTIVE SUMMARY

Introduction and Background

It is the intention of Mafube Coal on behalf of the Mpumalanga Department: Public Works, Roads and Transport to upgrade a section of the existing Provincial Road D684, and to construct a new access road to link the existing Provincial R104 and the D684, near the Sikhululiwe Village, situated approximately 31.6km east of Middelburg in the Mpumalanga Province. Enviross CC was requested to undertake the surface water ecosystems ecological and delineation surveys for the project area and to rate the overall impacts to the ecological features associated with the road development. This report details the findings of the field survey undertaken during May 2021.

Methods and Materials

DESKTOP SURVEY

Prior to the field survey, the desktop survey was undertaken to gather relevant ecological processes data for the survey area. Sources included available online data, Geographic Information Systems (GIS) databases, aerial imagery, and topographical maps. Biodiversity data was sourced from available online sources, as well as publications, field guides, and the databases developed by EnviRoss CC from field surveys undertaken within the same vicinity.

FIELD SURVEY

Wetland delineations were undertaken according to methods outlined in the Department of Water Affairs and Forestry (DWAF) *Updated Manual* for *the Identification and Delineation of Wetlands and Riparian Areas, 2008*. These guidelines make use of four indicators of wetland habitats that enable the identification of a wetland. This does not necessarily mean that all four indicators are utilised, but rather that there are four indicators available to be utilised. Aspects such as severely degraded vegetation structures often lead to this indicator not being utilised. In this case, more emphasis is then placed on the other indicators. The four available indicators commonly used are:

- Terrain Unit Indicators (TUI)
- Soil Wetness Indicators (SWI)
- Soil Form Indicators (SFI)
- Vegetation Unit Indicators (VUI)

Consultation of various available mapping (1:50,000 topographical maps, databases), aerial photographs and catchment reviews formed part of reiterative data collection for the survey. The field survey concentrated on identifying the various wetland indicators by making use of samples taken with a soil auger, the digging of inspection pits, wetland floral species identification and the confirmation of topographical features that would support wetland formation and the observations of any saturated soils and surface water.

The outer edges of the temporary zones of the wetlands were then identified and mapped using a handheld GPS unit. These data sets were then transformed into GIS shapefiles that can be incorporated into the construction and layout plans of the proposed development activities.

Wetland ecological integrity was assessed by making use of the Wetland Index of Habitat Integrity (WETLAND-IHI) (DWAF, 2007) as well as the Wetland EcoServices (Kotze, *et al.,* 2007) models.

Impact significance ratings were then applied to pertinent ecological features that are then a function of evaluating the expected impacts associated with a development of this nature and how that would be expected to impact the habitat units that it is associated with. Screening of the impacts of existing infrastructure within the area forms part of this process.

Results and Discussions

The desktop review indicated the land use within the area to be dominated by formal cultivation and mining. The ecological functionality of the wetland units had been historically altered through transformation of the natural surface water drainage, which

was altered through earth berms, excavated trenches and linear foundations associated with railways, roads, and other infrastructure. This has led to a comparatively diminished wetland functional area than what would have historically existed.

Due to the dominant land use and the associated pressures and drivers of ecological change, the general Present Ecological State (PES) of the wetland units calculated to represent a C to C/D category, which is largely in line with the PES of the major wetland units throughout the catchment area (as noted by Nel *et al* [2011]). The Ecological Importance and Sensitivity ratings (EIS) of the wetland systems calculated to a moderate value. This is largely due to the wetland units not providing resources that are relied on by surrounding communities, but it did show the wetland units to be important to water quality maintenance as well as biodiversity support within the area. The most dominant pressures and drivers of ecological change were shown to be from agriculture (active cultivation) and infrastructure development within the wetland areas. Wetland areas adjacent to the village also were shown to suffer a degraded PES due to land use pressures.

The application of the DWS Risk Assessment Matrix indicated that a moderate risk to the wetland units could be expected for the construction of culverts within the functional wetland zones. This could be lowered to an overall low risk with the implementation of proposed mitigation measures. Further activities associated with the project were noted to score a low risk to the surrounding wetland areas. This is largely due to the proposed development being largely confined to the existing road and road reserves, the relatively low association that the project has with wetland habitat and the relatively transformed status of the wetland units that would be impacted.

Conclusions and Recommendations

Following the field survey of the proposed development area, the following salient recommendations can be proposed to aid in the conservation of the overall ecological integrity of the surface water ecosystems within the region:

- Wetland habitat units were noted to be associated with the proposed development. The units were delineated and are presented in Figure 11.
- The development is associated with an existing roadway. Minimal impact significance is expected to occur as the road rehabilitation procedures couple to an existing road.
- The proposed new road section was shown to have an association with a wetland unit (Figure 12). Although not considered a fatal flaw due to the wetland unit having already suffered a major loss of ecological functionality, the overall ecological integrity of the immediate area would benefit from a minor alignment shift within this area to accommodate the wetland unit and its associated buffer zone.
- The impact significance of the potential impacting features showed medium to low overall significance, with many impacts rendered insignificant with the application of the proposed mitigation measures.
- The wetland units were shown to fall within a C to C/D PES class, with the major pressure and driver of ecological change being the existing infrastructure development, and agricultural activities within the catchment areas.
- Erosion control measures and avoidance of indiscriminate habitat destruction outside of the ultimate construction footprint are regarded as the most pertinent mitigation measures.
- Culvert development sites must be suitably reinstated and landscaped to avoid erosion formation.
- Culverts should be spread over the width of the watercourse so that the surface water flows are not constricted. Designing of culvert placement, numbers and capacities must take into consideration flood flow volumes. Constriction of the watercourse will result in erosion within the channel at the downstream side of the culvert and will also reduce the lateral extent of the associated wetland.
- The overall ecological impact significance of the proposed development activities is expected to be low and therefore no justifiable reasons for opposing the development can be offered.

It should be noted that, to conserve the ecological structures within the region, a holistic habitat conservation approach should be adopted. This includes keeping general habitat destruction and construction footprints to an absolute minimum within the terrestrial habitat as well. Conserving the habitat units will ultimately conserve the species communities that depend on it for survival. This can only be achieved by the efforts of the contractor during the various processes of the construction phase.

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1. INTRODUCTION

1.1. Background & Project Description

It is the intention of Mafube Coal on behalf of the Mpumalanga Department: Public Works, Roads and Transport to upgrade a section of the existing Provincial Road D684, and to construct a new access road to link the existing Provincial R104 and the D684, near the Sikhululiwe Village, situated approximately 31.6km east of Middelburg in the Mpumalanga Province. The project falls within the Nkangala District Municipality, and the Steve Tshwete Local Municipality within Wards 7 and 9 and is situated approximately 31.6 km west of Middelburg, and approximately 38.2 km southwest of Belfast. The locality of the site is presented in Figure 1.

The existing Provincial Road D684 runs to the east of Mafube Coal and the Sikhululiwe Village, in a north-south direction. The D684 is an existing gravel road with a varying width (approximately 6 m minimum), and a road reserve width of 25 m. The D684 is linked to R104 via a gravel road approximately 1.8 km long, which runs adjacent to the railway line after the railway crossing before joining the R104. The R104 runs to the south of Mafube Coal, in an east-west direction, and joins the N11 in Middelburg with the N4, to the southwest of Belfast.

The existing D684 provides access to the Sikhululiwe Village, which is situated to the south of the existing Mafube Coal operations. The proposed access road to link the D684 to the R104 is situated to the southwest of the Village.

Rehabilitation of a Section of the existing D684

This project involves the rehabilitation of a 3.19 km section of the existing D684 gravel road. The upgrade will involve the resurfacing of this section of the road. The road will consist of two 3.5 m surfaced lanes with 1.5 m unsurfaced shoulders. A road reserve width of 30 m will be applicable where space allows. The current road and road reserve width, as well as the alignment of the D684, will remain unchanged as follows:

- 7 m wide surfaced cross section, with a 1.5 m unsurfaced gravel shoulder,
- Existing reserve of varying widths along existing property boundaries,
- Will remain a single carriageway with one lane in either direction.
- New minor culverts may be required along this section to be upgraded. No bridges will be constructed along this section.

New Access Road

The new proposed access road will be 0.21 km long and will link the R104 with the existing D684. The proposed new access road cross section will have 3.5 m wide surfaced lanes with 1.5 m unsurfaced gravel shoulders. The road reserve will be 30 m wide. This road will be a single carriageway with one lane in either direction.

Upgrade of drainage infrastructure

Various points along the road alignment have been identified where free drainage of surface water would have to be catered for with the implementation of culverts of varying capacities. The localities and design specifications are provided within Table 1. The localities of these points are presented in Figure 16.

Table 1: As part of the road rehabilitation, six new culverts (as per the details below) will be constructed.

Culvert	Culvert Size	Decimal Degrees (WGS84)	
		Lat_S	Lon_E
0+037 New access road	1 x 600 x 450 BC	-25.7793	29.7618
0+085 D684-A	1 x 600 x 450 BC	-25.7684	29.7806
0+994.900 D684-B	2 x 1500 x 900 BC	-25.7689	29.7803
1+050.000 D684-B	2 x 1200 x 900 BC	-25.7783	29.7635

Culvert	Culvert Size	Decimal Degrees (WGS84)	
		Lat_S	Lon_E
Village Road 1	750 diam PC	-25.7664	29.7812
Village Road 2	750 diam PC	-25.7628	29.7828

The sections of the road that are to be rehabilitated have an association with wetland habitat units. EnviRoss CC was commissioned to undertake the surface water ecosystems ecological, delineation, and impact surveys, to ascertain the overall ecological value of the habitat units, and to offer mitigation measures to abate negative ecological impacts emanating from the proposed development activities. This report details the findings of the surface water ecosystems survey that reflects the findings of the field survey undertaken during May 2021.

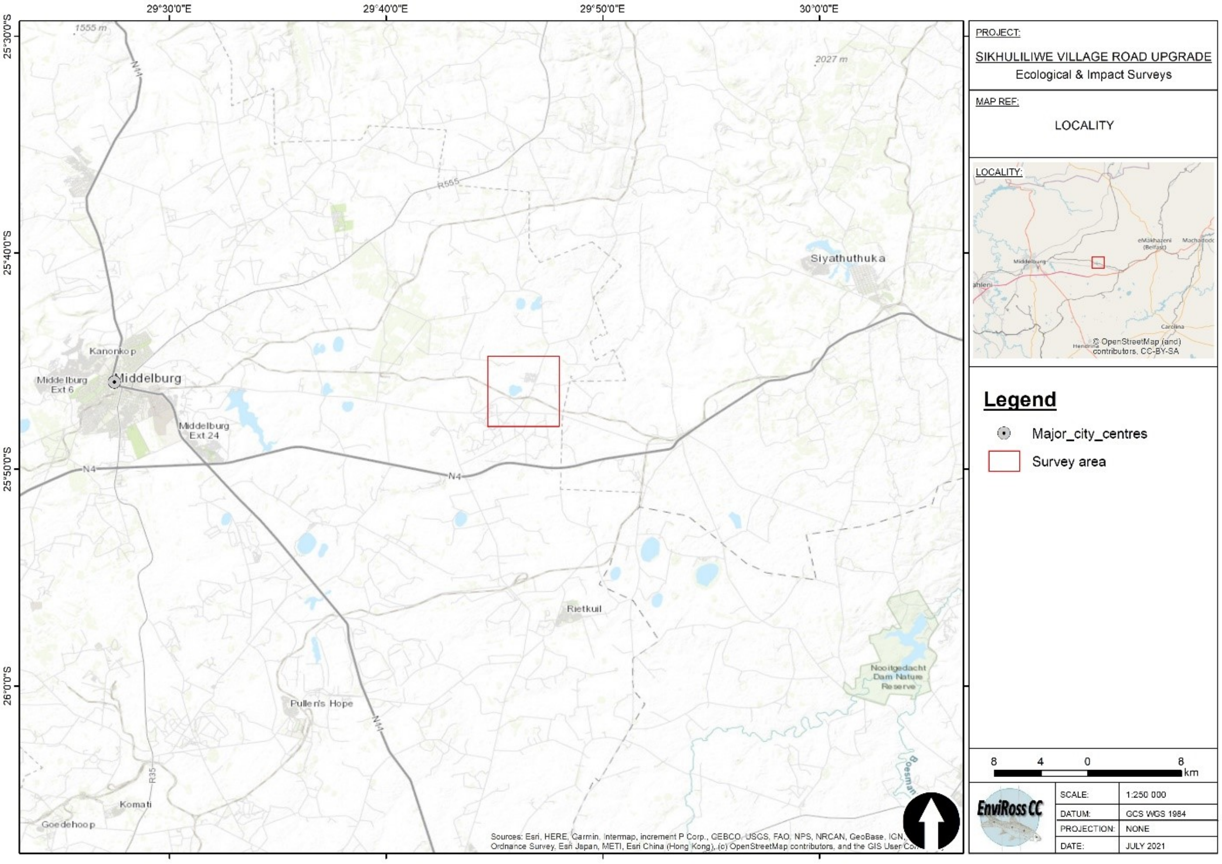

Figure 1: Locality of the survey area.

1.2. Scope of Work

The Scope of Work for the ecological survey encompasses the following aspects:

- Desktop survey, making use of available GIS databases, aerial imagery, and catchment data, to gain an understanding of the regional land use, the pressures and drivers of ecological change, catchment condition and to establish areas of focus,
- Field survey to ground-truth the information gathered during the desktop review. This includes accounts of the dominant floral species for the area and the habitat availability and condition to support biodiversity (with emphasis on species of conservational significance and species that would be dependent on surface water habitat units),
- An impact evaluation of the proposed development activities through the various phases of the road construction and rehabilitation process, and,
- To make recommendations to allow for reduction of the overall ecological impacts emanating from the proposed development.

1.3. Assumptions & Limitations

The following conclusions to the overall perceived impacts have been based on a desktop survey that was reiterated by ground-truthing through a single field survey of the area encompassing the proposed development. Due to this, the species and community structures that are mentioned within the report allude to the assessment of overall ecological health and functionality of the survey area or for the purposes of rating the significance of the ecological impacts and to allow for the objective presentation of the significance of the ecological impacts and the level of practical mitigation. Floral species accounts therefore do not represent a comprehensive account of the species that occur within the scope of the project area.

1.4. Aims & Objectives

The objective of this report is to indicate the present ecological state of the habitat units encompassed within the development impact zones and to highlight the ecologically sensitive and relevant areas to be avoided, if possible, by the proposed development activities. Mitigation measures are provided for abating the overall significance of the impacts associated with the proposed development activities where those impacts are determined to be unavoidable through alternative alignment routes. This information can then be utilised as supporting documentation for the design and construction teams of the proposed development activities.

1.5. Applicable Legislature

Legislation pertaining to environmental resources, the use and conservation thereof, is regulated by a multitude of inter-disciplinary laws. Only the pertinent laws (Acts) are discussed below.

Conservation of wetland habitat units and resources is protected by a myriad of legislature, including the Constitution of South Africa Act 108 of 1996, which states that everyone has a right to an environment that is not harmful or detrimental to their health and which is sustainable for future generations. Further to this, South Africa uses environmental-specific legal frameworks based on principles found in the National Environmental Management Act 107 of 1998 (NEMA). Section 28 (1) states that any person who causes or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment.

The National Water Act 36 of 1998 (NWA), which is the main water regulation statute of South Africa, defines what is meant as a "water use" as activities that require authorisation. Sections most applicable to developments impinging upon or within wetland boundaries are section 21(c) *impeding or diverting the flow of water in a watercourse,* and 21(i) *altering the bed, banks, course, or characteristics of a watercourse*. As per definition, this means any change affecting the resource quality within the riparian habitat or 1:100 year floodline, whichever is the greater distance. Subsequent to this, the DHSWS issued a Government Notice (GN) within the Government Gazette, No 1199 (18 December 2009), in which Section 6(b) indicates that any development within a 500 m radius of any wetland must seek authority through a Water User Licence Application (WULA) and that authority for these activities through a General Authorisation (GA) is no longer applicable. As the development activities are within a 500 m radial regulatory zone of the surrounding wetlands, authority will have to be sought prior to any development taking place. The application of a Risk Assessment Matrix pertaining to wetland habitat units has also become mandatory as per Government Gazette 39458, Notice 1180 of 2015 (27 Nov 2015), wherein the severity of the risk to the habitat unit is categorised and rated.

The designation of regulatory conservation buffer zones is also done in accordance with legislature. The extent of the buffer zone, however, is largely determined by the present ecological condition of the habitat unit, the ecological sensitivity of the unit and the impact severity of the development activity. It is largely the industry norm to stipulate a buffer zone of 32 m from the outer limits of the temporary zone of a wetland unit or the riparian zones of a watercourse. Wetland and aquatic habitat that is particularly ecologically sensitive or support species that are regarded as being particularly sensitive to disturbances and/or are of conservational significance often warrants the designation of larger buffer zones.

Under the NWA, a water resource includes a watercourse, surface water, estuary, or aquifer. A *watercourse* is defined as (inter alia):

- a river or spring,
- a natural channel in which water flows regularly or intermittently,
- a wetland, lake, or dam into which, or from which, water flows.

In this context it is important to note that reference to a watercourse includes, where relevant, its bed and banks (to within the 1:100 year floodline or outer limit of the riparian edge or temporary zones of a wetland, whichever is the greatest).

Protection of a water resource, as defined in the NWA entails:

- Maintenance of the quality of the water resource to the extent that the water use may be used in a sustainable way,
- Prevention of degradation of the water resource,
- The rehabilitation of the water resource.

The NEMA is the principal legislation governing Environmental Impact Assessment (EIA), under the authority of the Department of Forestry, Fisheries and the Environment (DFFE), and is applicable to both water resources and terrestrial habitat units. The NEMA makes provisions for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of the State, and to provide for matters connected therewith. Section 2 of the NEMA establishes a set of principles which apply to the activities of all organs of state that may significantly affect the environment. These include the following:

- Development must be sustainable,
- Pollution must be avoided or minimised and remedied,
- Waste must be avoided or minimised, reused or recycled,
- Negative impacts must be minimised and positively enhanced; and responsibility for the environmental health and safety consequences of a policy, project, product, or service exists throughout its entire life cycle.

The National Environmental Management: Biodiversity Act 10 of 2004 (NEM:BA) (G-26436) operates in conjunction with the National Environmental Management: Protected Areas Act 57 of 2003 (NEM:PA) and amendment No 15 of 2009 (G32404). Both Acts emerge from the recommendations of the White Paper on the Conservation and Sustainable Use of South Africa's Biodiversity (1998) and were originally conceived of as one Act.

Within the framework of the NEMA, to provide for:

- The management and conservation of biological diversity within the Republic and of the components of such biological diversity,
- The use of indigenous biological resources in a sustainable manner,
- The fair and equitable sharing among stakeholders of benefits arising from bio-prospecting involving indigenous biological resources,
- To give effect to ratified international agreements relating to biodiversity which are binding on the Republic,
- To provide for co-operative governance in biodiversity management and conservation; and to provide for a South African National Biodiversity Institute (SANBI) to assist in achieving the objectives of the Act.

The NEMBA provides specifically for the issuing of permits. Before issuing a permit, the issuing authority may in writing require the applicant to furnish it, at the applicant's expense, with such independent risk assessment or expert evidence as the issuing authority may determine. Regulations may be made pertaining to various matters regulated by the NEMBA, offences and penalties are provided for, and consultation processes are prescribed. Should Red Data species be directly affected by the proposed project, then the necessary permits will be required to be applied for. A list of the protected species that fall under the auspice of the NEMBA was published within the Government Gazette No 30568, under Government Notice No R 1187 issued on 14 December 2007.

2. MATERIALS AND METHODS

2.1. Desktop Review

The purpose of the desktop review process is to provide an overview of the associated ecological processes, the ecological descriptors and habitat units, and the important ecological and conservational features that have been identified at both the national and provincial level that are relevant to the project area. Review of the applicable resources pertaining to ecological aspects of the project area allows for a planned and targeted field survey that then allows for ground truthing of the pertinent areas identified through the desktop review process. A desktop review also very often provides a starting point for the infield wetland delineation process, especially in areas where wetland units tend to be more cryptic due to aspects such as thick vegetation, relatively undeveloped wetland units and other factors, which could lead to wetland units being missed by field consultants at the ground level.

2.1.1. Environmental Screening Tool Assessment

Regulations stipulated by the DFFE require the submission of a report that is generated by the National Environmental Screening Tool in terms of section 24(5)(h) of the NEMA and regulation 16(1)(b)(v) of the EIA regulations, 2014, as amended, forms part of the initial desktop review process. The survey area as well as a 1 km buffer zone was subject to the screening assessment to determine the level of sensitivity for the various themes and therefore provides an indication of the level of detail that is required during the analysis of the various ecological themes associated with the project area. The screening tool is an online resource that is available at https://screening.environment.gov.za/screeningtool.

2.1.2. Literature and Data Sources

Data at the provincial level are provided within the Mpumalanga Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA) Conservation Plan (Ferrar & Lötter, 2007) and the accompanying a GIS spatial dataset (Lötter, 2006). These data identify those areas of ecological significance from the region that provide varying levels of biodiversity support and therefore require focused attention for the aspects identified to be associated with the project area.

As well-established wetland units typically support unique vegetation units, the identification of the vegetation units and associated characteristics in terms of climatic data, topographical features, general geological and soil characteristics, defining floral species identified as being diagnostic of the vegetation unit, conservation status of the vegetation unit, and other relevant data are considered important. Most of these data were sourced from SANBI (2006), together with the accompanying GIS spatial datasets (updated in 2012) that indicate the extent of the vegetation units at the national level. These datasets are scaled at the national level and therefore, although indicative of the expectations of the wetland units and types associated with a project area, cannot be used as an accurate account of the extent of the wetland units associated with a project area.

The most recent as well as historical aerial imagery from Google Earth ® Pro was utilised to evaluate the project area. Digital 1:50,000 topographical maps and topographical mapping GIS spatial datasets (Chief Directorate Surveys and Mapping, Department of Land Affairs) and GIS datasets from ongoing GIS dataset development within EnviRoss CC. Spatial resources pertaining to surface water ecosystems were sourced through the National Freshwater Ecosystem Priority Areas (NFEPA) mapping datasets (Nel *et al*, 2011). Again, the spatial references of surface water ecosystem units that are indicated within the NFEPA datasets are mapped at the national level and are indicative of site characteristics expectations rather than accurate accounts of the extent of all surface water units within the project area.

Faunal and floral species identification was supported by various printed field guides, digital field guides and other taxa-specific resources, as well as experience and knowledge of the field consultants undertaking the surveys. The conservation status of relevant species was obtained through www.redlist.sanbi.org, and published red data books and conservation assessments of specific taxa. Species accounts were typically limited to those indicative of, and which would be supported by, surface water ecosystems within the scope of the project area.

2.2. Wetland Delineation Methods

Following on from the desktop review process where a general impression of the project area can be ascertained, a ground-truthing field survey to identify all surface water ecosystem units associated with the project area and to determine the extent of those units is performed. This procedure is undertaken according to the *DWAF Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas* (DWAF, 2008).

According to these guidelines, the wetland delineation procedure considers the following attributes to determine the outer boundaries of each unit:

- Terrain Unit Indicator – helps to identify those parts of the landscape where wetlands are more likely to occur,
- Soil Form Indicator – identifies the hydromorphic soil forms and the chemical processes that are associated with prolonged and frequent saturation and associated anoxia and ferrolysis.
- Soil Wetness Indicator – identifies the morphological "signatures" developed in the soil profile resulting from prolonged and frequent saturation, and,
- Vegetation Indicator – identifies hydrophilic vegetation associated with frequently saturated soils.

> According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps several centuries) (DWAF, 2008).

2.2.1. Terrain Unit Indicator (TUI)

The TUI takes into consideration the topography of the area to determine those areas most likely to support a wetland (DWAF, 2008). These include depressions and channels where water would be most likely to accumulate. This is done with the aid of topographical maps, aerial photographs, and engineering and contour data (if available, these are most often used as they offer the highest degree of detail needed to accurately delineate the valley-bottom and depression features that would be conducive to supporting wetland features). Seepage zones are also very often characterised by depressions, the identification of which aids in determining the presence of a wetland from a topographical perspective.

2.2.2. Soil Form Indicator (SFI)

The SFI considers the identification of hydromorphic soils that display unique characteristics resulting from prolonged and repeated saturation. This ongoing saturation leads to the soil eventually becoming anaerobic and therefore a change in the chemical characteristics of the soil. Certain soil components, such as iron and manganese, which are insoluble under aerobic conditions, become soluble when the soil becomes anaerobic, and can thus be leached out of the soil profile. Iron is one of the most abundant elements in soils and is responsible for the red and brown colours of many soils. Once most of the iron has been dissolved out of the soil because of the prolonged anaerobic conditions, the soil matrix is left a greyish, greenish, or bluish colour, and is said to be "gleyed". A fluctuating water table, common in wetlands that are seasonally or temporarily saturated, results in alternation between aerobic and anaerobic conditions in the soil. Aerobic conditions in the soil leads to the iron returning to an insoluble state and being deposited in the form of patches or mottles within the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Thus, soil that is gleyed and has many mottles may be interpreted as indicating a zone that is seasonally or temporarily saturated (DWAF, 2008).

Soil samples are taken periodically in a line running perpendicular to the permanent water zone (or other obvious signs of wetland conditions) until the outer limits of this zone are identified. This normally coincides with a particular contour level, but transformations and modifications to the landscape often lead to the zone limits not conforming to this theory. Soil samples are taken using a Dutch-type soil auger to a depth of 500 mm. The soil sample is then examined for indications of soils particular to the characteristics described above. Sample pits are also dug periodically as a more thorough and therefore more reliable means of confirming the presence or absence of hydromorphic soil characteristics. These get dug using a garden spade and the profiles thus created are examined for hydromorphic processes within the soil.

2.2.3. Soil Wetness Indicator (SWI)

In practise, this indicator is used as the primary indicator, but can be rendered unreliable during heavy rainfall periods. The colour of various soil components is also often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix. Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils, and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils, until they disappear altogether in dry soils (DWAF, 2008). This indicator is also identified by taking a soil sample using a Dutch-type soil auger, or by digging a hole to examine the soil profile to a depth of 500 mm. The soil sample (or vertical profile) is then examined for indications of soils displaying the above-mentioned characteristics.

2.2.4. Vegetation Indicator (VI)

Vegetation is a key component of the wetland definition in the NWA. However, using vegetation as a primary indicator requires undisturbed conditions and expert knowledge (DWAF, 2008). As a result of this, greater emphasis is often placed on the SWI and SFI. Nonetheless, plant community structure analyses are still viewed as helpful guides to finding the boundaries of wetlands. Plant communities undergo distinct changes in species composition along the wetness gradient from the centre of the wetland to the edge, and into adjacent terrestrial areas. This change in species composition provides valuable clues for determining the wetland boundary, and wetness zones. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicator species (DWAF, 2008). In wetlands that have undergone extensive transformation through landscaping, the vegetation unit indicators can potentially be absent.

2.3. Wetland Hydrogeomorphic Forms Associated with the Project Area

Once the wetland units applicable to the project area have been identified and the boundaries of the units delineated, the different units are classified according to their different hydrogeomorphic forms. This was done according to the nomenclature presented in Ollis *et al* (2013).

2.4. Assessing the Present Ecological State (PES) of the wetland habitat units

The road rehabilitation and construction project is a linear development project that is approximately 3.3 km in length and is regarded as being spatially limited. It can therefore be assumed that a largely homogenous land use and associated pressures and drivers of ecological change would be applicable throughout the entire road alignment route. The survey area does, however, have an association with three separate wetland units and therefore these units have been surveyed separately. The three broad areas are presented in Figure 2.

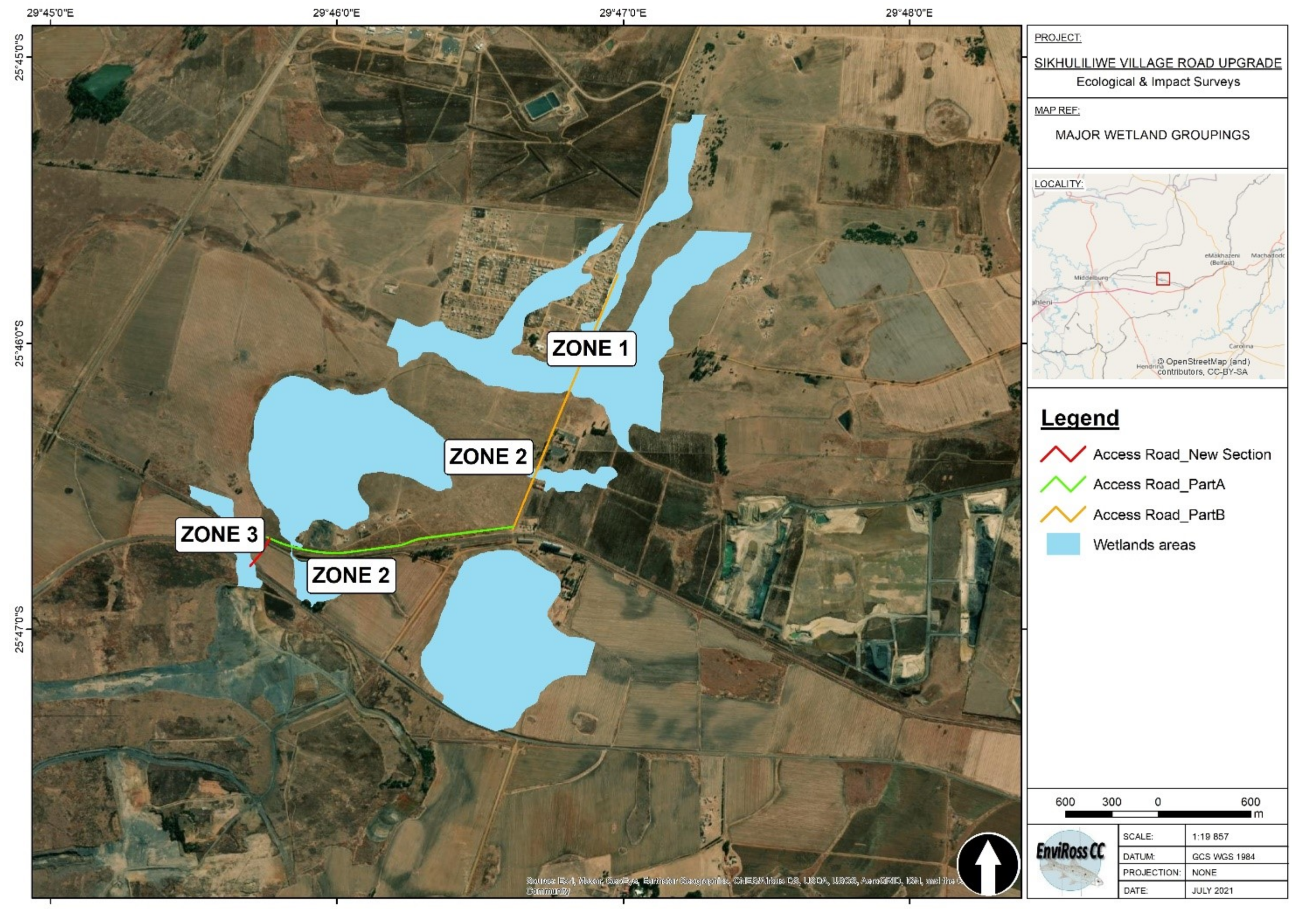

Figure 2: The three main wetland complexes identified that are applicable to the project area.

- Zone 1: Includes valley bottom wetland units that are associated with the village area, with tributary watercourses that drain southwards into the main watercourse that runs from east to west,
- Zone 2: Includes the main depression wetland unit together with the tributary system from the east and from the south. Agriculture and a level of urbanisation are the main drivers of ecological change within this area,
- Zone 3: Includes a valley bottom wetland unit that originates from areas to the south of the R104. Agriculture and mining activities are the two main drivers of ecological change associated with this unit.

2.4.1. Wetland Index of Habitat Integrity (WETLAND-IHI)

The WETLAND-IHI (Wetland Index of Habitat Integrity) was a wetland habitat assessment tool utilised to establish the overall PES of the various wetland habitat units associated with the proposed development area. The WETLAND-IHI was developed as a tool for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI was developed to allow the NAEHMP to include *floodplain and channelled valley bottom wetland types* to be assessed and the monitoring data incorporated into the national monitoring programme (DWA, 2007). The WETLAND-IHI has been applied to each wetland habitat unit associated with the project area and the results of each zone have been presented separately. The output scores of the WETLAND-IHI model are presented in the standard DHSWS A-F ecological categories (Table 2) and provide a score of the Present Ecological State (PES) of the habitat integrity of the wetland system being examined.

Table 2: Description of the A-F ecological categories (after Kleynhans, 1996; 1999) *from DWA, 2007.*

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

The model is composed of four modules (shown in Figure 3). The *Hydrology, Geomorphology* and *Water Quality* modules all assess the contemporary *driving processes* behind the wetland formation and maintenance. The *Vegetation Alteration* module provides an indication of the intensity of human land-use activities on the wetland surface itself and how these have modified the condition of the wetland. The integration of the scores from these four modules provides and overall PES score for the wetland system being examined (DWA, 2007).

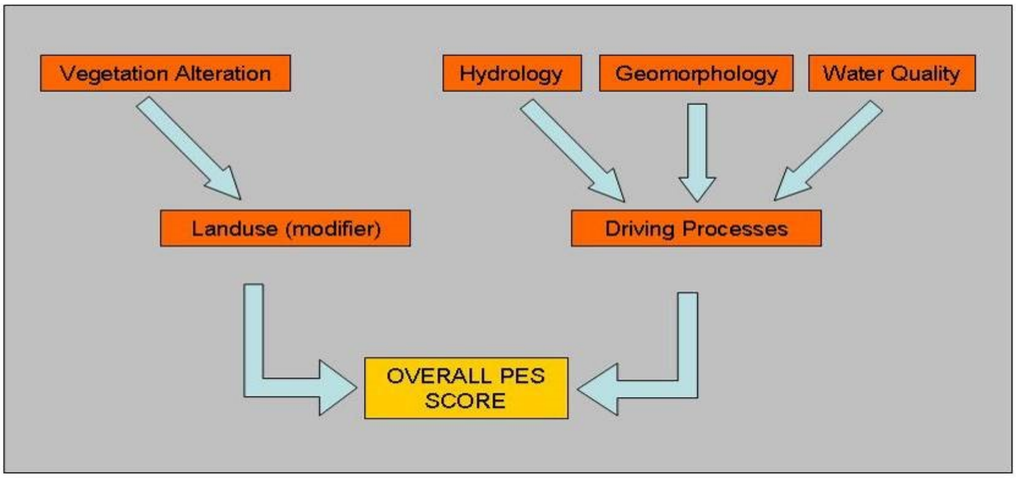

Figure 3: The four modules of the WETLAND-IHI model, and their relationship to the overall PES score, which is derived from them (from DWA, 2007).

Further observations of general ecological integrity at each site during the routine surveys will also be reported on. These points include:

- Erosion trends,
- Degree of siltation at downstream points,
- Unnecessary vegetation removal,
- Other general impacts on the aquatic system (dumping of rubble, litter, etc),
- Impacts of surrounding land use, including encroachment, restriction on the natural movement of water, etc.

2.4.2. WET-Ecoservices

WET-Ecoservices (Kotze *et al*, 2007) was used to assess the goods and services that individual the wetlands within each zone provide. This is taken as a combination of both ecological services and provision of services and resources to users. Through a series of scoring matrices for 15 different goods and service characteristics of a particular wetland, a rating score (out of 4) is provided. This is then compared to the class categories presented in Table 3.

Table 3: Recommended ecological importance and sensitivity categories (*adapted from* WCS, 2007). Interpretation of the median values and categories is also provided.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and ≤4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and ≤3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and ≤2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1	D

2.5. DHSWS Risk Assessment Matrix

The DHSWS developed a risk-based analysis matrix (published in Government Gazette 39458, Notice 1180 of 2015, 27 Nov 2015) that stipulates that a Risk Assessment Matrix be applied to water users in terms of the NWA, which then allows for the categorisation of the severity of the ecological risks pertaining to proposed developments associated with wetland habitat units. Based on the outcome of the Risk Assessment Matrix, *Low* risk activities will be generally authorised with conditions, while activities that are rated as *moderate* to *high* risk will be required to go through a Water Use Licence Application (WULA) Process.

Table 4: Ratings of the risk and associated management descriptions used for the DHSWS Risk Assessment Matrix.

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

Water use activities that are authorised in terms of the GA will still need to be registered with the DHSWS. The Risk Assessment Matrix has been used in the assessment of the risk posed to the wetland ecosystems for the proposed development to better quantify the risk to the resource. The categories (and interpretations of the scores) are assigned to the final ratings based on the ratings analysis (Table 4).

3. RESULTS & DISCUSSIONS

3.1. Environmental Screening Tool Assessment

As part of the desktop review process, regulations stipulated by the DFFE, there is a requirement to submit a report generated by the national web-based environmental screening tool in terms of section 24(5)(h) of the NEMA and regulation 16(1)(b)(v) of the EIA regulations, 2014, as amended. The survey area as well as a 1 km buffer zone was subject to the screening assessment to determine the level of analysis for the site for various themes. All ecological themes associated with this survey are included as there is an interplay between the surface water ecosystems and aspects of the plant and animal themes that are supported by them. The designated sensitivity of each theme and notes associated with each are presented in Table 5.

Table 5: The results of the DFFE screening tool analysis for the survey area, including a 1 km buffer zone.

Theme	Screening Tool Classification		Survey Observations
Aquatic biodiversity	Very high designated to main wetland zones. Remainder designated as low.		Applicable to only one crossing point along the road alignment.
Terrestrial biodiversity	All areas designated as very high.		Area is ecologically open and offers an expanse of habitat, but infrastructure development and land use has led to a degree of habitat fragmentation and transformation.
Animal species	Wetland areas designated as high. Remainder of the area designated as medium.		Area is ecologically open and offers an expanse of habitat, but infrastructure development and land use has led to a degree of habitat fragmentation and transformation. The areas offering the greatest potential to support animal species are associated with the surface water habtiat units. The project would impact on one crossing point of the wetland unit running from east to west.
Plant species	Wetland areas designated as medium. The remaining areas designated as low.		Historically, the grasslands of the project area were utilised for livestock grazing. Other areas were used for formal cultivation. The present land use continues to have a deleterious impact on the ecological features of the project area. Transformation of the floral species structures is therefore expected as a general impact throughout the area. Wetland zones still tend to offer the greatest potential for supporting floral diversity.

3.2. Mpumalanga DARDLEA Conservation Plan

The Mpumalanga Department of Agriculture, Rural Development, Land and Environmental Affairs (DARDLEA) provides a conservation plan that provides a spatial assessment that indicates the conservation significance of areas to both the aquatic and terrestrial features at the provincial level. Pertaining to surface water ecosystems, the province is divided into sub catchment areas. These areas are then rated according to their importance to the maintenance of aquatic biodiversity according to the level of support the habitat features provide in terms of migrations, refuge and species richness. The project area falls within a sub catchment that is classified as 3 – Highly significant, with scores for migrational support, provision of refuge, and species richness being allocated as 1, 2 and 2, respectively (Figure 4). This tends to reiterate the results from the Screening Tool Analysis (Section 3.1.) in that it highlights the importance of the surface water habitat units to biodiversity maintenance.

3.3. Catchment Area Descriptions & Characterisations

The survey area falls within the Olifants (North) (B) Primary catchment and the Upper Olifants River water management area. The project area falls within the B12C quaternary catchment, which is drained toward the northwest by the Klein Olifants River. The Klein Olifants River continues in a north-westerly direction to confluence with the Olifants River, which is the main watercourse of the primary catchment area. The watershed associated with the project area is drained in a westerly direction by a minor watercourse toward the Klein Olifants River. The major watercourses within the region tend to be classified within the PES C (moderately transformed) and D (largely transformed) categories (Nel *et al*, 2011) (Figure 5). The major wetland units within the region are largely categorised within a C (moderately modified) PES (Nel *et al,* 2011) (Figure 6).

The quaternary catchment of B12C is dominated by agriculture and a growing mining sector. The resulting vegetation transformation, erosion from disturbed soils and water quality degradation associated with agrochemical usage and mining runoff are identified as the main drivers of ecological change. Details of the land use within the project area are shown in Figure 7. Various views of the project area are presented in Figure 8.

The dominant vegetation unit associated with the project area is Eastern Highveld Grassland, which forms part of the Mesic Highveld Grassland bioregion within the Grassland biome. Established wetland units within the region support an azonal freshwater wetlands vegetation type typically found embedded within the Highveld grasslands, namely Eastern Temperate Freshwater Wetlands of the Freshwater Wetlands biome. Eastern Highveld Grasslands, as a vegetation unit, is regarded as conservationally *Endangered*, with the main drivers being identified as transformation of the unit to accommodate cultivation and mining and the lack of substantial areas representing primary vegetation features within protected areas. Eastern Temperate Freshwater Wetland is regarded as conservationally *Least Concern* (SANBI, 2006).

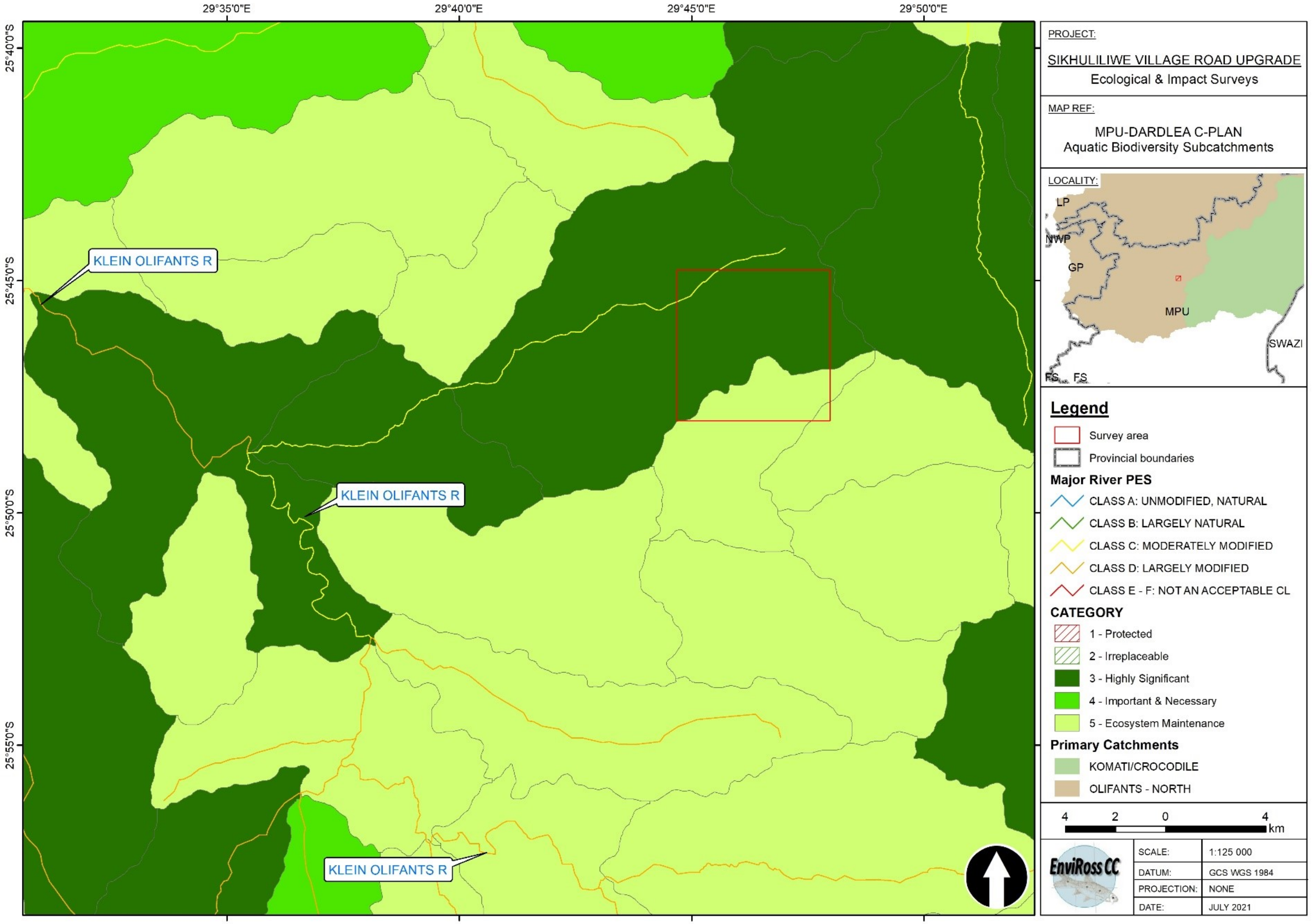

Figure 4: The Mpumalanga DARDLEA C-Plan for aquatic biodiversity for the sub catchment pertaining to the project area.

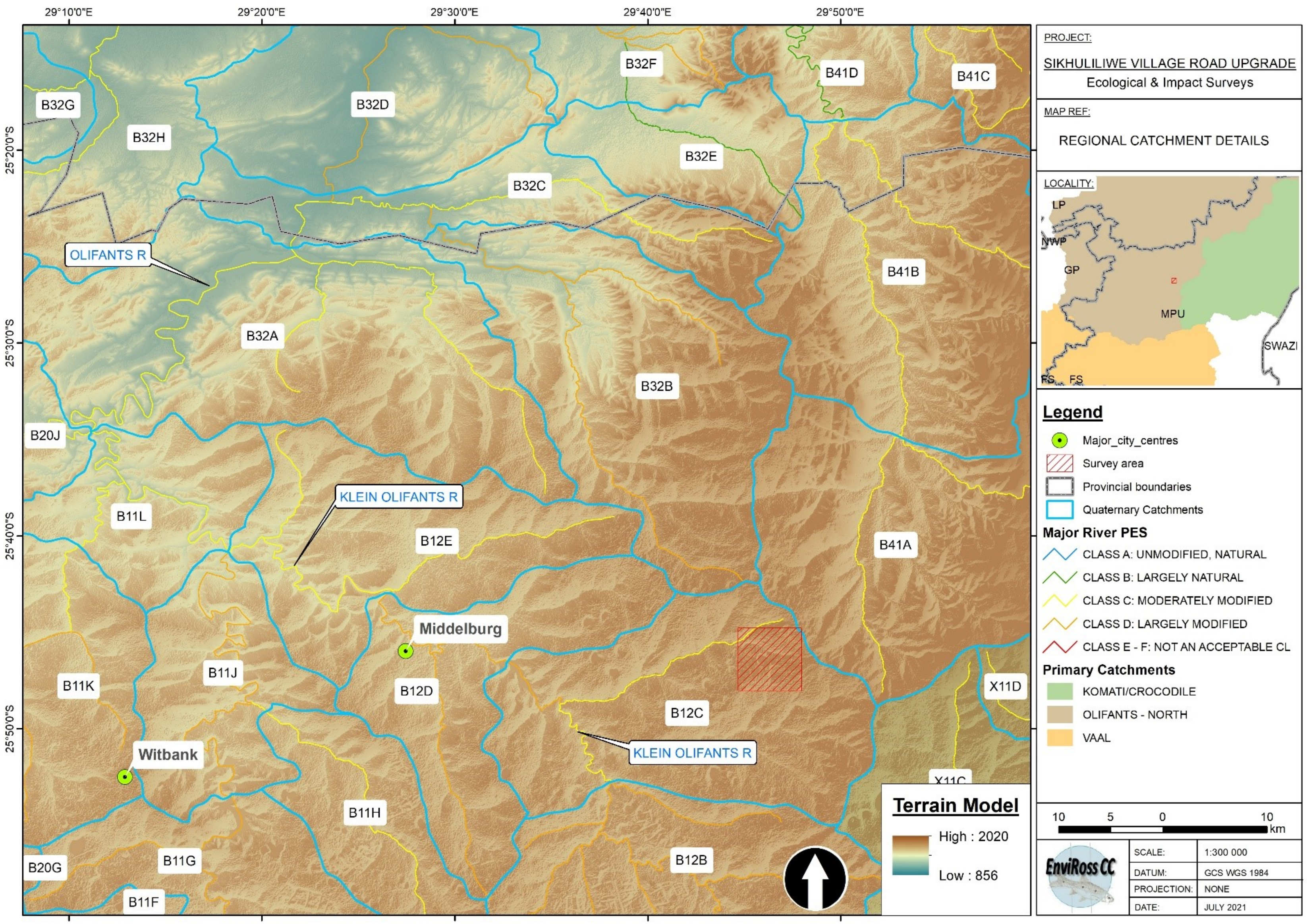

Figure 5: Regional catchment details, showing the major rivers and their relative PES categories within the region.

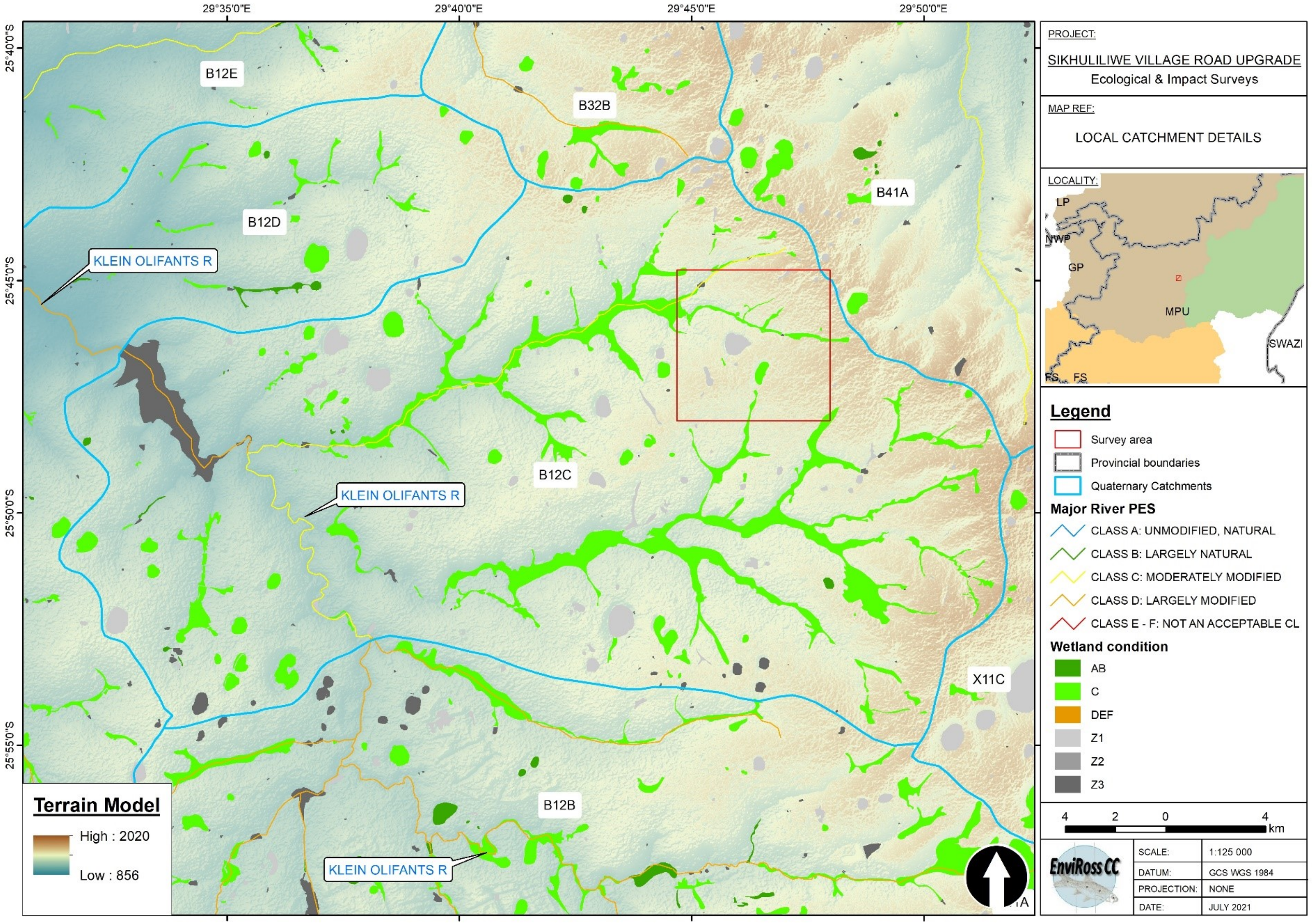

Figure 6: Local catchment details, showing the major rivers and wetland units.

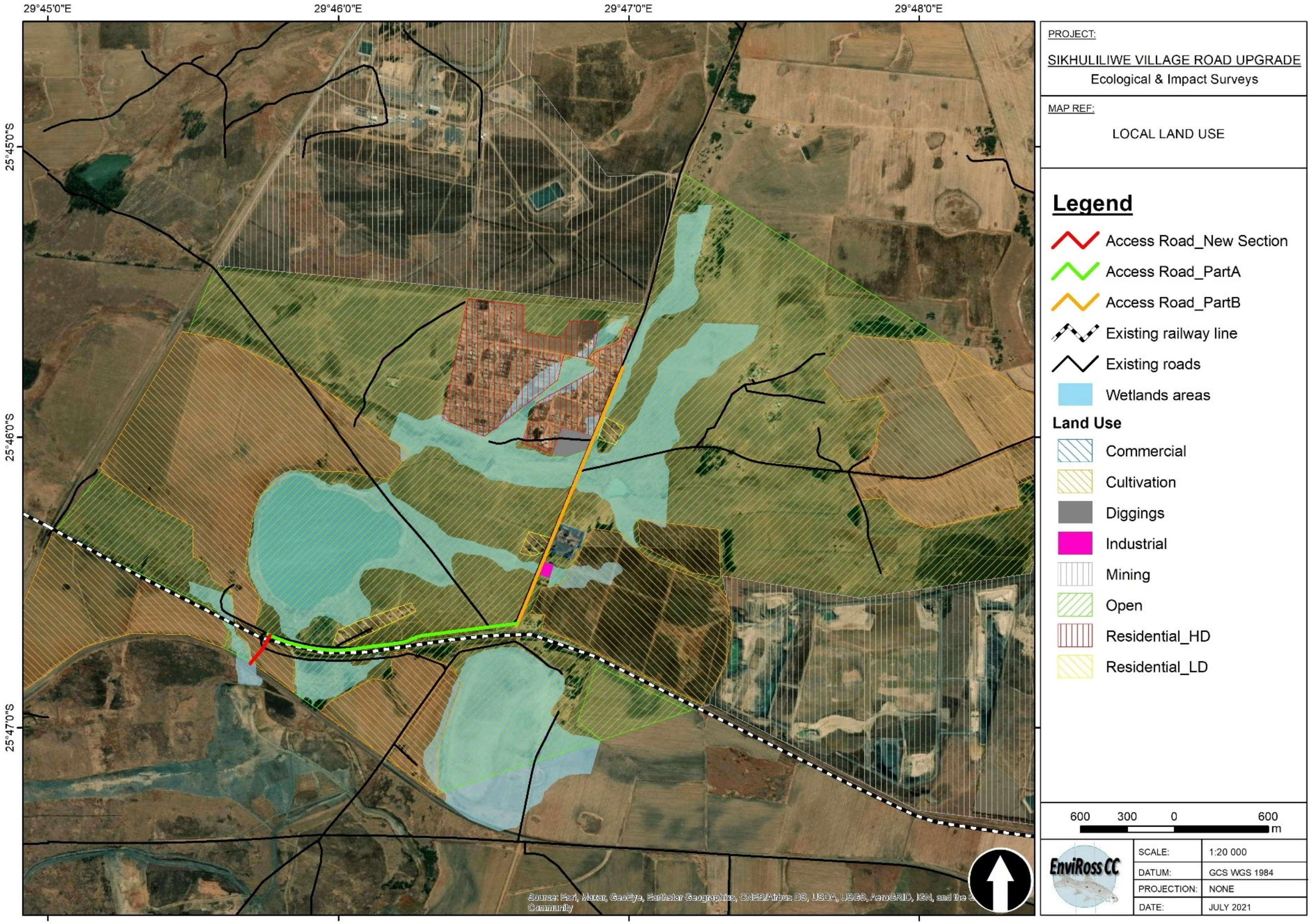

Figure 7: Local land use details, and how the land uses associate with the road alignment route and wetland areas within the project area.

 A section of the road to be rehabilitated.	 Typical characteristics of the open areas, which can be classified as improved grasslands (ie grassland areas that are improved to increase grazing value).
 Formal cultivation is a prominent driver of ecological change within the project area. This is the area where the new road section is to be constructed.	 An existing gravel road that runs parallel to the existing railway, which is used largely as a service road as well as an access for the agricultural sector.
 Excavated trenches are commonplace within the project area that have been historically established to control surface water runoff patterns and to prematurely drain wetland areas.	 Earth berms are commonplace within the project area that have been historically established to increase the cultivation potential of the agricultural sector.

Existing bridge/culverts. This allows surface water drainage beneath the existing railway.

Another trench that was established to manipulate surface water drainage, which has prematurely drained the wetland units within many areas. Land use and the resultant alteration of the hydrological features of the wetland units are regarded as a dominant driver of ecological change.

An impoundment captures surface water runoff before it enters the large depression wetland unit.

Another section of the roadway that is to be rehabilitated.

Part of the road section to be rehabilitated. The village can be seen in the distance on the left side of the road.

Areas along the roadway to be rehabilitated that associate with residential buildings where exotic trees have been purposefully cultivated.

 The main wetland watercourse within the survey area that runs from east to west.	 The bridge design of the main watercourse, showing the series of side-by-side culvert pipes.
 Grazing pressure as a driver of ecological change within the wetland areas becomes more prominent with proximity to the village area.	 An area to the south of the village where excavations resulting from sand winning and/or historical borrow pits that has resulted in transformation of wetland zones.
 Another view of the excavated area showing the level of landscaping.	 A section of the road that was constructed within wetland habitat that has completely altered the functionality of the wetland area. Wetland seepage still occurs within some areas to drain within the road reserve.

	
Wetland seepage zones occur along the eastern side of the existing road, but ecological function within this section of wetland has been lost.	A view of the road section looking to the south. Vegetated wetland zones can be seen on the eastern side (left) and seep zones within the road drain can be seen in the distance.

Figure 8: Various views of the project area.

3.4. Delineation of Wetland Units

It is important to note that not all the four wetland indicators will necessarily be present for all wetland units. Disturbance factors and landscaping often lead to the vegetation indicators being largely transformed and unreliable. Landscaping also often diverts surface water flow that often dries certain areas of the wetlands, leading to the loss of the soil wetness indicators. Landscaping may also lead to alteration of the soil profiles. This is particularly true for the project area that has an association with a railway line that required the establishment of a substantial foundation, which acts as a major barrier to the free drainage of surface waters, the established road as well as various impoundment structures – all of which directs surface water drainage through various culverts and drains. The combination of all four of the unit indicators should therefore be taken into consideration, as well as a certain degree of "intuitive rationalisation" gained through experience, when assessing the existence and interaction of wetland zones. Soil auguring and digging of sample pits to gain an understanding of the soil processes and wetland forms and functions are utilised as reference points, and then analysis of aerial imagery is used in many cases when analysing wetland drainage and flow patterns, especially for projects that span over a relatively large area.

3.4.1. Terrain Unit Indicator

The TUI (taken from topographical maps, GIS data and visual observations at the site) indicated that the terrain is topographically conducive to supporting wetlands. The natural terrain unit indicator is influenced by historical development and any other activities that alter the natural topographical features of the site – the degree of which is dictated by the type of development. Roadways and railways typically alter topographical profiles and therefore the surface water ecosystem patterns. The wetland unit that falls under Zone 3 at the southern end of the new road section is impacted by an existing road and railway crossing, which has altered the hydrological characteristics of the unit and therefore the TUI is obscured within this area. The remaining wetland features associated with the project area are supported by the TUI as most have an association with valley bottoms and depressions. The northern section of the road runs parallel to a wetland unit, which has altered the topographical features though and therefore the TUI is also obscured within this section and was rather utilised as a reiterative or secondary consideration.

3.4.2. Soil Form Indicator

Soil form indicators pertaining to ferrolytic processes within the soil profiles as well as leached soils were noted within the wetland zones. The established wetland units showed prominent soil form indicators and therefore the SFI was used as one of the primary indicators when delineating the wetland zones within these areas. Figure 9 presents views of the SFI indicators shown in profile within various inspection holes that were dug. The rust-red colours that indicate ferrolytic processes within the soils can be seen. This is a typical indication of seasonally inundated soil profiles.

 Inspection holes were dug periodically throughout the project area to confirm wetland conditions though visual observations of SFI and SWI.	 Inspection holes were dug periodically throughout the project area to confirm wetland conditions though visual observations of SFI and SWI.
 Mottling (red nodules) observed in seasonal zone soils because of ferrolysis.	 Laterite at the surface was commonly observed along the main wetland area. Ferrolytic processes within soils due to seasonal inundation often leads to conglomeration and cementation of iron nodules that often migrate toward the surface.

A seasonal wetland soil profile, showing the iron mottling (seen as the rust-red dots).

Soil profiles in situ allow for the observation of mottling.

A ped (sand clod) showing further signs of mottling.

A vertical profile of soils within a transformed wetland area. This would have been an historical seasonal zone. Mottling is visible within the upper layers. The upper layer is also bleached (gleyed) as the iron pigment leaches. Desiccation of the soils due to channelling of the water within the wetland has led to soil destabilisation.

	
A closeup view of the mottling within the soil profile.	Soil profile showing the upper organic layer.

Figure 9: Results of soil profile inspections within the wetland units of the survey area. Soil form indicators as well as soil wetness indicators were clearly present in association with the depression-type wetland units.

3.4.3. Soil Wetness Indicator

The soil wetness indicator was also utilised to delineate the wetland boundaries (also indicated in Figure 9). This feature was mostly confined to well-established wetland units and was not strongly represented within those wetland areas associated with temporary zones.

3.4.4. Vegetation Indicator

Wetlands tend to be transitional in nature and therefore a gradual transition of soils, inundation and vegetation structures can be observed from the terrestrial areas, temporary, seasonal and into the permanent zones of a units. The ability to identify and differentiate wetland floral species as being obligate wetland species, facultative wetland species, facultative species and facultative dryland species is important in discerning the occurrence of wetland conditions.

Wetland-dependent (hydrophytic) vegetation has a floral species community structure that is dominated by species specifically adapted to inhabiting soils of varying degrees of waterlogging, and which can flourish in oxygen-poor (hypoxic) soils. Various species are adapted to survive under varying periods of prolonged water saturated soils and therefore form distinct communities. This is largely true for undisturbed floral community structures associated with wetlands. The outer limits of the various wetland zones can therefore very often be determined by the changes in floral community structures. This unit indicator was found to be useful in indicating the outer boundaries of the wetlands, but, due to the generally poorly developed status of the wetlands in some areas, it was not utilised as a reliable standalone indicator in some cases.

Figure 10: Vegetation zoning was strongly supported as an indicator of wetland conditions in some areas. A permanent zone is indicated by *Typha capensis* (left). A seasonal zone is indicated by *Imperata cylindrica* (right)

In poorly developed (temporary) wetland units, it was rather the growth form and vigour that was utilised for zonation purposes rather than the identification of the presence of obligate wetland species. In such cases, other indicators were also used to reiterate the extent of the wetland zoning. The dominant floral species that were considered useful in delineating wetland zonation are presented in Table 6.

Table 6: The dominant floral species noted within the wetland zones that were utilised for delineation purposes.

Species	Common name	Zonation indicator
Agrostis lachnantha	Bent grass	Seasonal zone
Eragrostis plana	South African lovegrass	Temporary zone
Panicum coloratum	White buffalo grass	Seasonal zone
Pennisetum thunbergii	Thunberg's pennisetum	Seasonal zone
Andropogon appendiculatus	Vlei bluestem	Seasonal zone
Arudinella nepalensis	River grass	Seasonal zone
Typha capensis	Cape bulrush	Permanent zone
Imperata cylindrica	Cotton wool grass	Seasonal zone
Setaria sphacelata	Common bristle grass	Seasonal/temporary zone
Pycreus macranthus	"biessie"	Seasonal zone
Juncus dregeanus	"biessie"	Seasonal zone
Juncus rigidus	"biessie"	Seasonal zone

3.5. Delineation Mapping

A handheld GPS (Model: *Garmin Montana 680*) was used to mark the outer edges of the various wetland zones. This information is then used together with aerial imagery overlays to generate digital shapefiles and maps of the various wetland zones.

The proposed development is mainly confined to the rehabilitation of an existing road and therefore is not going to significantly impact on the wetland units that are not directly associated with the road alignment. The surrounding wetland units were all delineated and designated conservation buffer zones extending 30 m from the outer limits of the units. These are indicated in Figure 11, with a more detailed view of the area associated with the new road section presented in Figure 12. The applicable digital shapefiles accompany this report.

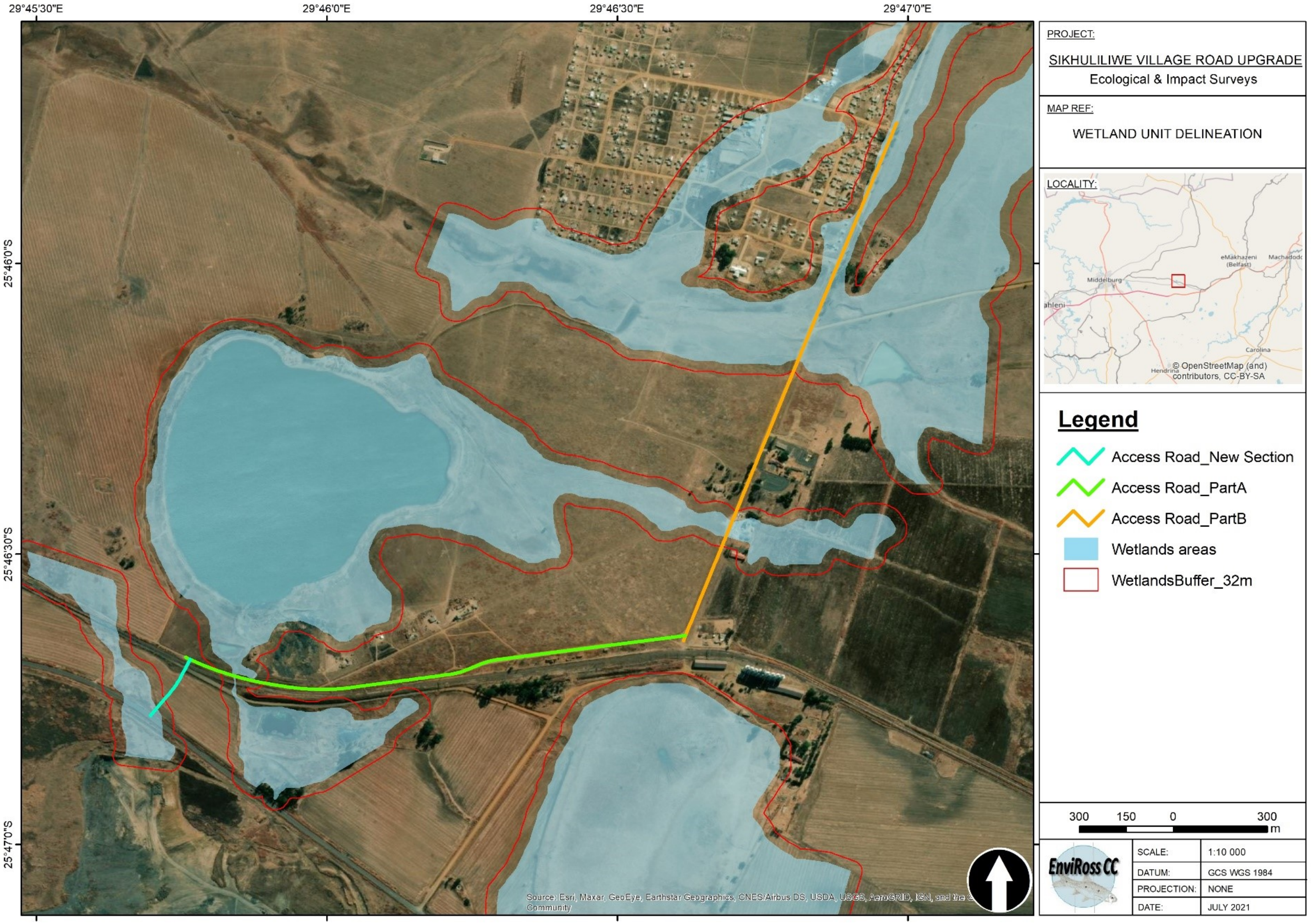

Figure 11: Delineation of the wetland units and presentation of the associated conservation buffer zones pertaining to the project area.

Figure 12: The proposed new road section and how the 30 m road reserve associates with the wetland unit within the area and the 30 m conservation buffer zone.

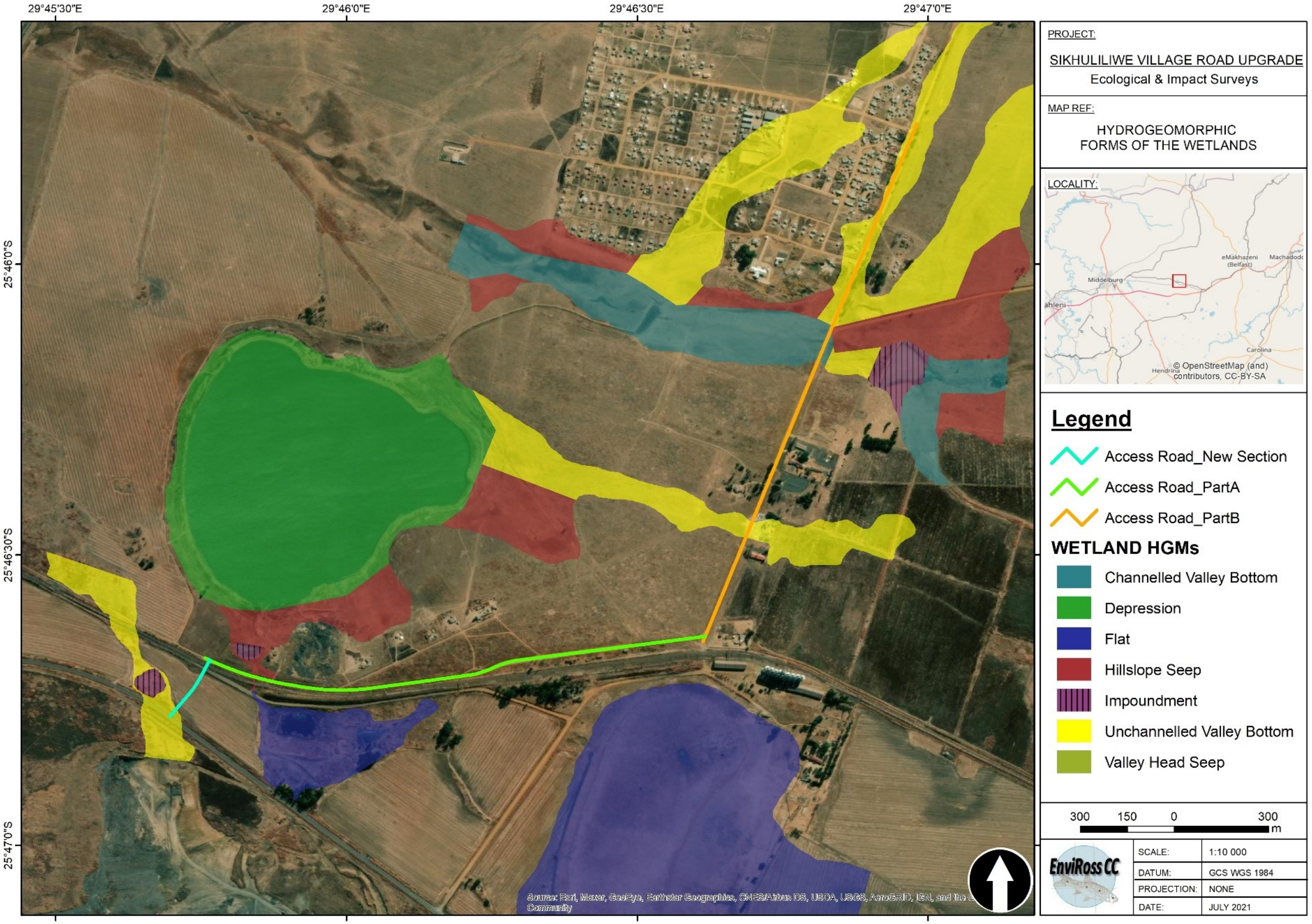

Figure 13: The hydrogeomorphic forms of the wetland units within the scope of the survey area.

3.6. Wetland Hydrogeomorphic Forms Associated with the Project Area

A wetland is defined as land that 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, under normal circumstances, supports or would support vegetation typically adapted to life in saturated soil (NWA). The identification of a wetland therefore requires a combination of factors, including hydrological (water drainage and movement), geomorphological (soil types, characteristics, and inundation) as well as vegetation (identification of hydrophytic species and communities). Figure 13 presents the hydrogeomorphic classification of the wetland units associated with the project area.

The wetland units associated with the project area are dominated by valley-bottom interconnected linear systems that tend to feed toward a common watercourse. There is a large depression-type wetland unit within the project area but occurs some distance from the road alignment. There is a valley-bottom unit that is also associated with hillslope seepage zones that feed into this depression from the east, which has an association with the road alignment. The northern sections of the road alignment have an interaction with further valley-bottom wetland units, but the historical development of the road as well as the establishment of the village residential area has transformed these branches of the units. These areas are therefore rather representative of historical wetland conditions. An interpretation of the wetland units within the project area that defines areas that offer wetland functionality and those that define areas that have lost functionality of the wetland units due to transformations induced by the land use. The wetland mapping is presented that indicates those areas that have lost function in Figure 16.

3.7. Assessing the Present Ecological State (PES) of the wetland habitat units

The Wetland Index of Habitat Integrity (Wetland-IHI) (DWAF, 2007) is a tool that was utilised to determine the PES of the various wetland units identified throughout the project area.

3.7.1. Wetland-IHI

The Wetland-IHI was applied to those wetland units that could be directly impacted by the proposed road rehabilitation project development. These scores are presented in Table 7. Due to the largely homogenous land use throughout the catchment area and the similar pressures and drivers of ecological change experienced by the wetland units, there is little variation in scores and ratings within the various zones identified and therefore splitting the Wetland-IHI for every single unit is not deemed necessary. The project area has therefore been divided into zones that display similar characteristics in terms of pressures and drivers of ecological change, which then divides the project area into three main wetland complexes. This zoning and the summary of the WETLAND-IHI results are presented in Figure 14. The overall ecological integrity of the wetlands within the project area could be regarded as falling within a C (moderately modified) category.

Table 7: Results from the WETLAND-IHI for the wetlands associated with the proposed development area.

Site	Vegetation	Hydrology	Geomorphology	Water quality	Overall PES
Zone 1	71.6%	63.5%	58.0%	73.3%	67.0% (C)
Zone 2	73.8%	58.5%	59.2%	71.3%	66.5% (C)
Zone 3	58.0%	54.9%	59.2%	71.3%	58.5% (C/D)

The wetland units falling within Zone 1 suffer the effects of the establishment of infrastructure within valley-bottom wetland units that feed into the main watercourse. The catchment area suffers transformation due to cultivation, mining, impoundments along the main watercourse, low-level bridges, and culvert crossing points. Ecological functionality has largely been lost from wetland units associated with infrastructure development, sand winning, dumping of building rubble and domestic refuse, and grazing of livestock. The main watercourse is a valley-bottom wetland unit that runs from east to west, crossing beneath the road alignment through an established formal bridge that includes a series of five side by side culverts. This section of the wetland unit is regarded as a permanent feature. There is an impoundment located upstream from bridge crossing point that would influence the geomorphological functioning of the unit. Livestock grazing within the generally unchannelled valley-bottom section of the watercourse at the eastern side of the road crossing is subject to livestock grazing and trampling. The watercourse is constricted as it passes through the culverts, which then creates erosive forces at the downstream side, resulting in a defined channel. Sediment runoff from the roadway tends to deposit within this area. These associated pressures and drivers of ecological change, as imposed by the land use within that zone, are reflected within the ratings of the various themes taken into consideration during the Wetland-IHI ratings process.

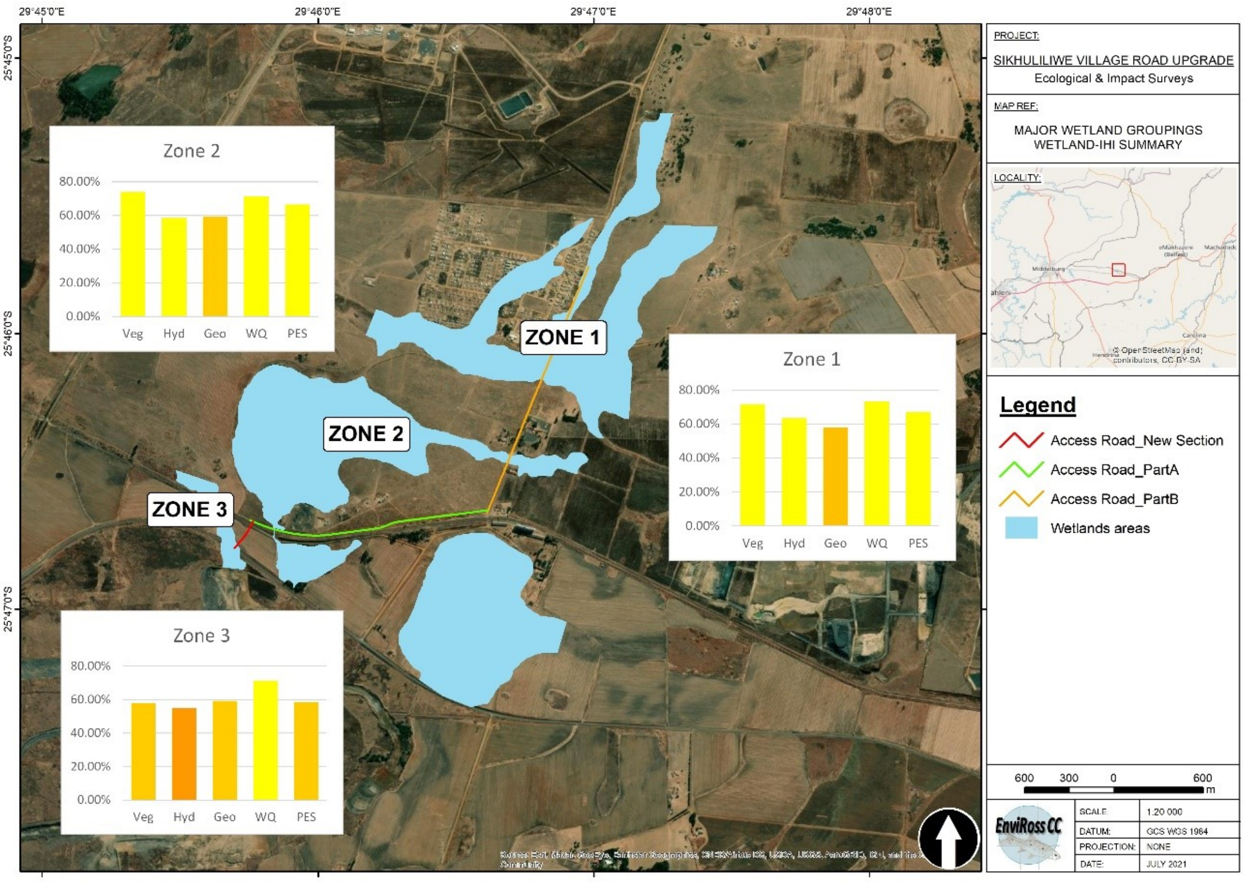

Figure 14: The wetland unit zoning and summary of the WETLAND-IHI results.

Similarly, the wetland units within Zone 2 are also subject to drivers of ecological change imposed by the surrounding land use. A poorly developed valley-bottom wetland unit that originates to the east of the existing roadway feeds into the large depression wetland unit. The wetland complex located to the east of the existing road has a catchment area transformed by cultivation and a network of trenches that are assumed to have been established to increase the workability of the wetland soils within that area. This area also includes mining activities. Both factors would have an impact to the water quality feeding into the depression wetland but tends to only link to this unit following periods of exceptional rainfall. It is assumed that the mining zones, cultivated soils and the trench network have a high attenuation capacity, which then has an impact on the hydrological functioning of this unit. The depression wetland has an inward draining catchment area but is also fed through a wetland unit originating to the south of the existing road and railway. A wetland flat occurs in this area that is surrounded by cultivated lands. Surface water drains northwards through road drains and culverts to spill into a landscaped area lying to the south of the depression wetland. An impoundment has been established within this area, which may have originated as a borrow pit for construction materials. Much of the runoff water originating from the south is captured within this area and seemingly little ultimately reaches the depression wetland unit.

Zone 3 includes an historical valley bottom wetland system that originates to the south of the R104 roadway. Similarly, mining and cultivation within that catchment area have transformed the hydrological functioning of the wetland unit. An impoundment structure lying to the immediate north of the R104 has allowed for the development of permanent wetland features. The impoundment has been historically intentionally breached to enhance the drainage of surface waters. An excavated trench sees the wetland unit draining prematurely from that point to increase the cultivation potential of the surrounding lands. Although this unit is technically connected to the depression wetland unit included in Zone 2, the connectivity through surface water drainage will only occur following exceptionally high rainfall periods. This wetland unit was shown to have suffered the greatest level of transformation, with the hydrological and geomorphological components being the largest drivers of ecological change.

The historical extent of the wetland units would have been relatively larger than what is observed during the present day. Historical infrastructure development has altered the hydrological features of the larger units, which has ultimately led to fragmentation and isolation of the units in many areas.

3.7.2. Ecological Importance & Sensitivity (EIS)

The EIS was undertaken according to the methods outlined in WET-EcoServices (Kotze *et al*, 2007). The EIS protocol tends to rate the services to the various sectors provided by the wetland units and utilises these results to designate an importance rating. The use of the wetland units tends to be similar throughout the survey area and therefore a generalised analysis was undertaken. The summary rating for the EIS is presented in Table 8.

Table 8: The results of the WET-Ecoservices index to determine the EIS of the wetland units.

Wetland functional features	Score (out of a possible 4)
Flood attenuation: The greater wetland complex feeds towards a common watercourse, but depressions, impoundments and altered hydrological features, together with relatively wide channel features do provide for a flood attenuation function.	2.1
Streamflow regulation: Groundwater interaction provides a relatively stable source of baseflow. Altered hydrological features through land use has isolated wetland units, leading to loss of baseflow to these sections.	2.0
Sediment trapping: Linear wetland units do trap sediments if their overall ecological integrity has been retained to a functional level. Valley-bottom wetland units with a structured vegetation component provide a valuable sediment trapping function. Surrounding cultivation destabilises soils, leaving them vulnerable to dispersal. The resulting sediments get transported toward the nearby watercourses.	2.4
Phosphate trapping: Wetland vegetation can trap and process phosphates to remove it from the environment. This is particularly relevant to valley-bottom units. Agrochemicals would be considered a main source of phosphates within the system.	2.7
Nitrate removal: Wetland vegetation can trap and process nitrates to remove it from the environment. This is particularly relevant to valley-bottom units. Agrochemicals, together with sewerage contamination from the adjacent village areas, would be considered a main source of nitrates within the system.	2.7
Toxicant removal: Wetland vegetation can trap and process toxicants to remove it from the environment. This is particularly relevant to valley-bottom units. Agrochemicals, mining, and roadway runoff would be considered a main source of toxicants within the system.	2.7
Erosion control: Isolated wetland units have limited significance in terms of erosion control, but well-vegetated valley-bottom units provide for erosion control. Although some valley-bottom areas have lost much of their vegetation cover, the main watercourse has retained good vegetation cover and therefore can provide a relatively high level of erosion control.	2.4
Carbon storage: Wetland units store a relatively high level of carbon, and this is relatively true for the wetland units associated with the project area.	2.0
Maintenance of biodiversity: Wetlands provide habitat for a high level of biodiversity. This is true for the wetland units within the project area that are surrounded by active cultivation.	2.1
Water supply for human use: The wetlands within the project area do not supply resources that support local communities and therefore this is of limited significance.	1.2
Natural resources: The wetlands within the project area could supply resources that support local communities, but this tends to be of limited significance.	2.0

Wetland functional features	Score (out of a possible 4)
Cultivated foods: The wetlands within the project area could supply resources that support local communities, but this tends to be of limited significance.	2.0
Cultural significance: The wetlands within the project area do not hold cultural value to local communities and therefore this is of limited significance.	1.0
Tourism and recreation: The open expanse of water provided by the depression wetland could support the presence of bird species such as Greater flamingo (*Phoenicopterus roseus*) and other wader species. Wetland areas with retained vegetation structures could also support other bird species such as African grass-owl (*Tyto capensis*). These features could be attractive to bird watchers, etc.	1.6
Education and research: This is of limited value as the wetland units associated with the project area do not form part of significant wetland types and therefore tend not to be the focus of any research or education.	0.8
Threats: The wetland units within the project area are surrounded by formal cultivation, semi-formal residential, and the mining sector. These are high-impact land uses that pose a threat to the ongoing ecological functioning of the wetland units.	2.0
Opportunities: The wetlands are mostly located within privately-owned land, which provides opportunity for private landowners to enhance the value and function of the wetland units.	2.0
Runoff intensity from the wetland unit's catchment: This is relatively low as the catchment area is generally topographically flat.	1.8
Alteration of sediment regime: Active cultivation within the project area tends to mobilise sediments.	3.0
Alteration of nutrient/toxicant regime: Active cultivation, mining and wastewater processing within the project area provides for nutrient enrichment and a source of toxicants to the wetlands.	3.0
Rating	2.1 (C)

These results indicate that the wetland systems are currently supplying a *Moderately low (C)* ecological service. This should, however, not be misinterpreted. The Ecoservices model places a large emphasis on the use of the wetland units to sustain surrounding residents in terms of resource harvesting, providing for agriculture, etc and therefore tends to be more applicable to the rural sector. This is indicated in the results that show an overall low direct dependency of people on the wetland units. It does, however, show high ratings of wetland functional components, such as maintenance of biodiversity, and water quality and quantity management. The overall importance of the wetland units should therefore be interpreted with this factor taken into consideration.

The various input features and how they scored for the wetland unit are presented in Figure 15. This shows which features (services) that are performed by the wetlands are currently scoring the highest, and which ones are ranked lower. The ecological services supplied by the wetland are rated as the relative highest. The wetland functionality elements associated with water quality management tend to rank the highest. Features of lesser significance are shown to be overall biodiversity maintenance. Low-scoring elements include the dependency of the rural sector on the resources offered by the wetland units and cultural significance of the wetland units. It should be noted, however, that the overall ecological functionality of a wetland is dependent on a balanced interplay between the various features and once feature tends to be dependent on another.

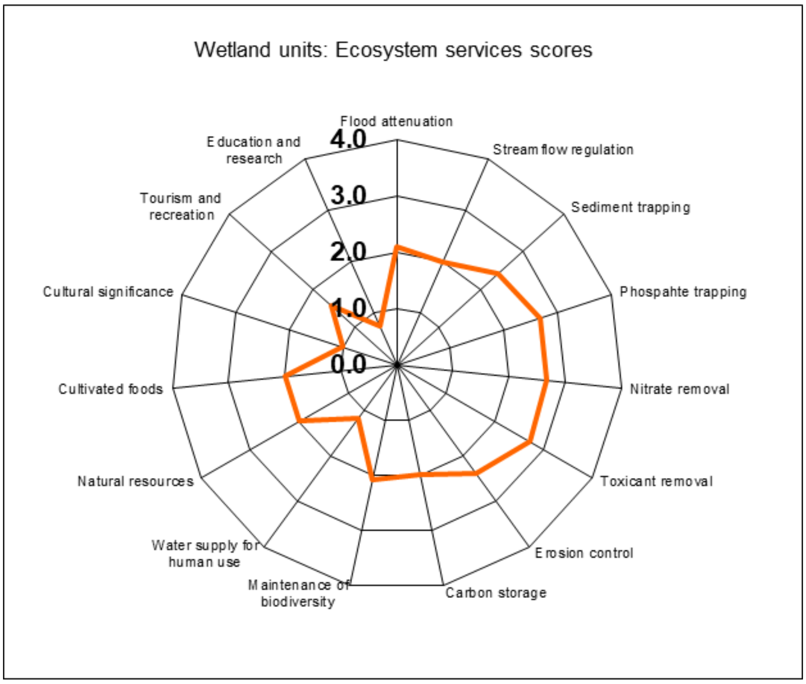

Figure 15: Scoring of the various aspects of ecological services provided for by the wetland habitat units present within the project area.

3.8. DHSWS Risk Assessment Matrix

The wetland units associated to the project area have all been delineated and the appropriate conservation buffer zones have been designated to the units (Figure 11). These data were used to determine the sections of the roadway that would fall within the wetland zones, those sections that fall outside of the wetland zones but within the conservation buffer zones, and those that fall within the terrestrial areas but still within the 500 m regulatory zones applicable to the wetland units. It also highlights the localities of the culvert upgrade points in relation to the wetland units. The risk assessment matrix (RAM) is aimed at activities that are to take place within these areas. Linear developments, by their very nature, must intersect with linear ecological units such as connected wetlands in most cases. The road alignment falls largely within an existing road, with only a small section being newly established. Total avoidance of all surface water ecosystems is unpractical as the road alignment crosses linear watercourses. The overall risk to the wetland units is considered low due to the limited interaction between the road development area of impact and the wetland units. Another consideration is that those points of interaction already have established culverts and road surfaces and therefore the rehabilitation of the road within these areas will ultimately pose an insignificant impact to the wetland units. There will, however, be construction activities within the wetland areas, which would present a certain level of risk to the associated wetland unit.

The level of risk to a wetland unit posed by a development is largely determined by the proximity of the development to the wetland. Developments that are to take place within wetland units pose an obvious risk and therefore specific mitigation measures would apply. The significance of the risk is, however, also determined by the ecological state of the wetland unit and whether the impact feature associated with permanent, seasonal, or temporary (peripheral) zones of the unit.

The calculations and results of the RAM indicate that the overall significance of the impacts and risks to the wetland unit increase within proximity to the wetland unit, as could be expected. The sections of the road that fall within the wetland unit and the culvert sites associated with the wetland zones have been calculated to present a moderate risk, with an average significance rating of 70. The construction of the sections of road within wetland sections can be successfully mitigated and fall within wetland units that suffer a level of degradation. The nature of the proposed development, the relatively low ecological state of the wetland unit and the readily achievable mitigation measures that have been proposed justify that the moderate rating could be reclassified as a Low rating.

The calculations and results of the RAM for road sections that fall within the conservation buffer zones indicate an average significance rating of between 32.5 and 40, which calculates to a low significance. This is, again, due to the impacts to the areas being readily mitigated. Similarly, the remaining sections of the road that fall within the terrestrial zones will have an insignificant impact, with the significant ratings calculating to 35 (Low significance). The results of the RAM are provided as a spreadsheet that accompanies this report.

Mitigation measures that were outlined within the RAM are all achievable with relatively little effort and cost to the project as most of the activities will be associated with the existing road and not create any new infrastructure.

4. SENSITIVITY MAPPING

Sensitivity mapping of the surface water ecosystem habitat units coincides with the wetland areas that have been zoned as having retained ecological function. These are set apart from those areas that have lost general function due to land use features. These zones are indicated in Figure 16.

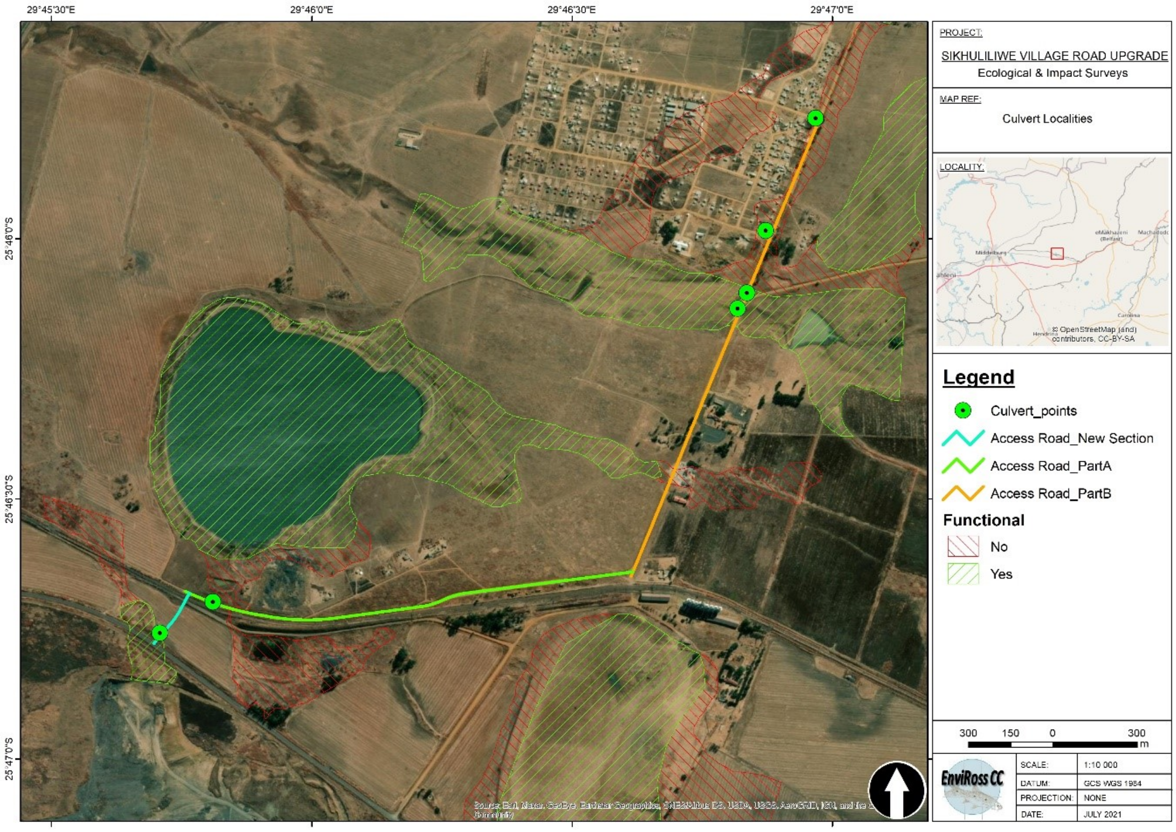

Figure 16: The localities of the proposed culvert upgrade points and how these points are associated with the wetland units within the project area. An indication of the wetland zones where ecological function has largely been lost due to transformations induced by the land use has been provided to aid in the ratings of the risk assessment matrix and impact significance ratings.

5. SIGNIFICANCE RATINGS OF PERCEIVED ENVIRONMENTAL IMPACTS

A detailed account of the impact analysis and the associated mitigation measures is presented in Table 9. This section provides for an elaboration of ecological impacts and recommended mitigation measures that are indicated within the impact analysis.

Many of the impacts and the associated mitigation measures are applicable to terrestrial habitat areas. These have been included here as these all contribute to catchment management, which ultimately also impacts on the surface water ecosystems within the project area.

5.1. Outline of the Construction Processes

The proposed development activities are aimed primarily at the rehabilitation of an existing roadway and the establishment of a small new connecting road. The rehabilitation procedures of the existing road include the widening of certain sections as well as refurbishment and upgrading of existing culvert drains where necessary. The existing roadway tends to already have suitable foundation materials and therefore minimal foundation materials will have to be imported to the site, excepting for the smaller connection road at the south of the alignment. No deep excavations will be needed. The largest impacting features would be associated with the culvert sites, where excavations would be required. These will coincide with existing culvert points, so natural habitat features will not be impacted excepting for some fringe effects at the sites. These can be readily mitigated to reduce the significance of the impacts.

Road reserve areas that are designed to drain surface water will carry silts and sediments toward the watercourses. This is true for all sloped road surfaces and therefore construction activities that take place within terrestrial habitat areas may induce impacting features that manifest within the nearby wetlands and watercourses.

5.2. Impact Analysis

Table 9 presents the significance ratings of the potential ecological impacts for the construction phase and Table 10 presents those associated with the operational phase of the project. The ratings are calculated and presented for the scenarios for both before and after the implementation of mitigation measures. This was done to show how the degree of impacts can be reduced by careful planning and the following of relatively simple mitigation measures. A rating for cumulative impacts is also provided. The full methodology for the scoring criteria is presented in Appendix A.

5.2.1. Construction Phase

Table 9: The ecological impact analysis and significance ratings for the impacts associated with the road rehabilitation project development.

ACTIVITY/IMPACT TYPE	**Destruction of sensitive habitat within areas designated as high ecological sensitivity.**			
PHASE	CONSTRUCTION			
IMPACT TYPE	DIRECT IMPACT Wetland units that have retained natural vegetation are considered sensitive and ecologically important habitat features. Destruction of ecologically sensitive habitat units will lead to undue destruction of natural biodiversity, impact on water quality and impact on the resource.			
RATINGS	**WITHOUT MITIGATION**		**WITH MITIGATION**	
	Extent	1 (local)	Extent	1 (local)
	Intensity	1 (low)	Intensity	1 (low)
	Duration	3 (long term)	Duration	1 (short term)
CONSEQUENCE RATING	5 (LOW)		3 (VERY LOW)	
PROBABILITY	Possible (40-70% chance)		Improbable (<40% chance)	
CUMULATIVE	HIGH		HIGH	
OVERALL SIGNIFICANCE	VERY LOW		INSIGNIFICANT	
STATUS OF IMPACT	NEGATIVE		NEGATIVE	
MITIGATION MEASURES	The ecologically sensitive features have been delineated and mapped. Conservation buffer zones have also been designated to these areas. Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services).			
ACTIVITY/IMPACT TYPE	**Destruction of sensitive habitat within areas designated as low to medium ecological sensitivity, including the terrestrial areas.**			
PHASE	CONSTRUCTION			
IMPACT TYPE	DIRECT IMPACT Destruction of natural areas will lead to displacement and destruction of natural biodiversity, and overall ecological degradation.			
RATINGS	**WITHOUT MITIGATION**		**WITH MITIGATION**	
	Extent	1 (local)	Extent	1 (local)
	Intensity	1 (low)	Intensity	1 (low)
	Duration	3 (long term)	Duration	1 (short term)
CONSEQUENCE RATING	5 (LOW)		3 (VERY LOW)	
PROBABILITY	Possible (40-70% chance)		Improbable (<40% chance)	
CUMULATIVE	HIGH		HIGH	
OVERALL SIGNIFICANCE	VERY LOW		INSIGNIFICANT	
STATUS OF IMPACT	NEGATIVE		NEGATIVE	
MITIGATION MEASURES	Indiscriminate habitat destruction to be avoided and the proposed development should remain as localised as possible (including support areas and services). The ecological integrity of the wetland unit associated with the proposed new road section would benefit from a minor shift in the road alignment to accommodate the feature and associated buffer zones.			

<table>
<tr><td>ACTIVITY/IMPACT TYPE</td><td colspan="4">Soil erosion</td></tr>
<tr><td>PHASE</td><td colspan="4">CONSTRUCTION</td></tr>
<tr><td>IMPACT TYPE</td><td colspan="4">DIRECT IMPACT
Soil erosion will take affect any unprotected soils that have suffered disturbances, including unprotected stockpiles of stored topsoil.
Drainage features established within the road reserve areas will also induce erosion impacts.
Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of sediment into the general environment and surrounding watercourses.</td></tr>
<tr><td rowspan="4">RATINGS</td><td colspan="2">WITHOUT MITIGATION</td><td colspan="2">WITH MITIGATION</td></tr>
<tr><td>Extent</td><td>1 (local)</td><td>Extent</td><td>1 (local)</td></tr>
<tr><td>Intensity</td><td>1 (low)</td><td>Intensity</td><td>1 (low)</td></tr>
<tr><td>Duration</td><td>3 (long term)</td><td>Duration</td><td>1 (short term)</td></tr>
<tr><td>CONSEQUENCE RATING</td><td colspan="2">5 (LOW)</td><td colspan="2">3 (VERY LOW)</td></tr>
<tr><td>PROBABILITY</td><td colspan="2">Possible (40-70% chance)</td><td colspan="2">Improbable (<40% chance)</td></tr>
<tr><td>CUMULATIVE</td><td colspan="2">HIGH</td><td colspan="2">HIGH</td></tr>
<tr><td>OVERALL SIGNIFICANCE</td><td colspan="2">VERY LOW</td><td colspan="2">INSIGNIFICANT</td></tr>
<tr><td>STATUS OF IMPACT</td><td colspan="2">NEGATIVE</td><td colspan="2">NEGATIVE</td></tr>
<tr><td>MITIGATION MEASURES</td><td colspan="4">Erosion must be strictly controlled through the utilization of silt traps, silt fencing, Gabions, etc. This is especially pertinent within areas of steeper gradients.
Topsoil stockpiles should be protected from erosion through the utilization of silt traps, silt fencing, Gabions, etc.</td></tr>
<tr><td>ACTIVITY/IMPACT TYPE</td><td colspan="4">Impacts to water quality within surface water ecosystems.</td></tr>
<tr><td>PHASE</td><td colspan="4">CONSTRUCTION</td></tr>
<tr><td>IMPACT TYPE</td><td colspan="4">DIRECT IMPACT
Impacts to water quality include accidental fuel/oil spills from poorly maintained equipment, accidents, or container failure, and poorly managed and/or non- bunded fuelling stations.
Water quality impacts will also occur as a result of unabated soil erosion.</td></tr>
<tr><td rowspan="4">RATINGS</td><td colspan="2">WITHOUT MITIGATION</td><td colspan="2">WITH MITIGATION</td></tr>
<tr><td>Extent</td><td>1 (local)</td><td>Extent</td><td>1 (local)</td></tr>
<tr><td>Intensity</td><td>3 (high)</td><td>Intensity</td><td>1 (low)</td></tr>
<tr><td>Duration</td><td>3 (long term)</td><td>Duration</td><td>1 (short term)</td></tr>
<tr><td>CONSEQUENCE RATING</td><td colspan="2">7 (HIGH)</td><td colspan="2">3 (VERY LOW)</td></tr>
<tr><td>PROBABILITY</td><td colspan="2">Possible (40-70% chance)</td><td colspan="2">Improbable (<40% chance)</td></tr>
<tr><td>CUMULATIVE</td><td colspan="2">HIGH</td><td colspan="2">HIGH</td></tr>
<tr><td>OVERALL SIGNIFICANCE</td><td colspan="2">MEDIUM</td><td colspan="2">INSIGNIFICANT</td></tr>
<tr><td>STATUS OF IMPACT</td><td colspan="2">NEGATIVE</td><td colspan="2">NEGATIVE</td></tr>
<tr><td>MITIGATION MEASURES</td><td colspan="4">No fuel to be stored at or near watercourses or waterbodies;
Equipment to be properly maintained and serviced;
Fuel storage and pump areas to be bunded to avoid accidental leakage;
No refuelling should be done within the riparian zones (exceptions are made for stationery motors i.e. pumps);
Accidental spills must be reported and cleaned immediately. Contaminated soils must be removed and disposed of at a registered disposal site.
Soil erosion must be managed as an ongoing concern throughout the development process.</td></tr>
</table>

5.2.2. Operations Phase

Table 10: The ecological impact analysis and significance ratings for the impacts associated with the road rehabilitation project.

ACTIVITY/IMPACT TYPE	**Soil erosion**			
PHASE	OPERATIONS			
IMPACT TYPE	INDIRECT IMPACT Soil erosion will impact any unprotected soils that have suffered disturbances, including unprotected stockpiles of stored topsoil. Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of sediment into the general environment and surrounding watercourses.			
RATINGS	**BEFORE MITIGATION**		**AFTER MITIGATION**	
	Extent	2 (regional)	Extent	1 (local)
	Intensity	2 (medium)	Intensity	1 (low)
	Duration	3 (long term)	Duration	1 (short term)
CONSEQUENCE RATING	7 (HIGH)		3 (VERY LOW)	
PROBABILITY	Possible (40-70% chance)		Improbable (<40% chance)	
CUMULATIVE	HIGH		HIGH	
OVERALL SIGNIFICANCE	MEDIUM		INSIGNIFICANT	
STATUS OF IMPACT	NEGATIVE		NEGATIVE	
MITIGATION MEASURES	Erosion must be strictly controlled through the utilization of silt traps, silt fencing, Gabions, etc. This is especially pertinent within areas of steeper gradients. Topsoil stockpiles should be protected from erosion through the utilization of silt traps, silt fencing, etc.			

6. PREFERRED ALTERNATIVES

No alignment alternatives were presented for analysis at the time of the survey. As the new road section has been shown to impinge on a wetland unit (as shown in Figure 12), the ecological functionality of the wetland unit would benefit from a slight shift in alignment to accommodate this feature. The alignment as presented does not, however, constitute a fatal flaw as the wetland unit has suffered a considerable loss of function due to historical land use and infrastructure development.

7. CONCLUSIONS AND RECOMMENDATIONS

Following the field survey of the proposed development area, the following salient recommendations can be proposed to aid in the conservation of the overall ecological integrity of the surface water ecosystems within the region:

- Wetland habitat units were noted to be associated with the proposed development. The units were delineated and are presented in Figure 11.
- The development is associated with an existing roadway. Minimal impact significance is expected to occur as the road rehabilitation procedures couple to an existing road.
- The proposed new road section was shown to have an association with a wetland unit (Figure 12). Although not considered a fatal flaw due to the wetland unit having already suffered a major loss of ecological functionality, the overall ecological integrity of the immediate area would benefit from a minor alignment shift within this area to accommodate the wetland unit and its associated buffer zone.
- The impact significance of the potential impacting features showed medium to low overall significance, with many impacts rendered insignificant with the application of the proposed mitigation measures.
- The wetland units were shown to fall within a C/D PES class, with the major pressure and driver of ecological change being the existing infrastructure development, and mining and agricultural activities within the catchment areas.
- Erosion control measures and avoidance of indiscriminate habitat destruction outside of the ultimate construction footprint are regarded as the most pertinent mitigation measures.
- Culvert development sites must be suitably reinstated and landscaped to avoid erosion formation.
- Culverts should be spread over the width of the watercourse so that the surface water flows are not constricted. Designing of culvert placement, numbers and capacities must take into consideration flood flow volumes. Constriction of the watercourse will result in erosion within the channel at the downstream side of the culvert and will also reduce the lateral extent of the associated wetland.
- The overall ecological impact significance of the proposed development activities is expected to be low and therefore no justifiable reasons for opposing the development can be offered.

It should be noted that, to conserve the ecological structures within the region, a holistic habitat conservation approach should be adopted. This includes keeping general habitat destruction and construction footprints to an absolute minimum within the terrestrial habitat as well. Conserving the habitat units will ultimately conserve the species communities that depend on it for survival. This can only be achieved by the efforts of the contractor during the various processes of the construction phase.

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APPENDIX A – METHODOLOGY TO ASSESS THE IDENTIFIED IMPACTS

The EIA impact assessment will focus on the direct and indirect impacts associated with the project. All impacts will be analysed with regard to their extent, intensity, duration, probability and significance. The significance of potential impacts that may result from the proposed project will be determined to assist decision-makers (typically by a designated authority or state agency, but in some instances, the proponent). The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The criteria used to determine impact consequence are presented in the table below:

Rating	Definition of Rating	Score
Extent - the physical extent or spatial scale of the impact.		
Local	Confined to project or study area or part thereof (e.g. the development site and immediate surrounds)	1
Regional	The region (District Municipality or Quaternary catchment)	2
National	Nationally or beyond	3
Intensity - the impact would be destructive or benign.		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
Duration – the timeframe which the impact would occur.		
Short Term	Up to 2 years and reversible	1
Medium Term	2 to 15 years and reversible	2
Long Term	More than 15 years and irreversible	3

The combined score of these three criteria corresponds to a Consequence Rating, as follows:

Combined Score	3-4	5	6	7	8-9
Consequence Rating	Very Low	Low	Medium	High	Very High

Once the consequence was derived, the probability of the impact occurring was considered, using the probability classifications presented in the table below:

Probability – likelihood of the impact occurring	
Improbable	<40% Chance of occurring
Possible	40% - 70% chance of occurring
Probable	<70% - 90% chance of occurring
Definite	>90% chance of occurring

The overall significance of impacts was determined by considering consequence and probability using the rating system prescribed in the table below:

		Probability			
		Improbable	**Possible**	**Probable**	**Definite**
Consequences	**Very Low**	Insignificant	Insignificant	Very low	Very low
	Low	Very low	Very low	Low	Low
	Medium	Low	Low	Medium	Medium
	High	Medium	Medium	High	High
	Very high	High	High	Very High	Very High

Finally, the impacts were also considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the table below:

Status of Impact	
Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a 'benefit')
	– ve (negative – a 'cost')
Confidence of assessment	
The degree of confidence in predictions based on available information, Hatch's judgment and/or specialist knowledge.	Low
	Medium
	High

The impact significance rating should be considered by authorities in their decision-making process based on the implications of ratings ascribed below:

- **Insignificant**: the potential impact is negligible and will not have an influence on the decision regarding the proposed activity/development.
- **Very low**: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity/development.
- **Low**: the potential impact may not have any meaningful influence on the decision regarding the proposed activity/development.
- **Medium**: the potential impact should influence the decision regarding the proposed activity/development.
- **High**: the potential impact will affect the decision regarding the proposed activity/development.
- **Very high**: The proposed activity should only be approved under special circumstances.

Practicable mitigation and optimisation measures are recommended, and impacts are rated in the prescribed way both without and with the assumed effective implementation of mitigation and optimisation measures. Mitigation and optimisation measures are either:

- **Essential**: measures that must be implemented and are non-negotiable; and
- **Best Practice**: recommended to comply with best practice, with adoption dependent on the proponent's risk profile and commitment to adhere to best practice, and which must be shown to have been considered and sound reasons provided by the proponent if not implemented.

The assessment of impacts adheres to the minimum requirements in the EIA Regulations, 2014 and considers applicable official guidelines. The issues raised by I&APs will also be addressed in the assessment of impacts.