Wetland Assessment for the proposed Mantuli Road Phase 2 Project

Nquthu Local Municipality, KwaZulu-Natal

September 2018

CLIENT

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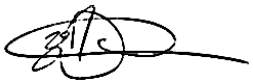
Report Name	**Wetland Assessment for the proposed Mantuli Road Phase 2 Project**	
Reference	**Mantuli Road Phase 2**	
Submitted to	**Isolendalo Environmental Consulting**	
Wetland Fieldwork/ Reporting	**Ndumiso Dlamini (Pr Sci Nat, 116579)**	
Report Reviewer	**Andrew Husted (Pr Sci Nat, 400213/11)**	

EXECUTIVE SUMMARY

The Biodiversity Company was commissioned to conduct a wetland assessment, as part of the environmental authorisation process and Water Use Licence Application (WULA) for the proposed upgrade of the roads associated with the Mantuli Road Phase 2 project and the construction of two causeway structures in the Amahlungulu area within the Nquthu Local Municipality, KwaZulu-Natal.

A site visit was conducted during the week of 17th September 2018, this would constitute a dry season or low flow survey based on the conditions on site.

One (1) wetland area was identified within the 500m assessment area of the proposed project. The identified wetland was classified as a channelled valley bottom wetland (HGM 1). Several drainage lines were identified in the project area.

The wetland was determined to be in a Largely Modified (D) state as a result of the surrounding built up areas, road crossing point and low wetland plant diversity. HGM 1 had an overall intermediate level of service. The wetland showed elevated indirect benefits for flood attenuation, toxicant, nitrate, and phosphate assimilation, sediment trapping and erosion control.

The EIS was calculated to have a Moderate (C) for HGM 1. The EIS was rated as Moderate although the wetland has been impacted upon by alien plant species and the crop fields; however, re-establishment of the wetland area may increase the functioning of the wetland. The wetland condition is recoverable with an effective rehabilitation plan.

The Hydrological Functionality of HGM 1 was determined to have a Moderate (C) levels of importance. The wetland's hydrology ensured that there was a constant water source within the area. Furthermore, the flood attenuation offered by the wetland contributes to the protection of the local area from flooding.

The Direct Human Benefits were calculated to have a have a Marginal (D) level of importance for HGM 1. The direct human benefits include the cultivation of crops within the wetland areas and the removal of toxicants in the water.

Conservative buffer zones of 15m (Post-mitigation) were suggested for the construction and operational phases of the causeway, respectively.

Risk Assessment

The proposed project is for the upgrade of two roads and the construction of two causeway structures. The causeway structures will be constructed within the boundaries of the channelled valley bottom (HGM 1) and a drainage line, which, as a result, will be directly impacted on. As this project entails the upgrade of infrastructure and the construction of new infrastructure, impacts associated with the area are potentially moderate to low, based on the current onsite crossings. Modifications to the wetland habitat is likely to occur during construction. The project will entail the cutting, reshaping, and change in hydrodynamics of the wetland. This has the potential to increase erosion and sedimentation of downstream habitats due to surface runoff during the wet season.

The risk assessment identified several risks as a result of the proposed project. A large number of the risks have been rated as Moderate risks (without mitigation). These Moderate risks are anticipated as the proposed project will be for the upgrade of the road and the

construction of the causeway structures and will lead to the direct physical disturbance of the channelled valley bottom wetland (HGM 1) and the drainage line. Due to the nature of the project the physical disturbance of the wetland area cannot be avoided.

The Moderate risks identified for the construction phase of the project are associated with changes in drainage from the wetland through channelling or compaction. The increase bare/impervious areas will increase the sediment loads carried down slope into wetland areas. The moderate risks associated with the construction phase were re-adjusted to Low ratings with the anticipation that all the prescribed mitigation measures will be implemented.

Moderate risks (pre-mitigation) were also identified for the operational phase of the project. This is largely a result of the longevity of the project and the potential for erosion within the wetland habitat. No aspects are considered to pose a Moderate risk post-mitigation with the implementation of mitigation measures.

It is the opinion of the specialist that the project be favourably considered and allow for the proposed road upgrade and causeway structure construction associated with the Mantuli Road Phase 2 project to proceed, but all prescribed mitigation measures and recommendations must be implemented.

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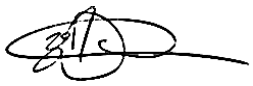
DECLARATION

I, Ndumiso Dlamini declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence and is punishable in terms of Section 24F of the Act.



Ndumiso Dlamini

Wetland Specialist

The Biodiversity Company

27 September 2018

1 Introduction

The Biodiversity Company was commissioned to conduct a wetland assessment, as part of the environmental authorisation process and Water Use Licence Application (WULA) for the proposed upgrade of the roads associated with the Mantuli Road Phase 2 project and the construction of two causeway structures in the Amahlungulu area within the Nquthu Local Municipality, KwaZulu-Natal.

A site visit was conducted during the week of 17th September 2018, this would constitute a dry season or low flow survey based on the conditions on site.

This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP), enabling informed decision making as to the ecological viability of the proposed development and to provide an opinion on the whether any environmental authorisation process or licensing is required for the proposed activities.

1.1 Objectives

The aim of the assessment is to provide information to guide the proposed project with respect to the current state of the associated wetlands in the area of study. This was achieved through the following:

- The delineation and assessment of wetlands within 500m of the project area;
- A risk assessment for the proposed development; and
- The prescription of mitigation measures and recommendations for identified risks.

2 Key Legislative Requirements

2.1 National Water Act (Act No. 36 of 1998)

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (NWA) (Act No. 36 of 1998) allows for the protection of water resources, which includes:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- 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; and

- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The NWA recognises that the entire ecosystem, and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS.

For the purposes of this project, a wetland area is defined according to the NWA (Act No. 36 of 1998): “Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil”.

Wetlands have one or more of the following attributes to meet the NWA wetland definition (DWAF, 2005):

- A high water table that results in the saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil;
- Wetland or hydromorphic soils that display characteristics resulting from prolonged saturation, i.e. mottling or grey soils; and
- The presence of, at least occasionally, hydrophilic plants, i.e. hydrophytes (water loving plants).

2.2 National Environmental Management Act (Act No. 107 of 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in December 2014, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

3 Project Area

The project is for the upgrade of the Mantuli Road and the construction of two causeway structures in Amahlungulu area with the Nquthu Local Municipality, KwaZulu-Natal. The project site is located approximately 12 km east of the Nquthu centre in the KwaZulu-Natal Province (Figure 1). The local area within the proximity of the project site is low density housing and road infrastructure.

The project is located within the W21E Quaternary Catchment within the Pongola - Mtamvuna Water Management Area (WMA 4) (NWA, 2016). It must be noted that the section of the WMA the project is situated within was previously known as the Thukela Water Management Area.

The portion of the WMA that the project lies mainly within the province of Kwazulu-Natal, the catchment is mainly composed of tributaries draining from the Drakensberg. Characterized by mountain streams in the upper reaches. Rainfall is concentrated along the mountains with a mean annual precipitation rate of 600 to 1500mm. Main impacts associated with the system are forestry and agriculture, Newcastle is the main area of industrial activity within the catchment. (StatsSA, 2010).

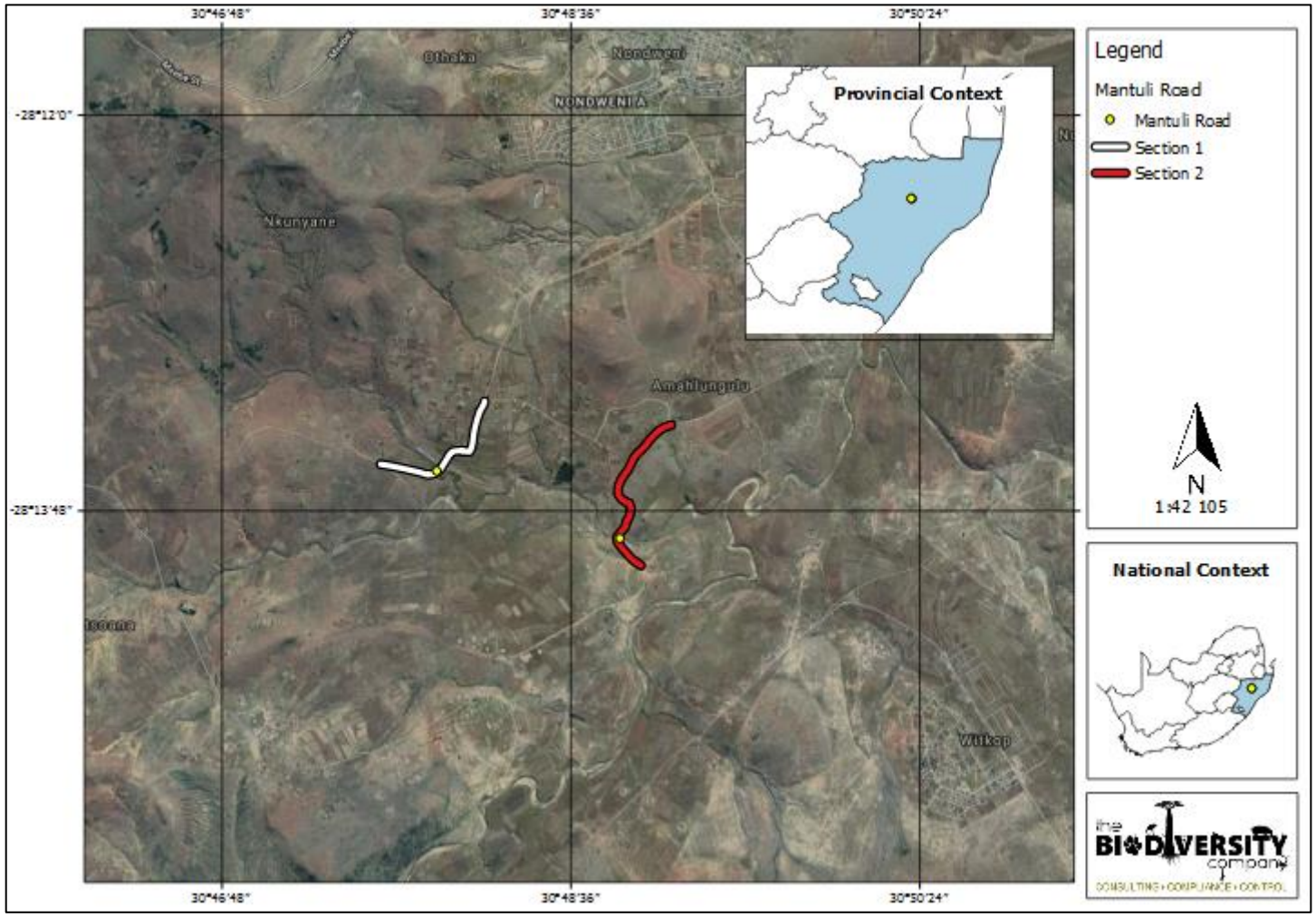


Figure 1: Local layout of the road and causeway upgrade

4 Limitations

The following aspects were considered as limitations;

- The wetland assessment was based on the results of a single survey only, and information provided should be interpreted accordingly;
- Only wetlands that were likely to be impacted by proposed development activities were assessed in the field. Wetlands located within a 500m radius of the sites but not in a position within the landscape to be measurably affected by the developments were not considered as part of this assessment;
- Some areas of the delineation in close proximity to the roads/houses have been extrapolated from the ground truthed areas;
- Field assessment were completed to assess as much of the site as possible with focus on the proposed directly impacted and downstream areas;
- The on-site conditions represented dry season conditions, many wetland plants had shed their flowering portions and could not be identified; and
- The GPS used for water resource delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least five meters to either side.

5 Methodology

5.1 Desktop Assessment

The following information sources were considered for the desktop assessment;

- Aerial imagery (Google Earth Pro);
- Department of Water and Sanitation (DWS, 2018);
- Land Type Data (Land Type Survey Staff, 1972 - 2006);
- The National Freshwater Ecosystem Priority Areas (Nel et al., 2011); and
- Contour data (5m).

5.2 Wetland Assessment

The National Wetland Classification Systems (NWCS) developed by the South African National Biodiversity Institute (SANBI) will be considered for this study. This system comprises a hierarchical classification process of defining a wetland based on the principles of the hydrogeomorphic (HGM) approach at higher levels, and also then includes structural features at the lower levels of classification (Ollis *et al.,* 2013).

5.2.1 Delineation

The wetland areas are delineated in accordance with the DWAF (2005) guidelines, a cross section is presented in Figure 2. The outer edges of the wetland areas were identified by considering the following four specific indicators:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur;
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
    - The soil forms (types of soil) found in the landscape were identified using the South African soil classification system namely; Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991);
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation; and
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Vegetation is used as the primary wetland indicator. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role.

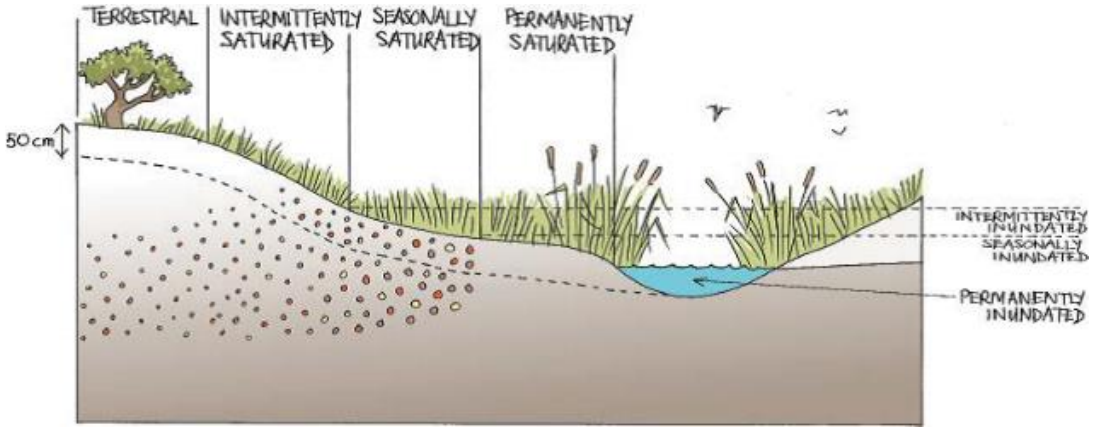


Figure 2: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change (Ollis et al., 2013)

5.2.2 Present Ecological Status (PES)

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present Ecological Status (PES) score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The Present State categories are provided in Table 1.

Table 1: The PES categories (Macfarlane, et al., 2009)

Impact Category	Description	Impact Score Range	Present State Category
None	**Unmodified, natural**	**0 to 0.9**	**A**
Small	**Largely Natural** with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	**1.0 to 1.9**	**B**
Moderate	**Moderately Modified.** A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	**2.0 to 3.9**	**C**
Large	**Largely Modified.** A large change in ecosystem processes and loss of natural habitat and biota has occurred.	**4.0 to 5.9**	**D**
Serious	**Seriously Modified.** The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.	**6.0 to 7.9**	**E**
Critical	**Critical Modification.** The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	**8.0 to 10**	**F**

5.2.3 Ecosystem Services

The assessment of the ecosystem services supplied by the identified wetlands was conducted per the guidelines as described in WET-EcoServices (Kotze, et al, 2009). An assessment was

undertaken that examines and rates the following services according to their degree of importance and the degree to which the services are provided (Table 2).

Table 2: Classes for determining the likely extent to which a benefit is being supplied

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

5.2.4 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWS (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 3.

Table 3: Description of EIS categories.

EIS Category	Range of Mean	Recommended Ecological Management Class
Very High	3.1 to 4.0	**A**
High	2.1 to 3.0	**B**
Moderate	1.1 to 2.0	**C**
Low Marginal	< 1.0	**D**

5.3 Buffer Determination

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane, *et al.,* 2014) was used to determine the appropriate buffer zone for the proposed activity.

5.4 Risk Assessment

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines. The significance of the impact is calculated according to Table 4.

Table 4: Significance ratings 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. Wetlands may be excluded.
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. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

6 Results and Discussion

6.1 Desktop Assessment

6.1.1 Desktop Soils

According to the land type database (Land Type Survey Staff, 1972 - 2006) the development falls within the Fb275 and Ca68 land types. The land types are dominated by Glenrosa and Mispah soils win the landscape. The land type characteristics are described in Table 5.

Table 5: Landtype Characteristics

Land type	Characteristics
Fb275	Glenrosa and/or Mispah forms (other soils may occur); Lime rare or absent in upland soils but generally present in low-lying soils
Ca68	Plinthic catena: upland duplex and/or margalitic soils common; Undifferentiated.

6.1.2 Desktop Vegetation

The proposed project is situated within the KwaZulu-Natal Highland Thornveld vegetation unit. The distribution of the vegetation unit is restricted to the KwaZulu-Natal Province. The vegetation unit is found in altitudes that range from 920m – 1440m above sea level (Mucina & Rutherford, 2006).

The unit occurs on both the dry valleys and the moist upland on a hilly and undulating landscape. The vegetation is dominated by tall grasses such as *Hyparrhenia hirta* with occasional intrusion of *Vechelia* woodlands which include *V. karroo, V. nilotica* and *V. sieberiana var. woodii* (Mucina & Rutherford, 2006).

The conservation status is regarded as Least Threatened with a conservation target of 23%. Approximately 2% of the vegetation unit is statutorily conserved in the Spioenkop, Weenen, Ntinini, Wagendrift, Moor Park and Tugela Drift Nature Reserves. Over 16% of the vegetation unit has been already transformed for cultivation, by urban sprawl and construction of dams. Most of the area is used for subsistence farming. Alien species in the unit include *Opuntia, Eucaltyptus, Populus,* Acacia and Melia. Erosion is very low (Mucina & Rutherford, 2006).

6.1.3 Wetland NFEPAs

There were no NFEPA wetland areas identified within 500m of the proposed project area.

6.2 Wetland Assessment

One (1) wetland area was identified within the 500m assessment area of the proposed project. The identified wetland was classified as a channelled valley bottom wetland (HGM 1).The wetland delineation is shown in Figure 4 and is classified in in Table 6. The wetland assessment focused on the area that will be directly impacted upon by the proposed project and groundtruthed the remaining areas for confirmation of the wetland extent.

The wetland was determined to be in a Largely Modified (D) state as a result of the surrounding of erosion within the wetland, driving through the wetland, subsistence farming and alien invasion. Several drainage lines were identified in the project area as presented in Figure 3.

Figure 3: Identified drainage line

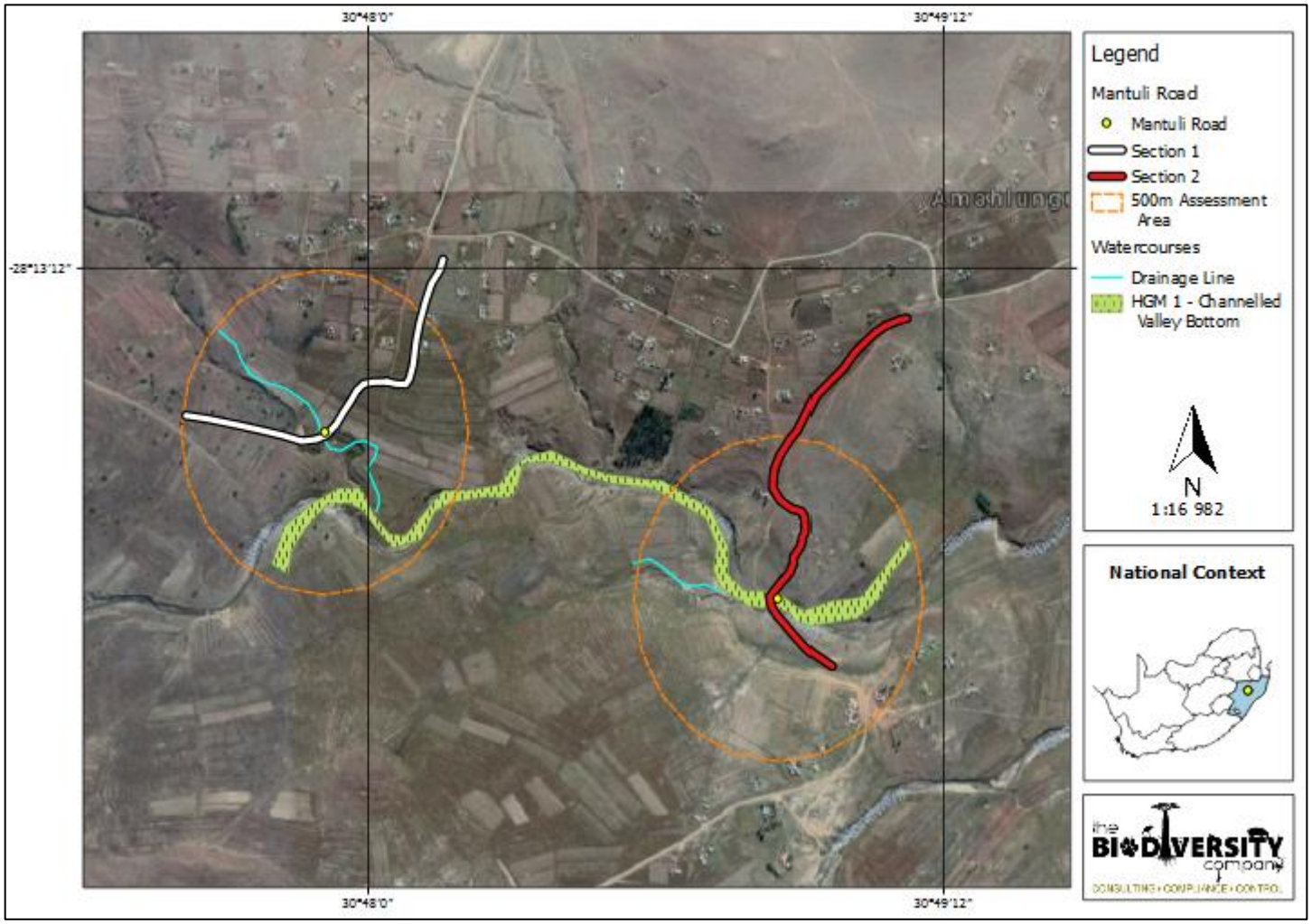


Figure 4: The delineated wetland within 500m WULA of the assessment area

Table 6: Wetland classification as per SANBI guideline (Ollis et al., 2013)

Wetland Name	Level 1	Level 2		Level 3	Level 4		
	System	DWS Ecoregion/s	NFEPA Wet Veg Group/s	Landscape Unit	4A (HGM)	4B	4C
HGM 1	Inland	North Eastern Coastal Belt	Sub-Escarpment Grassland	Valley Floor	Channelled Valley Bottom	N/A	N/A

The identified wetland is shown in Figure 5. The only wetland plant that could be identified was *Juncus spp*. Some intermediate wetland plants included *Digitaria eriantha* and *Pennisetum clandestenum*. The dominant soil within the wetland was the Katspruit soil form which can be seen in Figure 6.

Figure 5: Identified Channelled valley bottom wetland (HGM 1)

Figure 6: Katspruit soil form

6.2.1 Present Ecological State

The PES for the assessed HGM unit is presented in Table 7. The overall wetland health for HGM 1 was determined to be Largely Modified (D). The impacts affecting the wetland health are shown in Figure 7.

Table 7: Summary of the scores for the wetland PES

Wetland	Hydrology	Geomorphology	Vegetation
	Rating	Rating	Rating
HGM 1	D: Largely Modified	D: Largely Modified	D: Largely Modified
Overall PES		D: Largely Modified	

A summary for the respective modules is as follows:

- The **hydrological** component for the HGM 1 has been altered by the current road crossings, reduced vegetative cover, and the development of roads, the increased hardened surfaces in the form of housing units and agricultural practices on the wetland edges. The hardened surfaces have altered flow volumes and intensities which enter the wetland. The current crossing had resulted in the erosion of soil and created a hardened surface (exposed bedrock) within the wetland which causes increased flow velocities and erosion of downstream areas, where flows are intensified within the wetland and erosion occurs. The reduced and altered vegetation through the subsistence farming patches has impacted on the hydrology especially in HGM 1.

- The **geomorphology** component for the HGM units assessed were determined to be Largely Modified (D) with marked increase in runoff and severe erosion occurring within the catchment.
- The **vegetation** component for the HGM unit was Largely Modified (D) respectively as a result of the low wetland plants identified within the wetland.

Figure 7: Identified impacts A) Hardened surfaces (houses) in wetland catchment and decreased vegetative cover in the catchment B) Erosion in the wetland and invasive trees

6.2.2 Ecosystem Services Assessment

The Ecosystem services provided by the HGM unit identified at the site were assessed and rated using the WET-EcoServices method (Kotze, et al. 2009). The summarised results for the HGM unit are shown in Table 8.

HGM 1 had an overall intermediate level of service. The wetland showed elevated indirect benefits for flood attenuation, toxicant, nitrate, and phosphate assimilation, sediment trapping and erosion control. Although the wetland is impacted upon, in the local setting, sudden downpours and flash floods could pose a threat (scouring and erosion) to the surroundings

and the wetland channels allows for floods to be attenuated and slowed down and minimise damage. The wetlands further assist with the provision of a continuous water source for the downstream areas.

Table 8: The EcoServices being provided by the wetlands associated with the project

Wetland Unit					HGM 1
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		2.3
			Streamflow regulation		1.3
			Water Quality enhancement benefits	Sediment trapping	2.5
				Phosphate assimilation	2.5
				Nitrate assimilation	1.7
				Toxicant assimilation	2.2
				Erosion control	2.2
			Carbon storage		1.0
	Direct Benefits	**Biodiversity maintenance**			1.3
		Provisioning benefits	Provisioning of water for human use		0.6
			Provisioning of harvestable resources		1.0
			Provisioning of cultivated foods		1.0
		Cultural benefits	Cultural heritage		1.0
			Tourism and recreation		0.1
			Education and research		0.8
Overall					22.4
Average					1.6

6.2.3 Ecological Importance & Sensitivity

The EIS assessment was applied to the identified wetland area in order to assess the levels of sensitivity and ecological importance of the wetlands. The results of the assessment are shown in Table 9.

The EIS was calculated to have a Moderate (C) for HGM 1. The EIS was rated as Moderate although the wetland has been impacted upon by the crossing point and the erosion; however, re-establishment of the wetland area may increase the functioning of the wetland. The wetland condition is recoverable with an effective rehabilitation plan.

The Hydrological Functionality of HGM 1 was determined to have a Moderate (C) levels of importance. The wetland's hydrology ensured that there was a constant water source within the area. Furthermore, the flood attenuation offered by the wetland contributes to the protection of the local area from flooding. The Direct Human Benefits were calculated to have a have a Low (D) level of importance for HGM 1.

Table 9: The EIS results for the delineated wetland

Wetland Importance and Sensitivity	*HGM 1*
Ecological Importance & Sensitivity	1.7
Hydrological/Functional Importance	2.0
Direct Human Benefits	0.5

6.2.4 Buffer Zones

The wetland buffer zone tool was used to calculate the appropriate buffer required for the road and causeway upgrade. The model shows that the largest risk (Medium) posed by the project during the construction phase is that of “Increased sediment inputs and turbidity”. No threats are however expected during the operational phase. The upgrade is for an already existing crossing. Therefore, whatever threats will be posed after construction will not exceed the current level of threat posed by the road in its current state. On the contrary, the road will pose less threats given its upgrade. These risks are calculated with no prescribed mitigation and the calculated buffer requirement is presented in Table 10.

Table 10: Pre-mitigation buffer requirement

Required Buffer before mitigation measures have been applied	
Construction Phase	24 m
Operational Phase	15 m

According to the buffer guideline (Macfarlane, et al. 2014) a high-risk activity would require a buffer that is 95% effective to reduce the risk of the impact to a low-level threat.

Some mitigation measures can be implemented to decrease the size of the construction phase buffer requirement. Table 11 indicates the size of buffers required if these mitigation measures are successfully implemented. The above-mentioned mitigation measures are described in Table 12.

Table 11: Post-mitigation buffer requirement

Required Buffer after mitigation measures have been applied	
Construction Phase	15 m
Operational Phase	15 m

A conservative buffer zone was suggested of 15 m for the construction and operation phases respectively, this buffer is calculated assuming mitigation measures are applied. The buffer zone will not be applicable in the case of river/stream crossings, however, for all secondary activities such as lay down yards, storage areas and camp sites, the buffer zone must be implemented.

Table 12: Aspects expected to pose threats during the proposed activity

Threat Posed by the proposed land use / activity		Specialist Threat Rating	Threat Rating after Mitigation	Recommended Mitigation
Construction Phase	1. Alteration to flow volumes	Very Low	Very Low	
	2. Alteration of patterns of flows (increased flood peaks)	Low	Low	
	3. Increase in sediment inputs & turbidity	Medium	Low	The upgrade of the road and culvert construction should take place in the dry season to avoid sediments being carried off by overland flow. Materials must be pre-fabricated and not fabricated on site. Any stripping should take place in a phased approach with silt traps being installed to decrease the extent of sedimentation of the watercourse. All wetland areas should be cordoned off. The above-mentioned mitigation only accounts for cases where the proposed road impedes into the buffer zone. Post-construction rehab also has been recommended to decrease the operational impacts as much as possible and to decrease the rapid degradation in the future,
	4. Increased nutrient inputs	N/A	N/A	
	5. Inputs of toxic organic contaminants	Very Low	Very Low	
	6. Inputs of toxic heavy metal contaminants	Low	Low	
	7. Alteration of acidity (pH)	Very Low	Very Low	
	8. Increased inputs of salts (salinization)	N/A	N/A	
	9. Change (elevation) of water temperature	N/A	N/A	
	10. Pathogen inputs (i.e. disease-causing organisms)	N/A	N/A	
Operational Phase	1. Alteration to flow volumes	Very Low	Very Low	
	2. Alteration of patterns of flows (increased flood peaks)	Low	Low	
	3. Increase in sediment inputs & turbidity	Low	Low	
	4. Increased nutrient inputs	Low	Low	
	5. Inputs of toxic organic contaminants	Very Low	Very Low	
	6. Inputs of toxic heavy metal contaminants	Very Low	Very Low	
	7. Alteration of acidity (pH)	N/A	N/A	
	8. Increased inputs of salts (salinization)	Very Low	Very Low	
	9. Change (elevation) of water temperature	N/A	N/A	
	10. Pathogen inputs (i.e. disease-causing organisms)	N/A	N/A	

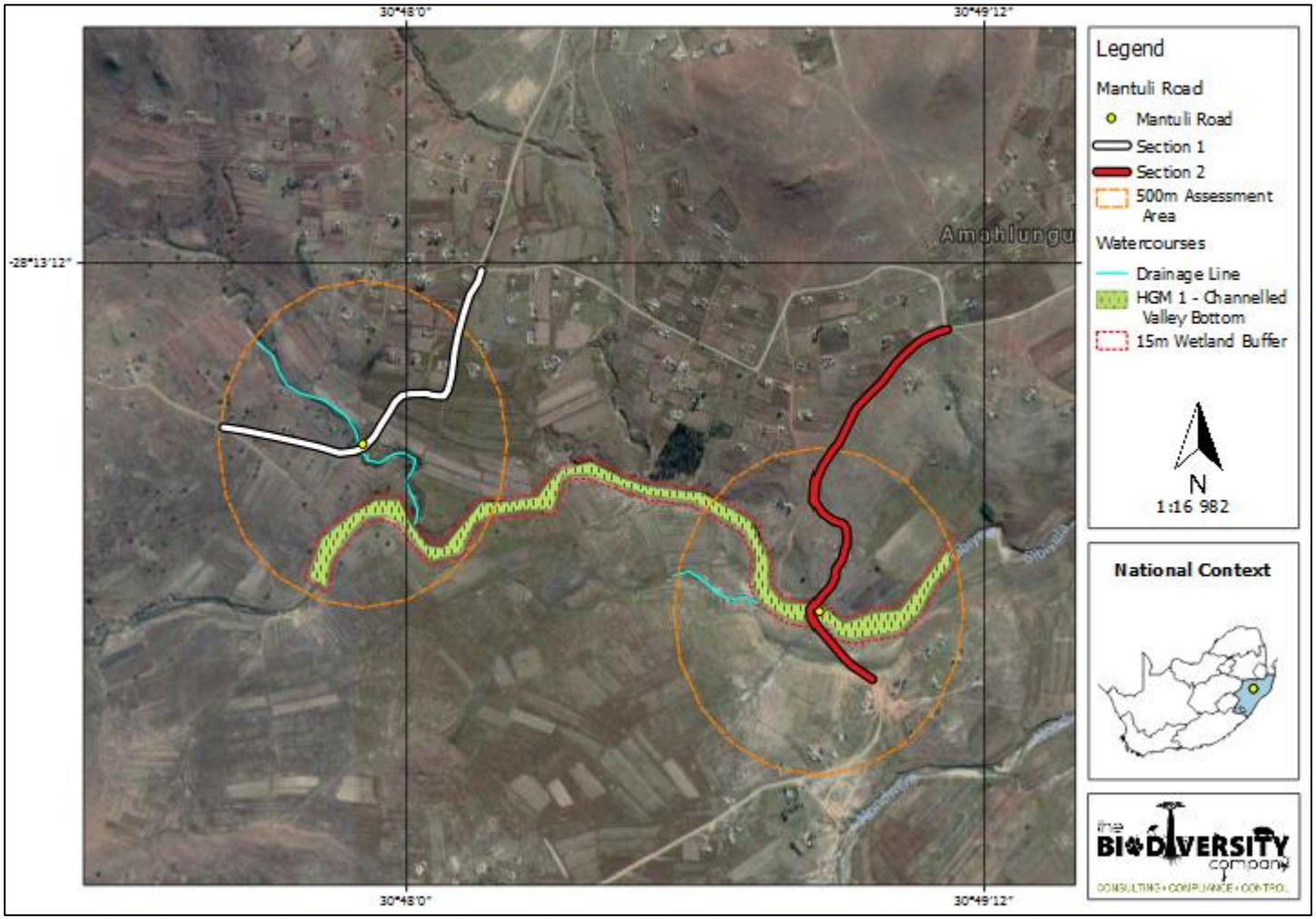


Figure 8: 15m buffer required for the wetland within the project

6.2.5 Post-Construction Rehabilitation

The proposed project will intersect a channelled valley bottom wetland and an associated drainage line. The resulting disturbance of the watercourse area may require rehabilitation once the construction phase is completed. It is important that the slopes of the wetland are re-vegetated so as to mitigate impacts of erosion, sedimentation and establishment of alien plant species. Table 13 presents listed plant species which should be obtained and planted in order to address the post-construction condition of the wetland area. After the removal of the current structure and construction of the new structure, it is anticipated that a large area will be disturbed. There will be large areas of bare and disturbed soils which will be susceptible to establishment of alien invasive plant species. Therefore, the post-construction rehabilitation should follow these steps:

1. Re-shape and contour the banks around the causeway structure;
2. Stabilise the embankments with necessary aids (gabions, geomats etc.);
3. Revegetate the embankments and channel areas with the plants listed in Table 13. It is recommended that these plants be salvaged from the area and re-planted, or a suitable (similar) seed mix be applied to the affected areas; and
4. Ensure that water flows through the channel are dispersed and that water flow is uninterrupted.

Table 13: Listed plant species which could be considered for post-construction rehabilitation efforts

Wetland Aspect	Risks	Objectives	Plant species	Recommendation
Embankments	Erosion, bank collapse and steep banks	To slow water flows and provide soil stability	• *Pycreus pelophilus* • *Schoenoplectus brachyceras* • *Pennisetum macrourum,* • *Cyperus esculentus* • *Cyperus sexangularis* • *Eragrostis curvula* • *Eragrostis gummiflua* • *Eragrostis lehmanniana* • *Imperata cylindrica* • *Setaria sphacelata* • *Sporobolus africana* • *Leersia hexandra* • *Melinis repens*	Slope banks and slight contouring to aid in plant establishment and slowing of water flows down the slopes. Seed should be sowed in a mix. Plants can be sourced from the area and replanted if removal is necessary to accommodate the project.
Saturated channel area	Erosion, soil dispersion and downstream impacts	Trapping of sediment, water filtration, improvement of plant diversity	• *Phragmites australis* • *Typha capensis* • *Nymphoides thundergiana* • *Juncus spp.*	Seed should be sowed in a mix and towards the end of the dry season. Plants can be sourced from the area and replanted if removal is necessary to accommodate the project.

7 Risk Assessment

The proposed project is for the upgrade of two roads and the construction of two causeway structures. The causeway structures will be constructed within the boundaries of the channelled valley bottom (HGM 1) and a drainage line, which, as a result, will be directly impacted on. As this project entails the upgrade of infrastructure and the construction of new infrastructure, impacts associated with the area are potentially moderate to low, based on the current onsite crossings (Figure 9). Modifications to the wetland habitat is likely to occur during construction. The project will entail the cutting, reshaping, and change in hydrodynamics of the wetland. This has the potential to increase erosion and sedimentation of downstream habitats due to surface runoff during the wet season.

Figure 9: One of the crossings (Crossing 1) and the current road

Findings from the DWS aspect and impact register / risk assessment are provided in Table 14, Table 15 and Table 16.

Table 14: Potential risk posed by the Culvert Upgrade

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Activity	**Impact**	**Aspect**
Excavating and levelling of culverts and roads to surveyed levels	Alteration to flow volumes	Channelling of flow from road embankment.
		Removal of wetland areas (reshaping road contours).
		Compaction from operation of heavy machinery in wetland areas.
	Alteration of patterns of flows (increased flood peaks)	Channelling of flow from road embankment.
		Removal of wetland areas (reshaping road contours).
		Increased impermeable surfaces from cleared area.
		Compaction from operation of heavy machinery in wetland areas.
	Increase in sediment inputs & turbidity	Channelling of seepage from road embankment.
		Removal of wetland areas (reshaping road contours).
		Increased impermeable surfaces from cleared area.
		Compaction from operation of heavy machinery in wetland areas.
	Inputs of toxic organic contaminants	Hydrocarbon spills from working machinery
		Waste and ablution facilities
	Loss of wetland habitat	Removal of wetland areas (reshaping road contours).
	Loss of wetland functionality	Channelling of flow from road embankment.
		Removal of wetland areas (reshaping road contours).
		Compaction from operation of heavy machinery in wetland areas.
		Hydrocarbon spills from working machinery
	Alteration to flow volumes	Channelling of flow from road embankment.

Construction of Culverts and stormwater management systems		Compaction from operation of heavy machinery in wetland areas.
	Alteration of patterns of flows (increased flood peaks)	Channelling of flow from road embankment.
		Increased impermeable surfaces from cleared area.
		Compaction from operation of heavy machinery in wetland areas.
	Increase in sediment inputs & turbidity	Channelling of flow from road embankment.
		Increased impermeable surfaces from cleared area.
		Compaction from operation of heavy machinery in wetland areas.
	Inputs of toxic organic contaminants	Hydrocarbon spills from working machinery
		Waste and ablution facilities
	Loss of wetland functionality	Channelling of flow from road embankment.
		Removal of wetland areas (reshaping road contours).
		Compaction from operation of heavy machinery in wetland areas.
		Hydrocarbon spills from working machinery
Construction of stormwater management systems	Alteration to flow volumes	Channelling of flow from road embankment.
		Compaction from operation of heavy machinery in wetland areas.
	Alteration of patterns of flows (increased flood peaks)	Channelling of flow from road embankment.
		Compaction from operation of heavy machinery in wetland areas.
	Increase in sediment inputs & turbidity	Channelling of flow from road embankment.
		Increased impermeable surfaces from cleared area.
		Compaction from operation of heavy machinery in wetland areas.
	Inputs of toxic organic contaminants	Hydrocarbon spills from working machinery
		Waste and ablution facilities

	Loss of wetland functionality	Channelling of flow from road embankment.
		Compaction from operation of heavy machinery in wetland areas.
		Hydrocarbon spills from working machinery
Operation of the causeways	Alteration to flow volumes	Channelling of flow from road embankment.
	Alteration of patterns of flows (increased flood peaks)	Channelling of flow from road embankment.
	Increase in sediment inputs & turbidity	Channelling of flow from road embankment.
		Increased impermeable surfaces from cleared area.
	Inputs of toxic organic contaminants	Hydrocarbon spills from everyday traffic
	Loss of wetland functionality	Channelling of flow from road embankment.

Table 15: DWS Risk Impact Matrix for the proposed project

Activity	Severity								
	Impact	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence
Construction Phase									
Excavating and levelling of causeways to surveyed levels	Alteration to flow volumes	3	2	3	2	2.5	1	2	5.5
	Alteration of patterns of flows (increased flood peaks)	3	2	2	1	2	2	2	6
	Increase in sediment inputs & turbidity	1	3	3	3	2.5	2	2	6.5
	Inputs of toxic organic contaminants	1	4	3	3	2.75	1	2	5.75
	Loss of wetland habitat	3	2	3	3	2.75	1	2	5.75
	Loss of wetland functionality	3	2	2	3	2.5	2	2	6.5
	Alteration to flow volumes	3	2	3	2	2.5	1	2	5.5

Construction of roads and causeways	Alteration of patterns of flows (increased flood peaks)	3	2	2	1	2	2	2	6
	Increase in sediment inputs & turbidity	1	3	3	3	2.5	2	2	6.5
	Inputs of toxic organic contaminants	1	4	3	3	2.75	1	2	5.75
	Loss of wetland functionality	3	2	2	3	2.5	2	2	6.5
Construction of stormwater management systems	Alteration to flow volumes	3	2	3	2	2.5	1	2	5.5
	Alteration of patterns of flows (increased flood peaks)	3	2	2	1	2	2	2	6
	Increase in sediment inputs & turbidity	1	3	3	3	2.5	2	2	6.5
	Inputs of toxic organic contaminants	1	4	3	3	2.75	1	2	5.75
	Loss of wetland functionality	3	2	2	3	2.5	2	2	6.5
Operational Phase									
Operation of the roads and causeways	Alteration to flow volumes	3	2	3	2	2.5	1	4	7.5
	Alteration of patterns of flows (increased flood peaks)	3	2	2	1	2	2	4	8
	Increase in sediment inputs & turbidity	1	2	3	3	2.25	2	2	6.25
	Inputs of toxic organic contaminants	1	3	2	2	2	1	2	5
	Loss of wetland functionality	4	2	3	3	3	2	3	8

Table 16: DWS Risk Impact Matrix for the proposed project continued

Activity	Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Construction Phase									
Excavating and levelling of causeways to surveyed levels	Alteration to flow volumes	3	3	5	2	13	71.5	**Moderate***	**Low**
	Alteration of patterns of flows (increased flood peaks)	3	3	5	1	12	72	**Moderate***	**Low**
	Increase in sediment inputs & turbidity	3	3	5	1	12	78	**Moderate***	**Low**
	Inputs of toxic organic contaminants	2	2	5	1	10	57.5	**Moderate***	**Low**
	Loss of wetland habitat	3	4	5	1	13	74.75	**Moderate***	**Low**
	Loss of wetland functionality	3	3	5	1	12	78	**Moderate***	**Low**
Construction of roads and causeways	Alteration to flow volumes	3	3	5	2	13	71.5	**Moderate***	**Low**
	Alteration of patterns of flows (increased flood peaks)	3	3	5	1	12	72	**Moderate***	**Low**
	Increase in sediment inputs & turbidity	3	3	5	1	12	78	**Moderate***	**Low**
	Inputs of toxic organic contaminants	2	2	5	1	10	57.5	**Moderate***	**Low**
	Loss of wetland functionality	3	3	5	1	12	78	**Moderate**	**Low**
Construction of stormwater management systems	Alteration to flow volumes	3	3	5	2	13	71.5	**Moderate***	**Low**
	Alteration of patterns of flows (increased flood peaks)	3	3	5	1	12	72	**Moderate***	**Low**
	Increase in sediment inputs & turbidity	3	3	5	1	12	78	**Moderate***	**Low**
	Inputs of toxic organic contaminants	2	2	5	1	10	57.5	**Moderate***	**Low**

	Loss of wetland functionality	3	3	5	1	12	78	**Moderate***	**Low**
Operational Phase									
Operation of the roads and causeways	Alteration to flow volumes	3	3	1	2	9	67.5	**Moderate***	**Low**
	Alteration of patterns of flows (increased flood peaks)	3	3	1	1	8	64	**Moderate***	**Low**
	Increase in sediment inputs & turbidity	3	3	1	2	9	56.25	**Moderate***	**Low**
	Inputs of toxic organic contaminants	2	2	1	1	6	30	**Low**	**Low**
	Loss of wetland functionality	3	3	1	1	8	64	**Moderate***	**Low**

(*) denotes - In accordance with General Notice 509 “Risk is determined after considering all listed control / mitigation measures. Borderline Low / Moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures detailed below.

The risk assessment identified several risks as a result of the proposed project. A large number of the risks have been rated as Moderate risks (without mitigation). These Moderate risks are anticipated as the proposed project will be for the upgrade of the road and the construction of the causeway structures and will lead to the direct physical disturbance of the channelled valley bottom wetland (HGM 1) and a drainage line. Due to the nature of the project the physical disturbance of the wetland area cannot be avoided.

The Moderate risks identified for the construction phase of the project are associated with changes in drainage from the wetland through channelling or compaction. The increase bare/impervious areas will increase the sediment loads carried down slope into wetland areas. The moderate risks associated with the construction phase were re-adjusted to Low ratings with the anticipation that all the prescribed mitigation measures will be implemented.

Moderate risks (pre-mitigation) were also identified for the operational phase of the project. This is largely a result of the longevity of the project and the potential for erosion within the wetland habitat. No aspects are considered to pose a Moderate risk with the implementation of mitigation measures.

7.1 Road and causeway construction mitigation measures

The following causeway construction specific mitigation measures are provided:

- The footprint area of the construction should be kept a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas;
- All construction activities and access must make use of the existing road;
- Batching plants must be allocated outside of the 15m buffer zones;
- Culverts are to be placed during the dry season;
- Exposed road surfaces awaiting grading must be stabilised to prevent the erosion of these surfaces. Signs of erosion must be addressed immediately to prevent further erosion of the road;
- Silt traps and fences must be placed in the preferential flow paths along the road to prevent sedimentation of the watercourse;
- Temporary storm water channels should be filled with aggregate and/or logs (branches included) to dissipate flows;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- It is recommended that the material surrounding and holding the culverts in place include a coarse rock layer that has been specifically incorporated to increase the porosity and permeability to accommodate flooding and very low flows;
- The culverts used in the design should be as large as possible, partially sunken and energy dissipating material must be placed at the discharge area of each culvert to prevent erosion of these areas;
- Large aggregate outsourced or from the project area (if available) can be used for energy dissipation in the channel downstream of the culverts to reduce the likelihood

of scouring the river bed and sedimentation of the catchment. It is preferable that larger aggregate be used to avoid flows removing material from the site;

- The use of larger culverts will prevent the build-up of debris by allowing the free movement of debris through the large culverts;
- Culverts should avoid inundation (damming) of upstream areas by facilitating streamflow and catering properly for both low flows and high flows;
- Surface run-off from the roads flowing down the embankments often scours the watercourse on the sides of the culvert causing sedimentation of the channel. This should be catered for with adequate concreted storm water drainage depressions and channels with energy dissipaters that channel these flows into the river in a controlled manner;
- The culvert installations should further take into account the scouring action of high flows and gabion structures or similar should be placed on both sides of the culvert on the embankments both upstream and downstream. This will serve as retention of the soils from scouring around and underneath the culvert structures aiding in the protection of the structure; and
- A suitable storm water plan must be compiled for the road. This plan must attempt to displace and divert storm water from the road and discharge the water into adjacent areas without eroding the receiving areas. It is preferable that run-off velocities be reduced with energy dissipaters and flows discharged into the local watercourses.

7.2 General Mitigation Measures

The following general mitigation measures are provided:

- The water resources outside of the specific project site area must be avoided where possible;
- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;
- Laydown yards, camps and storage areas must be beyond the aquatic areas. Where possible, the construction of the crossings must take place from the existing road and not from within the watercourse and associated buffer;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are clean-up and discarded correctly;
- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces;
- Prevent uncontrolled access of vehicles through the water resources system that can cause a significant adverse impact on the hydrology and alluvial soil structure of these areas;
- All chemicals and toxicants to be used for the construction must be stored outside the channel system and in a bunded area;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;

- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good “housekeeping”;
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- Have action plans on site, and training for contactors and employees in the event of spills, leaks and other impacts to the aquatic systems;
- All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;
- Erosion and sedimentation into the channel must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed banks;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil;
- Large trees and other debris often collect upstream against the causeways, damming up the channel with risk of flooding and damaging the crossing and its banks. This debris should be cleared routinely with appropriate disposal of the debris. Timber can be sold or donated to local communities;
- No dumping of construction material on-site may take place; and
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported.

8 Conclusion

One (1) wetland area was identified within the 500m assessment area of the proposed project. The identified wetland was classified as a channelled valley bottom wetland (HGM 1). Several drainage lines were identified in the project area.

The wetland was determined to be in a Largely Modified (D) state as a result of the surrounding built up areas, road crossing point and low wetland plant diversity. HGM 1 had an overall intermediate level of service. The wetland showed elevated indirect benefits for flood attenuation, toxicant, nitrate, and phosphate assimilation, sediment trapping and erosion control.

The EIS was calculated to have a Moderate (C) for HGM 1. The EIS was rated as Moderate although the wetland has been impacted upon by alien plant species and the crop fields; however, re-establishment of the wetland area may increase the functioning of the wetland. The wetland condition is recoverable with an effective rehabilitation plan.

The Hydrological Functionality of HGM 1 was determined to have a Moderate (C) levels of importance. The wetland’s hydrology ensured that there was a constant water source within

the area. Furthermore, the flood attenuation offered by the wetland contributes to the protection of the local area from flooding.

The Direct Human Benefits were calculated to have a have a Marginal (D) level of importance for HGM 1. The direct human benefits include the cultivation of crops within the wetland areas and the removal of toxicants in the water.

Conservative buffer zones of 15m (Post-mitigation) were suggested for the construction and operational phases of the causeway, respectively.

Risk Assessment

The proposed project is for the upgrade of two roads and the construction of two causeway structures. The causeway structures will be constructed within the boundaries of the channelled valley bottom (HGM 1) and a drainage line, which, as a result, will be directly impacted on. As this project entails the upgrade of infrastructure and the construction of new infrastructure, impacts associated with the area are potentially moderate to low, based on the current onsite crossings. Modifications to the wetland habitat is likely to occur during construction. The project will entail the cutting, reshaping, and change in hydrodynamics of the wetland. This has the potential to increase erosion and sedimentation of downstream habitats due to surface runoff during the wet season.

The risk assessment identified several risks as a result of the proposed project. A large number of the risks have been rated as Moderate risks (without mitigation). These Moderate risks are anticipated as the proposed project will be for the upgrade of the road and the construction of the causeway structures and will lead to the direct physical disturbance of the channelled valley bottom wetland (HGM 1) and the drainage line. Due to the nature of the project the physical disturbance of the wetland area cannot be avoided.

The Moderate risks identified for the construction phase of the project are associated with changes in drainage from the wetland through channelling or compaction. The increase bare/impervious areas will increase the sediment loads carried down slope into wetland areas. The moderate risks associated with the construction phase were re-adjusted to Low ratings with the anticipation that all the prescribed mitigation measures will be implemented.

Moderate risks (pre-mitigation) were also identified for the operational phase of the project. This is largely a result of the longevity of the project and the potential for erosion within the wetland habitat. No aspects are considered to pose a Moderate risk with the implementation of mitigation measures.

It is the opinion of the specialist that the project be favourably considered and allow for the proposed road upgrade and causeway structure construction associated with the Mantuli Road Phase 2 project to proceed, but all prescribed mitigation measures and recommendations must be implemented.

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