REHABILITATION OF NATIONAL ROUTE R56 SECTION 8 FROM MATATIELE (KM130.15) TO THE KZN BORDER (KM168.71)

Aquatic Biodiversity Assessment

Version 2

Date: 31 March 2023

Prepared by:

Eco-Pulse Environmental Consulting Services

Report No: EP657-01

Draft for Client Review

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Suggested report citation:

Eco-Pulse Consulting, 2022. Rehabilitation of National Route R56 Section 8 from Matatiele (KM 130.15) to the KZN border (KM168.71). Aquatic Biodiversity Assessment. Version 2. Unpublished specialist report prepared for CES. 31 March 2023.

SPECIALIST ASSESSMENT REPORT DETAILS AND DECLARATION OF INDEPENDENCE

Assessment Title:	Aquatic Biodiversity Assessment
Project:	Rehabilitation of National Route R56 Section 8 from Matatiele (KM 130.15) to the KZN border (KM168.71)
Location:	Alfred Nzo District Municipality
Report No.	657-01
Version No.	2
Date:	31 March 2023
Author:	Shaun McNamara *(MSc.)*
Field of study/expertise:	Wetland & Aquatic Ecology
Reviewed by:	Ryan Kok *Pr.Sci.Nat.* (Ecological Sciences)

I, **Shaun McNamara**, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the relevant environmental authorities.

Signed: ______________________ Date: 31 March 2023

Details of Specialist Team

The relevant experience of specialist team members involved in the compilation of this report are briefly summarized below. *Curriculum Vitae* of the specialist team are available on request.

Specialist	Role	Details
Ryan Kok Scientist Eco-Pulse *Pr.Sci.Nat.*	Sign off	Ryan is a Scientist and Wetland / Aquatic Ecologist at Eco-Pulse with a BSc degree in Environmental Science, BSc Honours, and MSc degree in Biological & Ecological Sciences. He is a registered Professional Natural Scientist (Pr. Sci. Nat.) with >5 years' experience, having worked extensively on numerous specialist ecological assessment projects, for wetland/aquatic habitats in KZN, the Free State, Gauteng, Eastern Cape, and Mpumalanga.
Shaun McNamara Scientist Eco-Pulse	Fieldwork & author	Shaun holds an Honours degree in Environmental Water Management and a master's degree in Fluvial Geomorphology. Shaun has 4 years' experience in the compilation of wetland and aquatic assessments.

EXECUTIVE SUMMARY

This report sets out the findings of the Baseline Aquatic Biodiversity Assessment for the rehabilitation of National Route R56 Section from the town of Matatiele to the KZN border.

Catchment Context:

Most of the study area is in DWS quaternary catchments T31F. A portion of the western edge of the target section of the R56 is located within DWS quaternary catchments T33A (Figure A). The primary river draining the T31F catchment area is the Mzimvubu which flows in a general southerly direction. The R56 crosses the Mzimvubu River immediately east if the town of Cedarville. With one exception, all watercourses crossed by the target length of the R56 are tributary of the Mzimvubu River. The exception being a seasonal stream near Matatiele which is a tributary of the Kinira River which drain catchment T33A. The study area is located within the Mzimvubu – Tsitsikamma water management area.

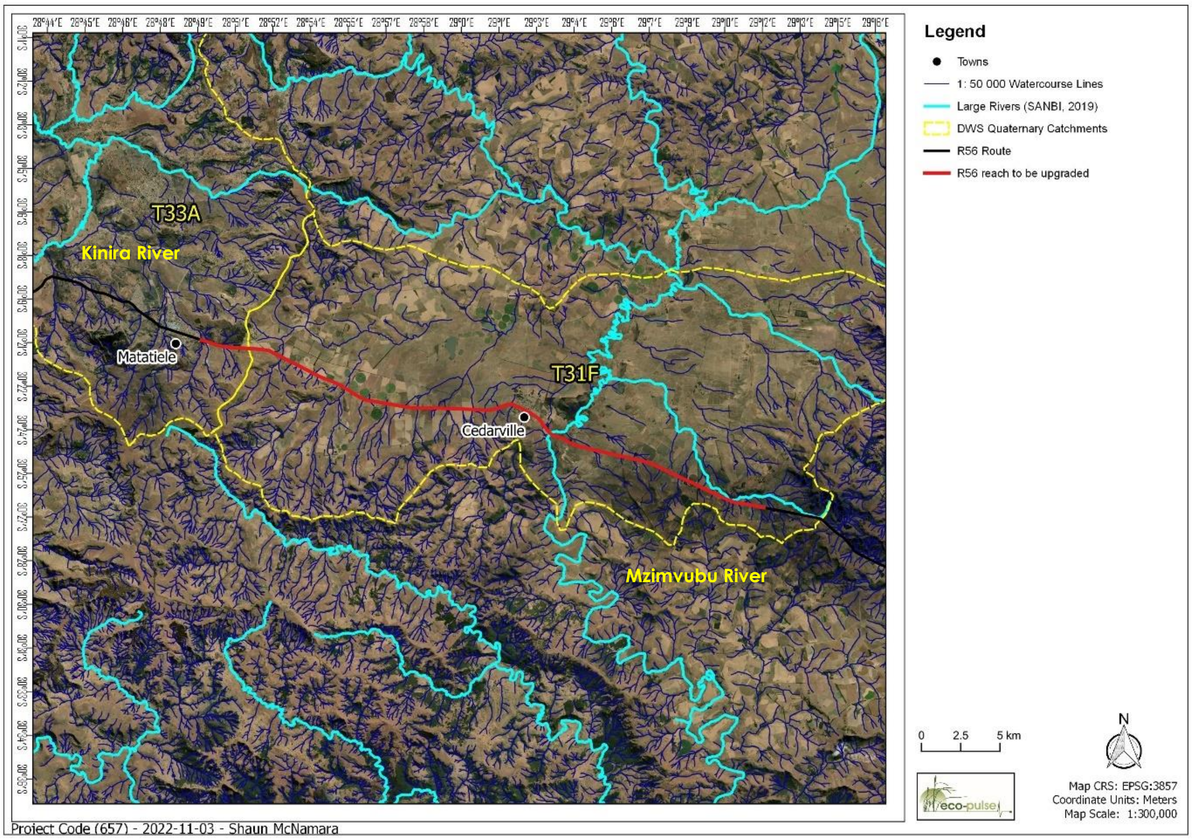

Figure A: Regional drainage network for the project study area.

Baseline Aquatic Assessment

The results of the baseline aquatic biodiversity assessment revealed that the sampled watercourses are not associated with notably diverse freshwater faunal species. The in-situ water sampling results suggest that water quality is unlikely to be the main contributing factor for the limited aquatic macroinvertebrate species diversity. It is more likely that the habitat along the sampled watercourses was not suitable for hosting a diverse range of macroinvertebrate types. The only site at which indigenous fish were recorded was T3MZIM-STRYD. Here four (4) specimens of Enteromius anoplus were recorded. At T3MZIM-EDNDL, T3MZIM-DSR56, and T3MZIM-ALING only exotic / introduced fish were recorded, namely Cyprinus carpio and Micropterus sp.

The Index of Habitat Integrity (IHI), Version 2 (Kleynhans, 1996 - updated 2012) was applied to each of the Sterkspruit River monitoring sites. The water quality results, SASS5 findings and fish survey results were also used to inform aspects of the IHI assessments. An outline of the outcomes is as follows:

- Instream habitat condition was assessed as being C: moderately modified for all assessed sites. Notable instream impacts include altered flow regime due to the establishment of dams along many of the watercourses, altered water quality due to runoff from agricultural lands, and channel scour (erosion) associated with altered catchment runoff processes.
- Riparian habitat condition was assessed as ranging from C: moderately modified to D: largely modified. Key impacts include, altered inundation of macro-bank areas due to the presence of dams along most of the sampled watercourses, bank erosion, and the infestation of macro-channel areas by woody invasive tree species.

The instream / aquatic component of assessed reaches of the watercourses associated with sites T3KINI-USMAT, T3MZIM-CMPSN, T3MZIM-EDNDL, T3MZIM-ALING, and T3MZIM-RSTFN were all assessed as being of 'Low' overall EIS. This is due to the prevailing ephemeral / seasonal flow regime of these units with these watercourses having limited aquatic species and habitat diversity and providing limited habitat or refugia for aquatic biota. These watercourses are however likely to be moderately sensitive to changes in its flow regime, as even minor increases in flow volume or velocity could change natural hydrological and geomorphological processes. The assessed reach of the watercourse associated with T3MZIM-STRYD was assessed as being of 'Moderate' EIS. This watercourse was associated with seasonal flow conditions and is considered sensitive to changes in flow. The assessed reach of T3MZIM-DSR56 (Mzimvubu River) was rated as being of 'Moderate' EIS. The perennial nature of this system means that it serves as refuge and a migration corridor for flow dependent taxa.

Impact Significance Assessment

The impact significance and risk assessment contained in this report are relevant to only the sampled rivers and the proposed construction and operation phase activities in the vicinity of these watercourses. The most notable impacts and risks associated with this project are construction phase direct impacts to watercourses, construction phase alterations to geomorphological and hydrological processes, and operation phase alterations to geomorphological and hydrological processes. Each of these impacts can be managed to acceptable levels through construction phase impact mitigation measures, and through appropriate design of road crossings.

Impact Type	**Impact Significance**	
	'poor' mitigation scenario	**'good' mitigation scenario**
CONSTRUCTION PHASE (C1)		
Direct physical loss or modification of freshwater habitat	Moderate	Moderately Low
Alteration of hydrological and geomorphological processes	Moderate	Moderately Low
Impacts to water quality	Moderately Low	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Moderately Low	Low
CONSTRUCTION PHASE (C1)		
Direct physical loss or modification of freshwater habitat	Moderately Low	Low
Alteration of hydrological and geomorphological processes	Moderately Low	Low
Impacts to water quality	Moderately Low	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Moderately Low	Low

Impact Type	**Impact Significance**	
	'poor' mitigation scenario	'good' mitigation scenario
OPERATIONAL PHASE (O2)		
Direct physical loss or modification of freshwater habitat	Moderately Low	Low
Alteration of hydrological and geomorphological processes	Moderate	Low
Impacts to water quality	Moderately Low	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Moderately Low	Low

<u>Risk Assessment to inform S21 c & i Water Use Licensing</u>

A summary of the potential risk and impacts ratings for the proposed development activities is provided in the table below, the results of which are discussed as follows:

- The risk of bridge and culvert crossings altering hydrological and geomorphological processes is regarded as 'moderate' but can be mitigated down to a 'low' risk level.
- All other construction and operational activities and risks associated with the project were regarded as 'Low'.

Phase(s)	Activity	Aspect	Risk of Impact	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating	KEY MITIGATION
Construction	ACTIVITY C1: Construction of the new access bridge crossing the Luzi River	Vegetation clearing and earthworks	Direct physical loss or modification of freshwater habitat	42,75	Low			• Limit instream habitat disturbance beyond the construction footprint. • Implement post-construction freshwater habitat rehabilitation strategy where necessary. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
		Temporary flow diversion	Alteration of hydrological and geomorphological processes	56,25	Moderate	31,25	Low	• Limit construction of instream structures to low flows during the dry (winter) season. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
		Risk from hydrocarbons (fuel/oil) and cement management	Impacts to water quality	54	Low			• Limit construction of instream structures to low flows during the dry (winter) season. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
		Temporary flow diversion	Impacts to ecological connectivity and/or ecological disturbance impacts	36	Low			• Limit instream habitat disturbance as far as possible. • Limit construction of instream structures to low flows during the dry (winter) season. • Restrict worker and machinery access to the construction site and site camp. • Remove temporary diversions and impoundments once construction is complete. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
	ACTIVITY C2: Upgrading of the dirt access road	Vegetation clearing and earthworks	Direct physical loss or modification of freshwater habitat	40,5	Low			• Limit instream habitat disturbance beyond the construction footprint. • Implement post-construction freshwater habitat rehabilitation strategy where necessary. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.as soon as practically possible.

Phase(s)	Activity	Aspect	Risk of Impact	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating	KEY MITIGATION
		Temporary flow diversion (if required)	Direct physical loss or modification of freshwater habitat	48	Low			• Limit construction of instream structures (low-level crossings and culverts) to low flows during the dry (winter) season. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
		Risk from hydrocarbons (fuel/oil) and cement management	Alteration of hydrological and geomorphological processes	54	Low			• Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
		Temporary flow diversion (if required)	Impacts to water quality	34	Low			• Restrict worker and machinery access to the construction site and site camp. • Prohibit poaching or collection of plants and biota during bridge construction. • Remove temporary diversions and impoundments once construction is complete. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
Operation	ACTIVITY O1: Operation of the bridge on the Luzi River	Risk of Invasive Alien Plant colonisation following disturbance	Impacts to ecological connectivity and/or ecological disturbance impacts	36	Low			• Undertake any future bridge repairs and/or maintenance during low flows (winter season). • Limit instream habitat disturbance during future bridge repairs and/or maintenance. • Implement post-construction river rehabilitation strategy where necessary. • Limit access to instream and riparian habitat. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
		Permanent flow impedance due to bridge infrastructure (instream pier)	Direct physical loss or modification of freshwater habitat	62,5	Moderate	37,5	Low	• Limit the number of instream piers. • Appropriately design and place culverts to avoid the onset of erosion. • Implement best practice pier design that limits scouring and deflects debris and sediment / other natural substrate around these structures.

Phase(s)	Activity	Aspect	Risk of Impact	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating	KEY MITIGATION
		Risk from hydrocarbons (fuel/oil) and cement management during future bridge repairs/maintenance	O1-3: Impacts to water quality	46	Low			• Undertake any road repairs and/or maintenance during low flows (winter season). • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
		Permanent flow impedance due to bridge infrastructure (instream pier)	O1-4: Impacts to ecological connectivity and/or ecological disturbance impacts	26	Low			• Limit instream habitat disturbance as far as possible. • Limit repairs/maintenance of instream structures to low flows during the dry (winter) season. • Restrict worker and machinery access. • Prohibit poaching or collection of plants and biota. • Remove temporary diversions and impoundments once repair/maintenance work is complete. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

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1. INTRODUCTION

1.1 Project Locality & Description

The South African National Roads Agency SOC Ltd (SANRAL) has earmarked Section 8 of the R56 road for rehabilitation and resealing. The length of road that forms the focus of this project extends from approximately 17km east of the town of Cedarville to the town of Matatiele (Figure 1). The project will involve offsetting the centreline of the existing road and widening the shoulder of the existing road by 3 m on each side. While this approach requires demolition and reconstruction of under-capacitated bridges and culvert systems along the route, the Mzimvubu River Bridge (Km 155) will not to be altered or modified.

The project previously received environmental authorization in 2016. The work was however never started. With more than 5 years having passed since the authorization was granted, the RoD has expired. The project is now being re-initiated and there is a need to re-apply for environmental authorization. The Environmental Authorisation (EIA) process is being undertaken by Coastal and Environmental Services (CES). As part of the EIA process, CES appointed Eco-Pulse to undertake a baseline aquatic biodiversity assessment. The scope of work for this assessment was informed by the previously completed aquatic baseline assessment completed by GIBB (Pty) Ltd in 2016. The aquatic baseline assessment was delivered to CES in November 2022. In March 2023 CES requested that an assessment of impacts be undertaken by Eco-Pulse.

Note: At the request of CES the baseline aquatic assessment focused on the seven (7) watercourses covered in the GIBB (2016) report. No infield sampling or analyses were conducted along any of the other watercourses crossed by the R56 road. The impact significance and risk assessment contained in this report are therefore relevant to only the sampled rivers and the proposed construction and operation phase activities in the vicinity of these watercourses.

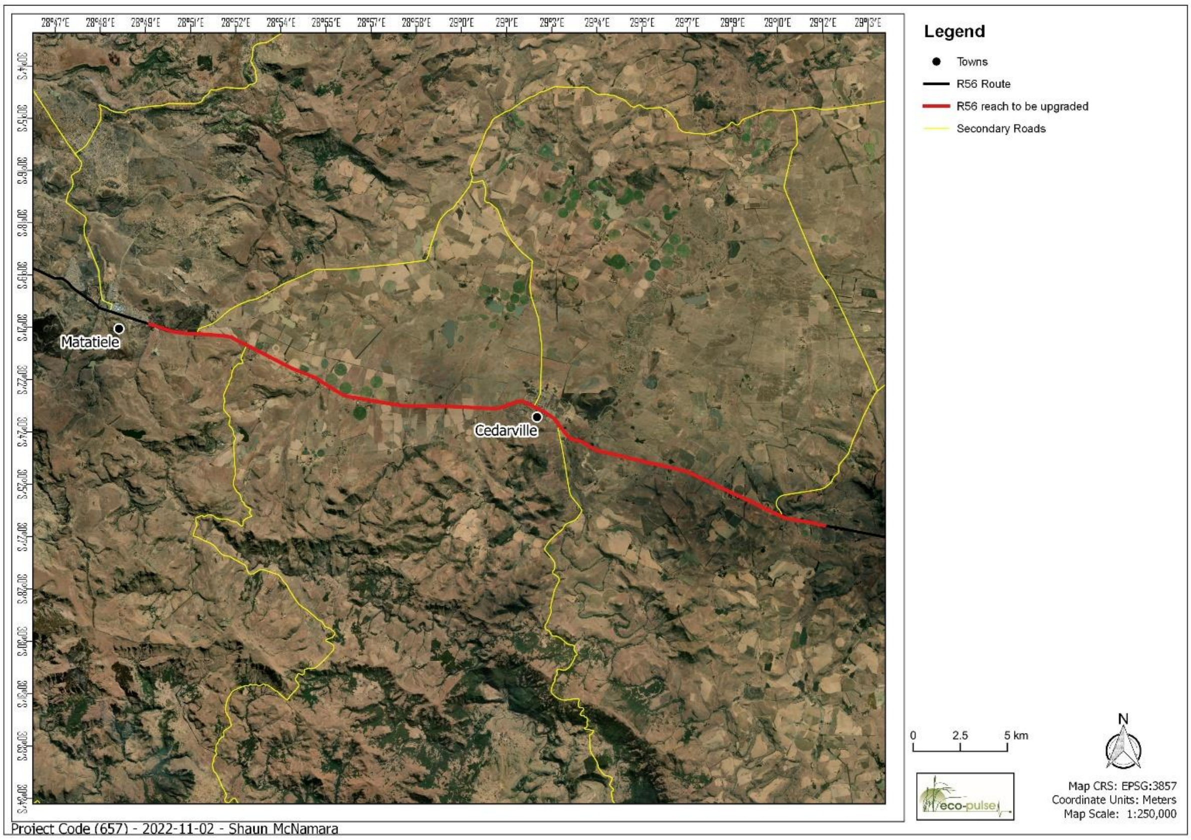

Figure 1. Map showing the length of the R56 route that is to be upgraded in relation to the towns of Cedarville and Matatiele.

1.2 Scope of Work

1. Contextualization of the study area in terms of important biophysical characteristics and freshwater conservation planning through a review of available spatial datasets and relevant conservation plans.

2. Assessment of Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) for the seven (7) selected watercourses included in the 2016 Baseline Aquatic Biodiversity Assessment (GIBB, 2016) (T3KINI-USMAT, T3MZIM-CMPSN, T3MZIM-EDNDL, T3MZIM-ALING, T3MZIM-DSR56, T3MZIM-RSTFN, T3MZIM-STRYD).
    - o Aquatic PES was assessed using the Index of Habitat Integrity (IHI) tool (Kleyhans, 1996).
        - ▪ IHI assessments were informed by the following:
            - In situ water quality sampling.
            - Adapted Invertebrate Habitat Assessment System (IHAS).
            - Aquatic macroinvertebrate assessment using the South African Scoring System Version 5 (SASS5), including deriving an ecological category using the Dallas (2007) SASS5 interpretation guidelines.
            - Ichthyofaunal survey.

  - Assessment of river EIS (Ecological Importance & Sensitivity) using an EIS assessment method developed by Eco-Pulse adapted from the DWAF Resource Directed Measures EIS tools (Kleynhans, 1999 & Duthie, 1999).

3. Description and assessment of the significance of wetland/aquatic impacts for the seven (7) assessed watercourses for all project phases (construction and operation).
4. Application of the "DWS Risk Assessment Matrix" for the seven (7) assessed watercourses, as detailed in the General Authorization in terms of Section 39 of the National Water Act No. 36 of 1998 for Water Uses as defined in Section 21 (c) or Section 21 (i), as contained in Government Gazette No. 40229, 26August 2016 and contained within the DWS document titled 'Section 21(c) and (i) Risk-based assessment and authorization, October 2014, Edition 2' to inform water licensing requirements for the project (i.e. full WULA vs GA).
5. Provision of mitigation recommendations to avoid unnecessary impacts to the seven (7) assessed watercourses.
6. Reporting: Compilation of a single (1) <u>Aquatic Biodiversity Assessment Report</u> including all relevant maps and supporting information.

2. APPROACH AND METHODS

2.1 Desktop & Baseline Assessment Methods

2.1.1 Data Sources Consulted

The data sources and GIS spatial information listed in Table 1 (below) were consulted to inform the specialist assessment. The data type, relevance to the project and source of the information has been provided.

Table 1. Data sources and GIS information consulted to inform the assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
Biophysical Context		
Colour aerial photography	*Desktop mapping of drainage network, wetlands, etc.*	NGI (online)
Latest Google Earth ™ imagery	*To supplement available aerial photography where needed*	Google Earth™ On
DWA Eco-regions (GIS Coverage)	*Classification of local Ecoregions*	DWA (2005)
Geomorphological Provinces of South Africa	*Understand regional geomorphology controlling the physical environment*	Partridge *et al.* (2010)
NFEPA: river and wetland inventories (GIS Coverage)	*Highlight potential onsite and local rivers and wetlands*	WRC (2011)
Conservation Context		
Inland Aquatic (Freshwater) Realm of the 2018 SANBI National Biodiversity Assessment (GIS Coverage)	*Provides insight into the national conservation planning status of watercourses in the study area*	Van Deventer et al. (2019)
NFEPA: River, wetland, and estuarine FEPAs (GIS Coverage)	*Shows location of national aquatic ecosystems conservation priorities*	WRC (2011)
Eastern Cape Biodiversity Plan 2019 (GIS Coverage	*Provides insight into the provincial conservation planning status of watercourses in the study area*	Desmet & Hawley (2019)

2.1.2 Baseline Aquatic Assessment

The methods of data collection, analysis and assessment employed as part of the baseline assessment are briefly discussed in this section. The assessments undertaken as part of this study are listed in Table 2 (below) along with the relevant published guidelines and assessment tools / methods / protocols utilised.

Table 2. Summary of methods used in the baseline assessment.

	Method/Technique	Reference for Methods/Tools Used
Rivers/Streams	**Present Ecological State (PES)**	Index of Habitat Integrity (IHI) (after Kleynhans, 1996). IHI assessments were informed by the following: • In situ water quality sampling. • Adapted Invertebrate Habitat Assessment System (IHAS). • Aquatic macroinvertebrate assessment using the South African Scoring System Version 5 (SASS5), including deriving an ecological category using the Dallas (2007) SASS5 interpretation guidelines. • Ichthyofaunal survey.
	Riparian Ecological Importance & Sensitivity (EIS)	EIS assessment tool developed by Eco-Pulse based on guidance in the WET-Ecoservices manual (Kotze, et al., 2021).

2.1.3 Sampling Sites

The sampling sites used in the GIBB (2016) baseline aquatic assessment were used in this present study. Site labels were also retained. GIBB (2016) reported that the in-field selection of the sampling sites was based upon available habitat (i.e., sufficient water level and sampling habitat), and proximity to road watercourse crossings within the study area. the sample sites are shown in Figure 2 and are summarised in Table 3.

Table 3. Summary of the aquatic assessment sampling site, including a photo of each site.

Name	Co-Ordinates	Photo	Description
T3KINI-USMAT	30°20'35.59" S 28° 49'31.56" E		Located along an unnamed non-perennial tributary of the Botsola (Kinira) River, immediately west of Matatiele.
T3MZIM-CMPSN	30°21'48.17" S 28° 52'33.21" E		Located along an unnamed non-perennial tributary of theMzimvubu River, directly upstream of a culvert crossing of the R56.
T3MZIM-EDNDL	30°22'16.28" S 28° 55'33.01" E		Located along an unnamed tributary of the Mzimvubu River, upstream of a dam situated on parent farm Edendale 185 and downstream of bridge crossing of the R56

T3MZIM-ALING	30°23'14.07" S 28°58'14.65" E		Located along an unnamed tributary of theMzimvubu River, immediately upstream of a small dam situated on parent farm Alingthun 181. The site is downstream of culvert crossing of the R56.
T3MZIM-DSR56	30°24'14.50" S 29° 03'28.08" E		Located along the main stem of the Mzimvubu River upstream of the R56 bridge crossing.
T3MZIM-RSTFN	30°25'35.83" S 29° 08'39.85" E		Located along an unnamed tributary of the Con Amore Stream, directly downstream of a culvert crossing of the R56.
T3MZIM-STRYD	30°26'02.65" S 29° 10'15.26" E		Located along the perennial stream referred to as the Con Amore Stream (for the purposes of this report).

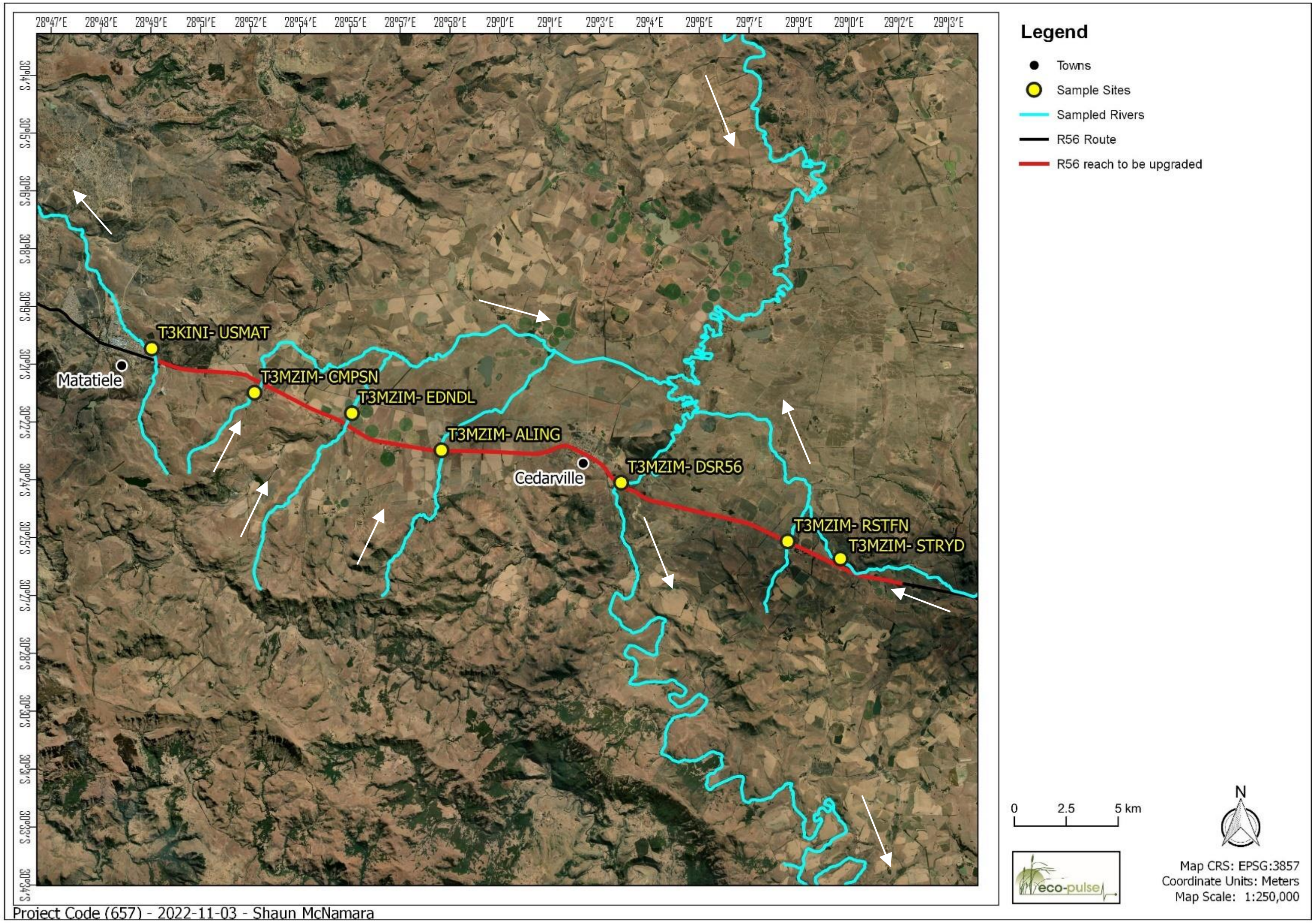

Figure 2. Location of the aquatic assessment sampling sites ('white' arrows indicates general direction of watercourse flow).

2.2 Impact Assessment Framework & Methodology

For the purposes of this study, the assessment of potential freshwater impacts was undertaken using an "*Impact Assessment Methodology for EIAs*" adopted by Eco-Pulse (2020). This assessment was informed by baseline information contained in this report relating to the sensitivity of freshwater habitats and potential occurrence of protected species, as well as on information relating to the proposed development. Note that the Freshwater Impact Assessment has been aligned as far as possible with the minimum criteria and requirements for Aquatic Biodiversity Impact Assessment contained in the "Procedures to be followed for the assessment and minimum criteria for reporting of identified environmental themes of Section 45 (a) and (h) of the National Environmental Management Act, 1998, when applying for Environmental Authorization", contained in Government Gazette No. 320 (20 March 2020).

The impact assessment process begins with a general description of the proposed project (construction and operation phases), with the various environmental stressors and risks associated with development activities then being defined (Table 15). Impacts are then described under four (4) distinct 'groups' with impact significance assessed for each group based on a range of assessment criteria. The general framework for the freshwater impact assessment is shown below in Table 4.

Table 4. Freshwater Ecosystem Impact Assessment Framework for development projects.

FRESHWATER ECOSYSTEM IMPACT ASSESSMENT FRAMEWORK	
DEVELOPMENT TYPE & ACTIVITIES	
Construction Activities:	**Operation Activities:**
1. Decommissioning and re-construction of the bridges and culvert crossings. **2. Construction works required to realignment and widen the road.**	**1. Operation of the road, bridges and culvert watercourse crossings.**
FRESHWATER ECOSYSTEM IMPACT & RISK ASSESSMENT GROUPS	
1 Direct physical loss or modification of freshwater habitat	
2 Alteration of hydrological and geomorphological processes (*flow, erosion & sediment regime changes*)	
3 Impacts to water quality (*pollution*)	
4 Impacts to ecological connectivity and/or ecological disturbance impacts	

The significance of potential impacts associated with the proposed development on freshwater ecosystems was assessed for the following scenarios:

- **Realistic "poor mitigation" scenario** – this is a realistic worst-case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.
- **Realistic "good" scenario** – this is a realistic best-case scenario involving the effective implementation of construction mitigation, incorporation of most of the design mitigation, good operational maintenance, and successful rehabilitation.

The approach to the impact significance assessment is to identify the main ultimate ecological consequences associated with each impact group. The four ultimate ecological consequences are:

1. **Water resource management:** The inter-connected nature of water resources is emphasised here by recognising that an impact at a site will ultimately affect downstream users and the ability to meet user requirements. An understanding of the catchment context, with emphasis on the existing use of and reliance on water resources by downstream communities is therefore required. Key concerns therefore relate to any direct impacts on water quantity and quality together with habitat-related impacts that could exacerbate downstream impacts by undermining the ability of wetlands and riparian areas to attenuate floods, trap sediments and assimilate pollutants (regulating & supporting services).
2. **Ecosystem conservation:** The focus here is specifically on understanding the significance of impacts in relation to the ability to meet habitat conservation targets. This is informed by an understanding of conservation significance that is influenced by factors such as the ecosystem threat status, regional conservation context, condition of habitat, and connectivity to other intact habitats.
3. **Species conservation:** The focus here is specifically on species of special or notable conservation importance or concern, including Red Data Book or Red List taxa in threatened or conservation concern categories, Threatened or Protected Species listed under the National Environmental Management: Biodiversity Act, endemic taxa, locally threatened taxa and/ or any particular taxa of special management concern. Includes both fauna and flora.
4. **Direct use values:** The emphasis here is specifically on understanding and assessing the social impacts of the development based on an understanding of the impacts on provisioning (water supply, harvestable natural resources, cultivated foods or food for livestock) and cultural services available to local communities. This assessment is therefore based on an understanding of the current importance of water resources for local users and supporting local livelihoods, including religious ceremonies, tourism & recreation, or educational activities.

Once the ultimate ecological consequence has been selected for each impact group, and the impact intensity rated (according to Eco-Pulses rating scheme), the likelihood of the impact occurring, as well as the anticipated extent and duration of the impact are rated and combined in a structured way to determine the impact significance. This is done in accordance with the following formula:

Impact significance = (impact intensity + impact extent + impact duration) x impact likelihood

This formula is based on the basic risk formula: **Risk = consequence x probability**

Table 5. Impact significance categories and definitions.

Impact Significance	Definition
High	**Totally unacceptable** and fatally flawed from an environmental perspective. The proposed activity should only be approved under very special circumstances (i.e., national priorities with large societal benefit). If authorised, residual impacts must be adequately compensated through appropriate offset mechanisms.
Moderately High	**Generally unacceptable** and should ideally be avoided. The potential impact will affect a decision regarding the proposed activity and require that the need and desirability for the project be clearly substantiated to justify the associated ecological risks. If authorised, residual impacts must be adequately compensated through appropriate offset mechanisms.
Moderate	**Potentially unacceptable** and should ideally be reduced to lower significance levels. The potential impact should influence the decision regarding the proposed activity and requires a clear and substantiated need and desirability for the project to justify the risks. If authorised, offsets should be considered to compensate for residual impacts.
Moderately Low	**Acceptable** with low to moderate risks. The potential impact may not have any meaningful influence on the decision regarding the proposed activity.
Low	**Acceptable**. The potential impact is very small or insignificant and should not have any meaningful influence on the decision regarding the proposed activity.

A confidence rating was also given to the rated impacts rated in accordance with the table below:

Table 6. Confidence ratings used when assigning impact significance ratings.

Level of confidence	Contributing factors affecting confidence
Low	A low confidence level is attributed to a low-moderate level of available project information and somewhat limited data and/or understanding of the receiving environment.
Medium	The confidence level is medium, being based on specialist understanding and previous experience of the likelihood of impacts in the context of the development project with a relatively large amount of available project information and data related to the receiving environment.
High	The confidence level is high, being based on quantifiable information gathered in the field.

2.3 Risk Assessment Method

Government Notice 509 of 2016 published in terms of Section 39 of the NWA sets out the terms and conditions for the General Authorization of Section 21(c[1]) and 21(i[2]) water uses, key among which is that only developments posing a 'Low Risk' to watercourses can apply for a GA. Note that the GA does not apply to the following activities:

- Water use for the rehabilitation of a wetland as contemplated in GA 1198 contained in GG 32805 (18 December 2009).
- Use of water within the 'regulated area'[3] of a watercourse where the Risk Class is **Medium or High.**

[1] 21(c): Impeding or diverting the flow of water in a watercourse
[2] 21(i): Altering the bed, banks, course, or characteristics of a watercourse
[3] The 'regulated area' of a watercourse; for Section 21 (c) or (i) of the Act refers to:

i. The outer edge of the 1:100 yr flood line and/or delineated riparian habitat, whichever is greatest, as measured from the centre of the watercourse of a river, spring, natural channel, lake or dam.

- Where any other water uses as defined in Section 21 of the NWA must be applied for.
- Where storage of water results from Section 21 (c) and/or (i) water use.
- Any water use associated with the construction, installation or maintenance of any sewerage pipeline, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

To this end, the DWS have developed a Risk Assessment Matrix/Tool to assess water risks associated with development activities. The DWS Risk Matrix/Assessment Tool (based on the DWS 2015 publication: 'Section 21 (c) and (i) water use Risk Assessment Protocol' was applied to the proposed project. The tool uses the following approach to calculating risk:

RISK = CONSEQUENCE X LIKELIHOOD

whereby:

CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION

and

LIKELIHOOD = FREQUENCY OF ACTIVITY + FREQUENCY OF IMPACT + LEGAL ISSUES + DETECTION

The key risks associated with the proposed development project are presented in Table 4, and are again outlined below:

1. Direct physical loss or modification of freshwater habitat.
2. Alteration of hydrological and geomorphological processes (flow, erosion & sediment regime changes).
3. Impacts to water quality (pollution).
4. Impacts to ecological connectivity and/or ecological disturbance impacts.

For each of the above stressors, risk was assessed qualitatively using the DWS risk matrix tool.

It is important to note that the risk matrix/assessment tool also makes provision for the downgrading of risk to low in borderline moderate/low cases subject to independent specialist motivation granted that (i) the initial risk score is within twenty-five (25) risk points of the 'Low' class and that mitigation measures are provided to support the reduction of risk. The tool was applied to the project for the highest risk activities and watercourses and was used to inform WUL requirements for the proposed development.

2.4 Assumptions, Limitations & Information Gaps

The following limitations and assumptions apply to this assessment:

ii. In the absence of a determined 1:100 yr flood line or riparian area, refers to the area within 100m from the edge of a watercourse (where the edge is the first identifiable annual bank fill flood bench).
iii. A 500m radius from the delineated boundary of any wetland or pan.

2.4.1 General assumptions & limitations

- This report deals exclusively with a defined area and the extent and nature of wetland and aquatic ecosystems in that area.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the province at the time of the assessment.
- All field assessments were limited to day-time assessments.

2.4.2 Sampling limitations & assumptions

- At the request of CES the same sample sites used in the 2016 baseline aquatic assessment (GIBB, 2016) were sampled for this present study.
- During the field visit it was determined by Eco-Pulse that several of the aquatic sampling sites included in 2016 assessment by GIBB were located within wetlands. However, to achieve consistency in this study and the study from 2016, the same aquatic sampling techniques and assessment were employed at each site. This assessment therefore focused on the instream components of all assessed watercourses.
- This study did not include any watercourse delineations. Sampling focused exclusively on instream aquatic fauna and surface water quality.
- Sampling by its nature means that not all parts of the study area were visited. The assessment findings are thus only applicable to those areas sampled, which were extrapolated to the rest of the study area. A sampling map from the site visit is displayed in Annexure A.
- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.

2.4.3 'Seasonality' of the Assessment

Eco-Pulse undertook sampling for the baseline aquatic biodiversity assessment in October 2022. One infield visit does not fully cover the seasonal variation in conditions at the site. Nevertheless, seasonality is not a key factor for the target study area surveyed, and no further seasonal surveys will be required.

2.4.4 Baseline Ecological Assessment

- The PES and EIS assessments make use of qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have tried to substantiate all claims where applicable and necessary.
- The EIS assessment did not specifically address all the finer-scale ecological aspects of the water resources such as a detailed list of all aquatic fauna likely to occur (i.e., amphibians) within and make use of these systems.

2.4.5 Impact Assessment

- The impact significance assessment was only undertaken for the two ultimate consequences, namely (i) Impacts to water resource supply and quality; and (ii) Impacts to ecosystem and habitat conservation.
- The impact assessment was only undertaken for a single development scenario under two mitigation scenarios referred to as the 'realistic poor mitigation' and 'realistic good mitigation' scenarios.
- It is understood that the Mzimvubu River Bridge (Km 155) will not to be altered or modified. The upgrade or reconstruction of this bridge was not considered as part of this assessment.
- At the request of CES the baseline aquatic assessment focused on the seven (7) watercourses covered in the GIBB (2016) report. No infield sampling or analyses were conducted along any of the other watercourses crossed by the R56 road. The impact significance and risk assessment contained in this report are therefore relevant to only the sampled rivers and the proposed construction and operation phase activities in the vicinity of these watercourses.
- It is not known by Eco-Pulse which crossing will need to be decommissioned and upgraded and which will be retained in the current state. This assessment has therefore taken the conservative approach of assuming all assessed crossing locations will need to be re-constructed.
- The evaluation of impact significance under the 'realistic good mitigation' scenario assumes all project design and impact mitigation measures presented in Chapter 6 will be implemented during planning, construction, and operation of the project.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects.
- The impact descriptions and assessment are based on the author's understanding of the proposed development based on information provided.

2.4.6 Risk Assessment

- All risk ratings generated by the DWS risk matrix are conditional on the effective implementation of the mitigation measures provided in the specialist freshwater habitat assessment report for the project.
- For the purposes of this study, the term 'stressor[4]' was favoured instead of the term 'aspect' referred to in the DWS risk matrix.
- For the purposes of this study, the criterion 'frequency of stressor occurrence' was favoured instead of the criterion 'frequency of activity' referred to in the DWS risk matrix.
- For the severity ratings, impacts were assessed on their merits rather than automatically scoring impacts as 'disastrous' as guided in the DWS risk matrix.

[4] Any physical, chemical, or biological entity that can induce an adverse response to the structure and function of an ecosystem (Reference: USEPA (1998). Guidelines for Ecological Risk Assessment; Notice Fed. Reg. 6326846-26924. Environmental Monitoring Systems Laboratory, Office of Research and Development, US Environmental Protection Agency, Cincinnati, Ohio.

- The severity assessment for changes in flow regime and physico-chemical impacts were interpreted in terms of the changes to the local freshwater ecosystem represented by the potentially affected reaches.
- For the scoring of impact duration, the predicted change in PES was also considered which could override the actual duration of the impact where applicable e.g., if the impact duration was long term (typically a score of 4 out of 5) but the predicted change in PES is negligible, the impact duration was downs-scored to a score of 2 in line with the duration criteria descriptions in the risk matrix tool.

3. DESKTOP ASSESSMENT

3.1 Biophysical & Conservation Context

Understanding the biophysical and conservation context of the study area and surrounding landscape is important as it informs decision making regarding the significance of the area to be affected.

3.1.1 Biophysical Setting & Context

A summary of key biophysical details for study area and catchment area is presented in Table 7, below.

Table 7. Key details of the study area.

Location	Alfred Nzo District Municipality
Level 1 Ecoregion (DWAF, 2007)	South Eastern Uplands
Geomorphic Province	South-eastern Coastal Hinterland
National Water Act Water Management Area (WMA)	Mzimvubu - Tsitsikamma
Quaternary Catchment	T31F & T33A
Main Collecting River in the Catchment	Mzimvubu River

3.1.2 Drainage Setting & Catchment Context

Most of the study area is in DWS quaternary catchments T31F. A portion of the western edge of the target section of the R56 is located within DWS quaternary catchments T33A (Figure 3). The primary river draining the T31F catchment area is the Mzimvubu which flows in a general southerly direction. The R56 crosses the Mzimvubu River immediately east of the town of Cedarville. With one exception, all watercourses crossed by the target length of the R56 are tributaries of the Mzimvubu River. The exception being a seasonal stream near Matatiele which is a tributary of the Kinira River which drains catchment T33A. The study area is located within the Mzimvubu – Tsitsikamma water management area.

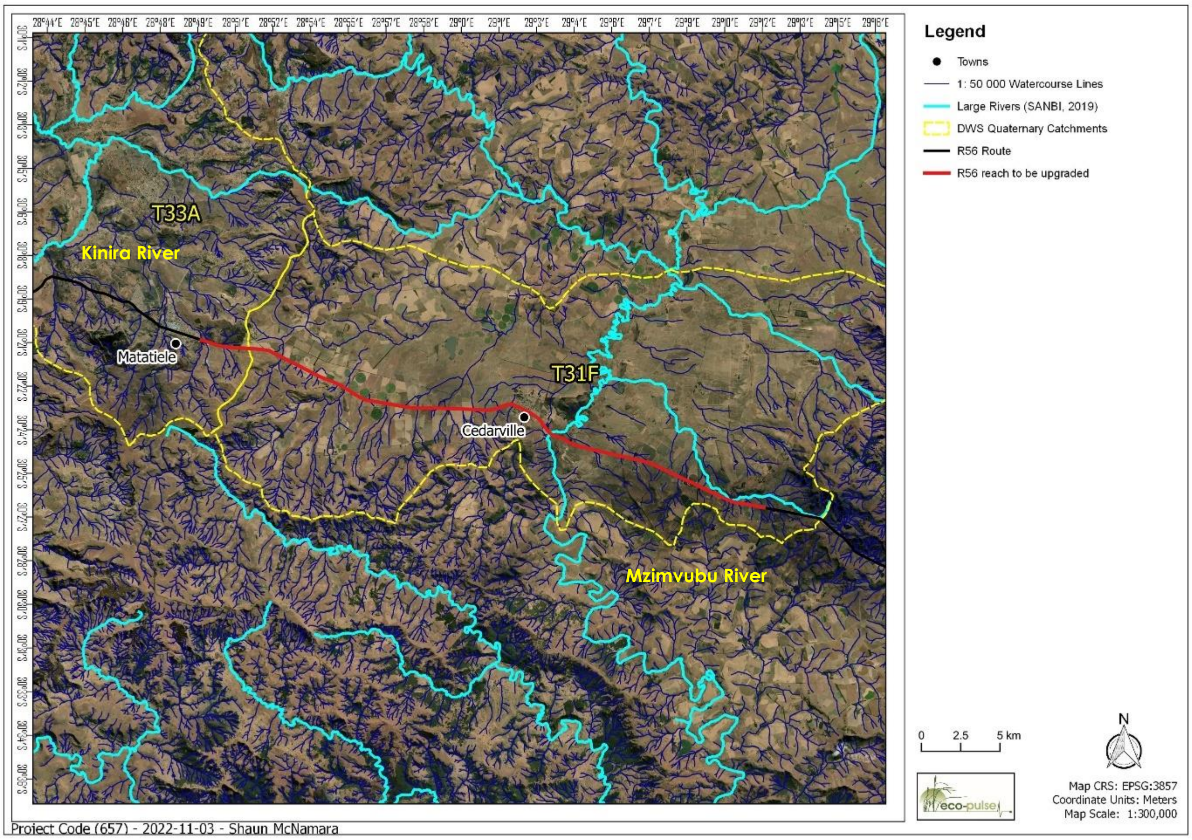

Figure 3. Regional drainage network for the project study area.

3.1.3 Freshwater Conservation Context

National and provincial conservation datasets were screened for the study area, the results of which are presented in Table 8.

Table 8. Key freshwater conservation context details for the study area.

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset		**Relevant Conservation Feature**	**Conservation Planning Status**
National Freshwater Ecosystem Priority Areas (NFEPA) (WRC, 2011)	Rivers	**Catchment Planning Units:** • 5134 • 4990 • 5071	5134 – Upstream 4990 – Upstream 5071 – FEPA
	Wetlands	**FEPA Wetlands**	FEPA wetlands present
		NFEPA Wetland Vegetation Groups: Sub-escarpment Grassland Group 6	Seep - Endangered Unchanneled valley-bottom – Least Threatened Channelled valley-bottom – Least Threatened Floodplain - Least Threatened

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset		**Relevant Conservation Feature**	**Conservation Planning Status**
2018 National Biodiversity Assessment – Inland Aquatic / Freshwater Realm (GIS Coverage) (Van Deventer et al., 2019)	Rivers	**South Eastern Uplands** • Lowland River • Upper Foothills River	Lowland River – Critically Endangered Upper Foothills River – Endangered
	Wetlands	**Wetland Ecosystem Bioregions** Sub-escarpment Grassland Bioregion	Seep - Critically Endangered Unchanneled valley-bottom – Critically Endangered Channelled valley-bottom – Critically Endangered Floodplain – Critically Endangered
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset		**Relevant Conservation Feature**	**Conservation Planning Status**
Eastern Cape Biodiversity Conservation Plan (Desmet & Hawley 2019)		Watercourses within study area	CBA 1

4. BASELINE AQUATIC ASSESSMENT RESULTS

4.1 Water Quality Analysis

The in-situ water quality results are presented in Table 9, along with the results from the 2016 aquatic baseline assessment (GIBB, 2016). A brief interpretation of the results is presented below.

Table 9. In-situ water quality readings for each sample site.

	T3KINI-USMAT		T3MZIM-CMPSN		T3MZIM-EDNDL		T3MZIM-ALING		T3MZIM-DSR56		T3MZIM-RSTFN		T3MZIM-STRYD	
	2016	2022	2016	2022	2016	2022	2016	2022	2016	2022	2016	2022	2016	2022
Determinands	Not sampled – lack of appropriate flow and habitat		Not sampled – lack of appropriate flow and habitat											
Temperature (°C)					22.1	20.8	24.8	20.7	19.4	17.6	13.9	16.7	21.4	15.9
Dissolved Oxygen % Saturation)					57.1	83.3	88.8	84.5	84.4	62.3	47.7	89.4	65.2	87.0
Electrical Conductivity (µS/cm)					292.0	331.8	145.4	131.5	148.5	150.5	166.4	128.7	325.0	142.5
pH (pH units)					7.9	7.6	8.5	7.5	7.7	7.4	6.8	7.5	7.8	7.5

- The maintenance of adequate dissolved oxygen concentrations in rivers and streams is required for the survival and functioning of aerobic aquatic biota. Dissolved oxygen concentrations of 80%-120% saturation is generally considered to protect all life stages of most aerobic aquatic organisms that are endemic or adapted to inhabiting warm water habitats (DWAF, 1996). Dissolved oxygen saturation ranged between 80% and 90% for all sampled sites, except for site T3MZIM-DSR56 (Mzimvubu River) where a 62.3% oxygen saturation was measured. Dissolved oxygen concentrations along the sampled reach of the Mzimvubu River could therefore be a factor influencing aquatic faunal biodiversity.

- Electrical conductivity measurements were within acceptable limits for most aquatic biota at all sample sites, except for at site T3MZIM-EDNDL. Electrical conductivity was slightly elevated at this site during the most recent field visit (331.8 µS/cm). Electrical conductivity was similarly elevated at this site during the GIBB 2016 assessment (292.0 µS/cm). The sampling site is located immediately adjacent to a cultivated field that is irrigated by an overhead centre pivot. It is assumed that runoff of fertilizer from the crop area is resulting in increased concentrations of dissolved ions at this sample location.
- pH varied from 7.4 to 7.6 across all sampled sites. This is considered normal for inland surface freshwater resources.

4.2 SASS5 & IHAS Assessments

The SASS5 river health classes were derived using the 'South Eastern Uplands– Lower' biological bands set out by (Dallas, 2007). A summary of SASS5 and IHAS results has been presented in Table 10 followed by a brief description of the assessment outcomes.

Table 10. IHAS and SASS5 results for each sampling sites.

	T3KINI-USMAT		T3MZIM-CMPSN		T3MZIM-EDNDL		T3MZIM-ALING		T3MZIM-DSR56		T3MZIM-RSTFN		T3MZIM-STRYD	
	2016	2022	2016	2022	2016	2022	2016	2022	2016	2022	2016	2022	2016	2022
Determinands	Not sampled – lack of appropriate flow and habitat		Not sampled – lack of appropriate flow and habitat											
IHAS Biotope Class and Score					22 Poor	25 Poor	24 Poor	20 Poor	58 Fair	20 Poor	40 Poor	35 Poor	38 Poor	37 Poor
No. Taxa					13	9	12	10	24	9	15	14	26	14
SASS Score					54	40	44	45	128	39	58	74	121	71
ASPT[5]					4.15	4.44	3.67	4.5	5.33	4.33	3.87	5.29	4.65	5.07
SASS5 Ecological Category (Dallas, 2007)					E/F	E/F	E/F	E/F	C	E/F	E/F	D	C	D

- When applying ecological categories to the sampled sites using the Dallas (2007) SASS5 data interpretation guidelines sites T3MZIM-EDNDL, T3MZIM-ALING, and T3MZIM-DSR56 fall within the E/F category (seriously / critically modified). Sites T3MZIM-RSTFN and T3MZIM-STRYD both place within the D category (largely modified).
- For T3MZIM-EDNDL, T3MZIM-ALING the same ecological category outcome was observed during the GIBB 2016 study. For T3MZIM-DSR56 the 2016 study placed this system in the C category (moderately modified) while the most recent study shows a decrease to the E/F category. For T3MZIM-STRYD there is a decrease from a C to D category between 2016 and 2022. T3MZIM-RSTFN showed an increase from a D to C category.

[5] Average score per taxon

- Overall, the low SASS5 and ASPT scores at the sample sites are considered to be mostly influenced by the generally poor habitat quality for diverse aquatic macroinvertebrate colonization. This is reflected in the 'poor' outcome for the IHAS assessments for each site, and the generally acceptable water quality (Table 10). In the days before the fieldwork for this aquatic assessment was completed, the study area received several high intensity and high-volume rainfall events. This caused the sampled watercourses to rise with many of them experiencing a level of flooding during sampling. This is expected to have caused 'drift' of some macroinvertebrates from the sampled reaches, which also likely had an effect on the outcomes of the assessment, with SASS5 assessments undertaken during flooding often not being considered representative of the biota at site (Dicken & Graham, 2002).
- The notable decline is the number of taxa, SASS5 score and ASPT for the Mzimvubu sample site between 2016 and 2022 is a result of this system being in flood at the time of sampling in 2022. This meant that sampling at this site was limited to the edges of the active channel as the channel area was extremely deep. Therefore, no stones or gravel were sampled at this site, which are biotopes known to typically host the greatest diversity of aquatic macroinvertebrates.

4.3 Ichthyofauna (Fish) Survey

4.3.1 Expected fish species.

Fish records available on the Freshwater Biodiversity Information System (FBIS) indicate no native species have been recorded and submitted on the database. The nearest fish records are non-native *Micropterus dolomieu* (smallmouth bass) some distance downstream of the study area on the Mzimvubu River.

According to the DWS (2014) PES and EIS database, excepted native fish species with in the sub quaternary reaches T31G-05071 and T31F-05134 in the study area include two species, namely *Enteromius anoplus* and *Anguilla mossambica*. Both species are considered moderately sensitive to physico-chemical (water quality) and 'no-flow' modifications according to the DWS (2014). Species with moderate physico-chemical sensitivity can survive and breed under moderately modified water quality conditions. Species with moderate 'no-flow' sensitivity require flow during certain phases of their life-cycle to breed or make nursery areas with suitable cover available. Generally, increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. Flow also often stimulates breeding activities and migration in such species. A summary of the DWS desktop PES and EIS fish data has been provided below in Table 11 along with the IUCN threat status for listed species.

Table 11. Summary of DWS Desktop PES and EIS fish data

Scientific name	IUCN status	Confidence of presence of in SQ reach	Physico-chemical sensitivity	No-flow sensitivity
Enteromius anoplus	**LC**	**Low**	**Moderate**	**Moderate**
Anguilla mossambica	**NT**	**Low**	**Moderate**	**Moderate**

In addition to the expected species mentioned above, GIBB (2016) also recorded *Lepomis macrochirus* (bluegill) and *Micropterus punctulatus* (spotted bass) during their survey in 2016. Both species are introduced alien/ non-native species. GIBB (2016) also noted that several other alien species were expected to occur in the study area, including *Cyprinus carpio (common carp)*, *Oncorhynchus mykiss (rainbow trout)* and *Perca fluviatilis (European perch)*. *Tilapia sparrmanii* (banded tilapia) was also noted as an expected extralimital[6] species in the study area.

4.3.2 Fish survey results

The only site at which indigenous fish were recorded was T3MZIM-STRYD. Here four (4) specimens of *Enteromius anoplus* were recorded. At T3MZIM-EDNDL, T3MZIM-DSR56, and T3MZIM-ALING only exotic / introduced fish were recorded, namely *Cyprinus carpio* and *Micropterus sp*. At T3MZIM-RSTFN no fish were recorded. Table 12 provides a summary of fish survey data for sampled sites. A summary and interpretation of fish findings for each site are provided below:

- At T3MZIM-STRYD native fish diversity was expected to be low based on the reference species list for the study area. Habitat for fish was available but was limited to shallow run-riffle biotopes with emergent reeds and herbaceous marginal vegetation.
- At T3MZIM-EDNDL, habitat for fish was limited to shallow run and pool habitat with herbaceous marginal vegetation. Modifications to instream habitat from dams and weirs had resulted in the colonisation of non-native, invasive fish species. These species often prey on smaller native species such as *Enteromius sp.* and/or compete with native fish for resources and habitat.
- At T3MZIM-RSTFN, instream habitat was very limited. The channel was characterised by an excavated drain through wetland habitat. The lack of available instream habitat and flow seasonality were likely the primary causes of no fish being recorded at this site.
- At T3MZIM-DSR56, sampling was made very difficult by high flows. The nature of instream habitat favoured invasive species. Additionally, instream habitat diversity was limited, and the reach was characterised by relatively deep run habitat with limited refugia for smaller native fish.
- At T3MZIM-ALING, only non-native, invasive species were recorded. The site was characterised by artificial damming which has created favourable habitat for the alien species recorded.

[6] Not naturally found within a given geographical area/ occurring outside of its natural/ expected range.

Table 12. Summary of fish survey results.

<table>
<tr><th>Scientific name</th><th>Common name</th><th>T3KINI-USMAT</th><th>T3MZIM-CMPSN</th><th>T3MZIM-EDNDL</th><th>T3MZIM-ALING</th><th>T3MZIM-DSR56</th><th>T3MZIM-RSTFN</th><th>T3MZIM-STRYD</th></tr>
<tr><td>Enteromius anoplus</td><td>Chubbyhead barb</td><td rowspan="4">Not sampled – lack of appropriate flow and habitat</td><td rowspan="4">Not sampled – lack of appropriate flow and habitat</td><td>-</td><td>-</td><td>-</td><td>-</td><td>4</td></tr>
<tr><td>Anguilla mossambica</td><td>Longfin eel</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Cyprinus carpio</td><td>Common carp</td><td>8</td><td>3</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Micropterus sp.</td><td>Bass</td><td>5</td><td>1</td><td>3</td><td>-</td><td>-</td></tr>
</table>

4.4 Index of Habitat Integrity (IHI)

The Index of Habitat Integrity (IHI), Version 2 (Kleynhans, 1996 - updated 2012) was applied to watercourse reaches associated with each monitoring sites. The water quality results, SASS5 findings and fish survey results were also used to inform aspects of the IHI assessments. The outcomes of the IHI assessment, including a summary of key impacts, are contained in Table 13, below. An outline of the outcomes is as follows:

- Instream habitat condition was assessed as being 'C: moderately modified' for all assessed sites. Notable instream impacts include altered flow regime due to the establishment of dams along many of the watercourses, altered water quality due to runoff from agricultural lands, and channel scour (erosion) associated with altered catchment runoff processes. The presence of the Carp fish species in watercourses is also known to have an influence on instream habitat as they increase water column turbidity.
- Riparian habitat condition was assessed as ranging from 'C: moderately modified' to 'D: largely modified'. Key impacts include, altered inundation of macro-bank areas due to the presence of dams along most of the sampled watercourses, bank erosion, and the infestation of macro-channel areas by woody invasive tree species.

Note: Several of the sampled watercourses could be classified as wetland units and should therefore be assessed using the WET-Health Version present ecological state assessment tool. However, given that the GIBB (2016) baseline aquatic assessment applied the IHI assessment tool, this same tool was applied in 2022. This was done as CES requested that an assessment consistent with the 2016 assessment be conducted in 2022.

Table 13. Summary of the IHI assessment results for each sample site.

<table>
<tr><th>Site</th><th>Component</th><th>IHI (%)</th><th>Ecological Category</th><th>Key Impacts</th></tr>
<tr><td rowspan="2">T3KINI-USMAT</td><td>Instream Habitat</td><td>63.6</td><td>C Moderately Modified</td><td rowspan="2">• Notable infestation of macro channel bank by woody alien invasive plant species (Eucalyptus sp., Salix sp., Melia azedarach, and Populus cf. canescens).
• Minor alteration of instream water quality due to runoff of fertilizers from agricultural lands.
• Bed and bank erosion due to altered catchment runoff processes (overgrazing and urbanization)</td></tr>
<tr><td>Riparian Habitat</td><td>48.1</td><td>D Largely Modified</td></tr>
</table>

T3MZIM-CMPSN	Instream Habitat	70.4	**C Moderately Modified**	• Notable infestation of macro channel bank by woody alien invasive plant species (i.e. *Acacia mearnsii* and *Populus* cf. *canescens)* was evident. • Minor alteration of instream water quality due to runoff of fertilizers from agricultural lands. • Alteration of natural flow regimes and fragmentation of habitat due to the construction of several dams along the length of the watercourse. • Increased water inputs into system from irrigation runoff.
	Riparian Habitat	62.3	**C Moderately Modified**	
T3MZIM-EDNDL	Instream Habitat	63.6	**C Moderately Modified**	• Notable infestation of macro channel bank by woody alien invasive plant species (i.e. *Robinia pseudoacacia, Salix sp., Gnnamomum comphora, Eucalyptus sp.,* and *Capreasus sp.*) • Bed and bank erosion due to altered catchment runoff processes (cultivation of lands). • Minor alteration of instream water quality due to runoff of fertilizers from agricultural lands. • Alteration of natural flow regimes and fragmentation of habitat due to the construction of several dams along the length of the watercourse. • Increased water inputs into system from irrigation runoff.
	Riparian Habitat	40.7	**D Largely Modified**	
T3MZIM-ALING	Instream Habitat	70.4	**C Moderately Modified**	• Notable infestation of macro channel bank by woody alien invasive plant species (i.e. *Acacia mearnsii, Salix sp., Gnnamomum comphora, Eucalyptus sp.,* and *Capreasus sp.*) • Bed and bank erosion due to altered catchment runoff processes (cultivation of lands). • Minor alteration of instream water quality due to runoff of fertilizers from agricultural lands. • Alteration of natural flow regimes and fragmentation of habitat due to the construction of several dams along the length of the watercourse. • Increased water inputs into system from irrigation runoff.
	Riparian Habitat	43.2	**D Largely Modified**	
T3MZIM-DSR56	Instream Habitat	70.2	**C Moderately Modified**	• Altered flow regime due to water abstraction from irrigation pumps and construction of a stone weir was expected to *moderately* modify the system's flow. • Minor alteration of instream water quality due to runoff of fertilizers from agricultural lands. • Notable *Salix sp.* infestation along macro channel bank. • Bed and bank erosion due to altered catchment runoff processes (overgrazing and cultivation of lands) • Alteration of natural flow regimes and fragmentation of habitat due to the construction of several dams along the tributaries that drain into this system.
	Riparian Habitat	57.4	**D Largely Modified**	

4.5 Ecological Importance & Sensitivity (EIS)

The instream / aquatic component of assessed reaches of the watercourses associated with sites T3KINI-USMAT, T3MZIM-CMPSN, T3MZIM-EDNDL, T3MZIM-ALING, and T3MZIM-RSTFN were all assessed as being of 'Low' overall EIS. This is due to the prevailing ephemeral / seasonal flow regime of these units with these watercourses having limited aquatic species and habitat diversity and providing limited habitat or refugia for aquatic biota. These watercourses are however likely to be moderately sensitive to changes in its flow regime, as even minor increases in flow volume or velocity could change natural hydrological and geomorphological processes. The assessed reach of the watercourse associated with T3MZIM-STRYD was assessed as being of 'Moderate' EIS. This watercourse was associated with seasonal flow conditions and is considered sensitive to changes in flow. The assessed reach of T3MZIM-DSR56 (Mzimvubu River) was rated as being of 'Moderate' EIS. The perennial nature of this system means that it serves as refuge and a migration corridor for flow dependent taxa.

Table 14. EIS Summary for the assessed watercourses.

Variables	T3KINI-USMAT	T3MZIM-CMPSN	T3MZIM-EDNDL	T3MZIM-ALING	T3MZIM-DSR56	T3MZIM-RSTFN	T3MZIM-STRYD
Rare & endangered species	0.0 None	0.0 None	0.0 None	0.0 None	0.0 None	0.0 None	0.0 None
Unique species (endemic, isolated, etc.)	0.0 None	0.0 None	0.0 None	0.0 None	0.0 None	0.0 None	0.0 None
Intolerant species sensitive to flow/water quality modifications	1.0 Low	1.0 Low	1.0 Low	1.0 Low	1.0 Low	1.0 Low	1.0 Low
Species/taxon richness	1.0 Low	1.0 Low	1.0 Low	1.0 Low	1.0 Low	1.0 Low	1.0 Low
Diversity of habitat types	2.0 Mod	2.0 Mod	2.0 Mod	2.0 Mod	2.0 Mod	2.0 Mod	2.0 Mod
Refugia for biota	1.0 Low	1.0 Low	1.0 Low	1.0 Low	2.0 Mod	1.0 Low	2.0 Mod
Sensitivity to flow changes	2.0 Mod	2.0 Mod	2.0 Mod	2.0 Mod	1.0 Low	2.0 Mod	3.0 High
Sensitivity to flow related water quality changes	3.0 High	3.0 High	3.0 High	3.0 High	2.0 Mod	3.0 High	3.0 High
Migration route/corridor (instream & riparian)	2.0 Mod	2.0 Mod	2.0 Mod	2.0 Mod	3.0 High	2.0 Mod	2.0 Mod
Importance of conservation & natural areas	1.0 Low	1.0 Low	1.0 Low	1.0 Low	2.0 Mod	1.0 Low	1.0 Low
EIS Score	**1.0**	**1.0**	**1.0**	**1.0**	**1.5**	**1.0**	**1.5**
EIS Rating	**Low**	**Low**	**Low**	**Low**	**Moderate**	**Low**	**Moderate**

5. IMPACT SIGNIFICANCE & RISK ASSESSMENTS

This section deals with the assessment of the potential decommissioning, construction and operation phase risks and impacts associated with the proposed project. Potential impact consequences are discussed and assessed separately for the construction and operational phases under a 'realistic poor' and 'realistic good' or 'best practice' mitigation scenarios as defined in the 'methods' section of this report.

Note: The impact significance and risk assessments contained in this report are relevant to only the sampled rivers and the proposed construction and operation phase activities in the vicinity of these watercourses.

5.1 Impact Significance Assessment

5.1.1 Identification of Impact-Causing Activities

Potential impact-causing activities identified for the construction and operational phases of the road settlement repair project are summarised in table 15, below.

Table 15. Potential impact-causing activities identified for the construction and operational phases of the road settlement repair project.

Construction Phase Activities	Operational Phase Activities
C1 – Decommissioning of old crossings structures, and the construction of new ones. • Clearing of vegetation to create a suitable working environment. • Use of heavy machinery and workers to remove crossing structures that are to be decommissioned. • Earthworks and concrete works immediately adjacent to watercourses during abutment, wing wall and deck construction. • Temporary impoundment and diversion of flow along the watercourses to create a dry working area during culvert installations and / or bridge pier construction. • Concrete works within the active channel of watercourses bridge pier construction. • Temporary stormwater and sediment management, and hazardous substances handling and storage.	**Operation of the upgraded road including watercourse crossings**: • Long-term use of the road by vehicles. • Operation of stormwater infrastructure associated with the upgraded road. • Future road repairs and maintenance.
C2 - Construction of the realigned and widened roadway. • Vegetation clearing, soil stripping and bulk earthworks where the existing road is to be re-aligned or widened. • Accidental incursion of machinery and workers into watercourse areas. • Temporary stormwater and sediment management, and hazardous substances handling and storage.	

Note that impacts have been separated for the bridge construction and access road upgrade due to the activities and impact pathways being markedly different.

5.1.2 C1 - Decommissioning of old crossings structures, and the construction of new ones: Impact Significance

This sub-section of the report deals with the decommissioning and construction of crossing structures along the watercourses sampled as part of the baseline aquatic assessment. It is understood that the Mzimvubu River Bridge (Km 155) will not to be altered or modified. The upgrade or reconstruction of this bridge was not considered as part of this assessment. This impact assessment has therefore considered decommissioning and construction activities at a total of five (5) watercourse crossing locations. It is not known by Eco-Pulse which of these five (5) crossing structures will need to be decommissioned and upgraded and which will be retained in the current state. This assessment has therefore taken the conservative approach of assuming all assessed crossing locations will need to be re-constructed. Photos of each of these crossings are shown below. the location of each crossing can be seen in Figure 2.

T3KINI- USMAT

T3MZIM-CMPSN

T3MZIM-EDNDL

T3MZIM-ALING

T3MZIM-RSTFN

<table>
<tr><td colspan="2" rowspan="2">Construction Phase Impact Assessment</td><td colspan="2">Impact Significance</td></tr>
<tr><td>'poor' mitigation scenario</td><td>'good' mitigation scenario</td></tr>
<tr><td>C1-1</td><td>Direct physical loss or modification of aquatic habitat</td><td>Moderate</td><td>Moderately Low</td></tr>
<tr><td colspan="4">Limited physical disturbance of aquatic vegetation and riparian habitat is expected during watercourse decommission and construction as the sites of the assessed crossing are associated prevailing vegetation disturbance due to the presence of existing crossing structures. The permanent physical destruction of instream freshwater ecosystem habitat will be inevitable during bridge / culvert crossing construction (if the bridge design includes a support pier with a base) if these structures are realigned to not coincide with the current crossing location. Given the limited extent of pier bases and culverts, the ecological significance of any direct habitat loss is considered minimal. The presence of use of machinery within and surrounding the assessed watercourses will result in at least some modifications to aquatic habitat at crossing locations. This impact could be of 'moderate' significance under a 'poor' mitigation scenario. With best practical mitigation implemented (as listed below and explained in detail in Chapter 6 of this report), impact significance can be potentially reduced to a 'Moderately Low' and ecologically acceptable level.

<u>Key mitigation recommendations:</u>
• Construct new crossings within the same footprint of the current features.
• Limit instream habitat disturbance beyond the construction footprint.
• Limit access to instream and riparian habitat beyond the direct footprint of the bridge.
• Rehabilitate any exposed soil. erosion or vegetation clearing impacts as soon as practically possible.</td></tr>
<tr><td rowspan="3">C1-2</td><td rowspan="3">Alteration of hydrological and geomorphological processes (erosion and sediment)</td><td colspan="2">Impact Significance</td></tr>
<tr><td>'poor' mitigation scenario</td><td>'good' mitigation scenario</td></tr>
<tr><td>Moderate</td><td>Moderately Low</td></tr>
<tr><td colspan="4">The temporary diversion and/or impoundment of flows to create a 'dry' construction area is likely to be a key impact causing activity during the construction of bridges and culvert crossings. Potential impacts include altered flow, bed and bank erosion, and the temporary inundation of instream and riparian habitat, depending on the method of diversion used. These impacts will however be temporary and with adequate mitigation, including undertaking watercourse crossing construction during low-flow periods, impacts are unlikely to significantly affect long-term ecological processes within the affected river reach.

The earthworks involved in bridge / culvert construction could also mobilise and disturb sediment that could enter watercourses and temporarily increase water turbidity whilst potentially affecting instream habitat and biota. This impact is expected be limited given the short-term nature of the required construction earthworks. If poorly managed, flow and sediment related impacts could be of a 'Moderate' ecological significance and where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Moderately-Low' and acceptable level.

<u>Key mitigation recommendations:</u>
• Limit construction of instream structures to low flows during the dry (winter) season.
• Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
• Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.</td></tr>
<tr><td rowspan="3">C1-3</td><td rowspan="3">Impacts to water quality</td><td colspan="2">Impact Significance</td></tr>
<tr><td>'poor' mitigation scenario</td><td>'poor' mitigation scenario</td></tr>
<tr><td>Moderately Low</td><td>Low</td></tr>
<tr><td colspan="4">Water quality impacts during construction will be limited to potential increased water turbidity (discussed under impact C1-2 above) and pollution related to potential spillages of cement and any fuels. If poorly managed, impacts to water quality could be of 'Moderately Low' significance. Where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Low' and environmentally acceptable level.</td></tr>
</table>

Key mitigation recommendations:

- Limit construction of instream structures to low flows during the dry (winter) season.
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.

		Impact Significance	
		'poor' mitigation scenario	'poor' mitigation scenario
C1-4	**Impacts to ecological connectivity and/or ecological disturbance impacts**	**Moderately Low**	**Low**

The temporary diversion and/or impoundment of flows to create a 'dry' construction area could temporarily impact instream habitat connectivity during watercourse crossing construction. This will however be a temporary impact and is unlikely to significantly affect the movement of important aquatic biota or the connectivity between watercourse reaches, especially if instream works are performed under low flow conditions in the dry (winter) period. The presence of workers and machinery may also create ecological noise and vibration disturbances that can temporarily disturb amphibians, reptiles, birds, and small mammals; however, these will be minor, and fauna will likely revisit the site once construction has ceased. Where impacts and risks are poorly managed, this impact could be of a 'Moderately-Low' significance and where best practical mitigation is implemented *(as listed below and explained in detail in Chapter 6 of this report)*, this can be potentially reduced to a 'Low' and environmentally acceptable level.

Key mitigation recommendations:

- Limit instream habitat disturbance as far as possible.
- Limit construction of instream structures to low flows during the dry (winter) season.
- Restrict worker and machinery access to the construction site and site camp.
- Prohibit poaching or collection of plants and biota during bridge construction.
- Remove temporary diversions and impoundments once construction is complete.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

5.1.3 C2 - Construction of the realigned and widened roadway: Impact Significance

This sub-section of the report deals with the road construction works in the vicinity of the seven (7) assessed river units. This excludes the construction activities at the bridge and culvert crossings.

Construction Phase Impact Assessment: access road upgrade		Impact Significance	
		'poor' mitigation scenario	'good' mitigation scenario
C2-1	**Direct physical loss or modification of freshwater habitat**	**Moderately Low**	**Low**

The vicinity of roadworks to assessed onsite watercourses means there is the potential for accidental incursions into watercourses by machinery during the construction phase of the project. Accidental incursion into onsite watercourses would result in a temporary direct physical modification of freshwater habitat which is likely to be easily mitigated through appropriate rehabilitation efforts. Accidental incursions are considered highly probable in a realistic poor mitigation scenario. The likelihood of this impact occurring can however be reduced through construction phase mitigation efforts.

Key mitigation:

- Prior to the commencement of any road construction activities the edge of nearby watercourses must be clearly marked.
- No workers or machinery should advance beyond the demarcated boundary for any reason.
- Drivers and machine operators must take specific care to avoid watercourses when manoeuvring vehicles and heavy equipment.

- All disturbed areas beyond the construction site that are intentionally or accidentally disturbed during the construction phase must be rehabilitated immediately to the satisfaction of the ECO. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO.

		Impact Significance	
C2-2	**Alteration of hydrological and geomorphological processes (erosion and sediment)**	'poor' mitigation scenario	'good' mitigation scenario
		Moderately Low	**Low**

Vegetation removal and bulk earthworks along the road alignment will temporarily reduce basal vegetation cover at the site. This will reduce rainfall infiltration rates, thus increasing the volume of surface water runoff being delivered to nearby watercourses. This is however likely to have a limited effect on overall watercourse hydrological processes. Bulk earthworks will disturb and expose notable areas of bare soil that could potentially be mobilised and washed into watercourses during storm events. This would temporarily increase water turbidity and potentially affect instream habitat. Soil stockpiles also present a large potential sediment source that could be mobilised during storms. The deposition of sediment into nearby watercourses during construction is considered highly probable in a realistic poor mitigation scenario. The likelihood of this impact occurring can however be reduced through construction phase mitigation efforts.

Key mitigation:

- The unnecessary removal of vegetation cover must be prevented.
- Sediment control measures such as silt curtains will be important for preventing the deposition of sediment into nearby watercourses.
- Exposed areas must be re-vegetated as soon as possible.
- Soil stockpiles should be located at least 30m away from delineated watercourses on the flattest ground available.
- Erosion/sediment control measures such as silt fences, low soil berms or wooden shutter boards must be placed around the stockpiles to limit sediment runoff from stockpiles.

		Impact Significance	
C2-3	**Impacts to water quality**	'poor' mitigation scenario	'good' mitigation scenario
		Moderately Low	**Low**

Water quality impacts during construction will be limited to potential increased water turbidity associated with increased sediment supply to watercourses, and pollution related to potential spillages of fuels and chemicals into watercourses. The expected intensity of such impacts on the water quality of onsite watercourse is considered 'Moderately Low' as volumes of pollutants that enter watercourses are likely to be low such that they can be easily processed by watercourses without causing a major disturbance to aquatic fauna and flora. These incidents are considered probable in a realistic poor mitigation scenario. The likelihood of this impact occurring can however be reduced through construction phase mitigation efforts.

Key mitigation:

- Address potential erosion and sedimentation risks through the implementation of Best Management Practices (BMPs) in erosion and sediment control.
- Address potential spill and leakage risks on site through the implementation of Best Management Practices (BMPs) for the control and management of hazardous substances

		Impact Significance	
C2-4	**Impacts to ecological connectivity and/or ecological disturbance impacts**	'poor' mitigation scenario	'good' mitigation scenario
		Moderately Low	**Low**

During construction, the presence of workers and machinery in the vicinity of onsite watercourses is likely to create noise, vibrations and dust which have the potential to temporarily disturb and displace fauna that make use of watercourse corridors for movement and refuge. Use of watercourses for refugia by fauna in the context of the study area is however likely to be limited due to the urban and per-urban nature of the area, and the generally degraded state of onsite watercourses. Additionally, construction phase disturbances will be temporary.

Key mitigation:

- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
- Temporary noise pollution due to construction works should be minimized where possible.

5.1.4 Operation of the upgraded road including watercourse crossings: Impact Significance

Operational Phase Impact Assessment: access road upgrade		Impact Significance	
		'poor' mitigation scenario	'good' mitigation scenario
O2-1	**Direct physical loss or modification of freshwater habitat**	**Moderately Low**	**Low**

Direct physical loss or modifications to freshwater habitat during the operation phase of the repaired road will be limited to accidental / unintended clearing, excavation or infilling of freshwater habitat during maintenance or repair activities in the vicinity of watercourses. Where best practical mitigation is implemented by crews operating during bridge repairs and maintenance, this impact can be potentially reduced to a 'Low' and acceptable significance level.

Key mitigation recommendations:

- Undertake any future road repairs and/or maintenance during low flows (winter season).
- Limit instream habitat disturbance during low-level crossing / culvert repairs and/or maintenance.
- Limit access to wetland, instream, and riparian habitat.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

		Impact Significance	
		'poor' mitigation scenario	'good' mitigation scenario
O2-2	**Alteration of hydrological and geomorphological processes (erosion and sediment)**	**Moderate**	**Low**

The uncontrolled discharge of stormwater into the environment could result in soil erosion at outfall locations and bed scour where stormwater is discharged directly into streams. Additionally, if poorly designed bridge piers and culverts at crossing could redirect flows and / or alter flow velocity. This could cause localised scouring of the channel bed at the downstream end of crossing and could also instigate headward erosion. Overall, this impact could be of a 'Moderate' significance in a 'poor' mitigation scenario, and where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Low' and environmentally acceptable level.

Key mitigation recommendations:

- Implement best practice bridge crossing, culvert crossing, and road stormwater infrastructure design.

		Impact Significance	
		'poor' mitigation scenario	'good' mitigation scenario
O2-3	**Impacts to water quality**	**Moderately Low**	**Low**

Water quality impacts during the operation of the upgraded road include to potential increased water turbidity due to sediment inputs associated with erosion, and physio-chemical pollution due to contaminated surface runoff / stormwater flows from roads. Where best practical mitigation is implemented by crews operating during bridge repairs and maintenance, this impact can be potentially reduced to a 'Low' and acceptable significance level.

Key mitigation recommendations:

- Undertake any road repairs and/or maintenance during low flows (winter season).
- Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control.

- Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.

		Impact Significance	
		'poor' mitigation scenario	'good' mitigation scenario
O2-4	**Impacts to ecological connectivity and/or ecological disturbance impacts**	**Moderately Low**	**Low**

The presence of workers and machinery during road repairs and maintenance may create ecological noise and vibration disturbances that can temporarily disturb amphibians, reptiles, birds and small mammals; however, these will be minor, and short-lived with fauna likely to revisit the site once maintenance has ceased, and the disturbance has halted. Where impacts and risks are poorly managed, this impact could be of a 'Moderately-Low' significance and where best practical mitigation is implemented (as listed below and explained in detail in Chapter 6 of this report), this can be potentially reduced to a 'Low' and environmentally acceptable level.

Key mitigation recommendations:

- Limit instream habitat disturbance as far as possible.
- Limit repairs/maintenance of instream structures to low flows during the dry (winter) season.
- Restrict worker and machinery access.
- Prohibit poaching or collection of plants and biota.
- Remove temporary diversions and impoundments once repair/maintenance work is complete.
- Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

5.1.5 Impact Significance Assessment Summary Table

Table 16. Construction phase Impact significance assessment summary table

Impact Type	Impact Significance	
	'poor' mitigation scenario	**'good' mitigation scenario**
CONSTRUCTION PHASE (C1)		
Direct physical loss or modification of freshwater habitat	Moderate	Moderately Low
Alteration of hydrological and geomorphological processes	Moderate	Moderately Low
Impacts to water quality	Moderately Low	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Moderately Low	Low
CONSTRUCTION PHASE (C1)		
Direct physical loss or modification of freshwater habitat	Moderately Low	Low
Alteration of hydrological and geomorphological processes	Moderately Low	Low
Impacts to water quality	Moderately Low	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Moderately Low	Low

Table 17. Operation phase Impact significance assessment summary table

Impact Type	Impact Significance	
	'poor' mitigation scenario	'good' mitigation scenario
OPERATIONAL PHASE (O2)		
Direct physical loss or modification of freshwater habitat	Moderately Low	Low
Alteration of hydrological and geomorphological processes	Moderate	Low
Impacts to water quality	Moderately Low	Low
Impacts to ecological connectivity and/or ecological disturbance impacts	Moderately Low	Low

5.2 Risk Assessment to inform S21 c & i Water Use Licensing

It is our understanding that the purpose of the risk matrix tool developed by the DWS is to give a preliminary indication of the likely impact / degree of change (consequence) of activities (water uses) to local and regional water resource quality. For the purposes of this study, the degree of change is reflected in PES change and/or the change in the supply of regulating ecosystem services.

Possible activities, aspects (or stressors) and potential ecological risks associated with the planned development, that could potentially manifest in impacts to the four drivers of wetland condition/functioning as defined by the DWS have been identified in Section 5.1.1 (see Table 18) of this report, and include the following aspects/activities:

- Clearing of vegetation to create a suitable working environment
- Earthworks and concrete works
- Temporary impoundment and/or diversion of flow to create a dry working area during instream construction
- Temporary stormwater and sediment management, and hazardous substances handling and storage
- Earthworks outside of watercourses during road grading and surfacing
- Long-term use of the road and bridge by local communities
- Future road repairs and maintenance

A summary of the potential risk and impacts ratings for the proposed development activities is provided in Table 18 below, the results of which are discussed as follows:

- The risk of bridge and culvert crossings altering hydrological and geomorphological processes is regarded as 'moderate' but can be mitigated down to a 'low' risk level.
- All other construction and operational activities and risks associated with the project were regarded as 'Low'.

Table 18. Summary of the risk matrix assessment scores and ratings for each activity and risk group.

Phase(s)	Activity	Aspect	Risk of Impact	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating	KEY MITIGATION
Construction	ACTIVITY C1: Construction of the new access bridge crossing the Luzi River	Vegetation clearing and earthworks	Direct physical loss or modification of freshwater habitat	42,75	Low			• Limit instream habitat disturbance beyond the construction footprint. • Implement post-construction freshwater habitat rehabilitation strategy where necessary. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
Construction	ACTIVITY C1: Construction of the new access bridge crossing the Luzi River	Temporary flow diversion	Alteration of hydrological and geomorphological processes	56,25	Moderate	31,25	Low	• Limit construction of instream structures to low flows during the dry (winter) season. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
Construction	ACTIVITY C1: Construction of the new access bridge crossing the Luzi River	Risk from hydrocarbons (fuel/oil) and cement management	Impacts to water quality	54	Low			• Limit construction of instream structures to low flows during the dry (winter) season. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
Construction	ACTIVITY C1: Construction of the new access bridge crossing the Luzi River	Temporary flow diversion	Impacts to ecological connectivity and/or ecological disturbance impacts	36	Low			• Limit instream habitat disturbance as far as possible. • Limit construction of instream structures to low flows during the dry (winter) season. • Restrict worker and machinery access to the construction site and site camp. • Remove temporary diversions and impoundments once construction is complete. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
Construction	ACTIVITY C2: Upgrading of the dirt access road	Vegetation clearing and earthworks	Direct physical loss or modification of freshwater habitat	40,5	Low			• Limit instream habitat disturbance beyond the construction footprint. • Implement post-construction freshwater habitat rehabilitation strategy where necessary. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.as soon as practically possible.

Phase(s)	Activity	Aspect	Risk of Impact	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating	KEY MITIGATION
		Temporary flow diversion (if required)	Direct physical loss or modification of freshwater habitat	48	Low			• Limit construction of instream structures (low-level crossings and culverts) to low flows during the dry (winter) season. • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
		Risk from hydrocarbons (fuel/oil) and cement management	Alteration of hydrological and geomorphological processes	54	Low			• Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
		Temporary flow diversion (if required)	Impacts to water quality	34	Low			• Restrict worker and machinery access to the construction site and site camp. • Prohibit poaching or collection of plants and biota during bridge construction. • Remove temporary diversions and impoundments once construction is complete. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
Operation	ACTIVITY O1: Operation of the bridge on the Luzi River	Risk of Invasive Alien Plant colonisation following disturbance	Impacts to ecological connectivity and/or ecological disturbance impacts	36	Low			• Undertake any future bridge repairs and/or maintenance during low flows (winter season). • Limit instream habitat disturbance during future bridge repairs and/or maintenance. • Implement post-construction river rehabilitation strategy where necessary. • Limit access to instream and riparian habitat. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.
		Permanent flow impedance due to bridge infrastructure (instream pier)	Direct physical loss or modification of freshwater habitat	62,5	Moderate	37,5	Low	• Limit the number of instream piers. • Appropriately design and place culverts to avoid the onset of erosion. • Implement best practice pier design that limits scouring and deflects debris and sediment / other natural substrate around these structures.

Phase(s)	Activity	Aspect	Risk of Impact	Significance	Risk Rating	Revised Risk Rating	Borderline LOW / MODERATE Rating	KEY MITIGATION
		Risk from hydrocarbons (fuel/oil) and cement management during future bridge repairs/maintenance	O1-3: Impacts to water quality	46	Low			• Undertake any road repairs and/or maintenance during low flows (winter season). • Address potential erosion and sedimentation risks on site through the implementation of Best Management Practices (BMPs) in erosion and sediment control. • Address potential spill and pollution risks on site through the implementation of Best Management Practices (BMPs) in spill and pollution control and hazardous substances management.
		Permanent flow impedance due to bridge infrastructure (instream pier)	O1-4: Impacts to ecological connectivity and/or ecological disturbance impacts	26	Low			• Limit instream habitat disturbance as far as possible. • Limit repairs/maintenance of instream structures to low flows during the dry (winter) season. • Restrict worker and machinery access. • Prohibit poaching or collection of plants and biota. • Remove temporary diversions and impoundments once repair/maintenance work is complete. • Rehabilitate any erosion or vegetation clearing impacts as soon as practically possible.

6. IMPACT MITIGATION

The protection of water resources begins with the avoidance of adverse impacts and where such avoidance is not feasible, to apply appropriate mitigation in the form of reactive practical actions that minimize or mitigate such impacts. 'Impact Mitigation' is a broad term that covers all components involved in selecting and implementing measures to conserve biodiversity and prevent significant adverse impacts because of potentially harmful activities. This generally follows some form of 'mitigation hierarchy' (see Figure 4), which aims firstly at avoiding disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts.

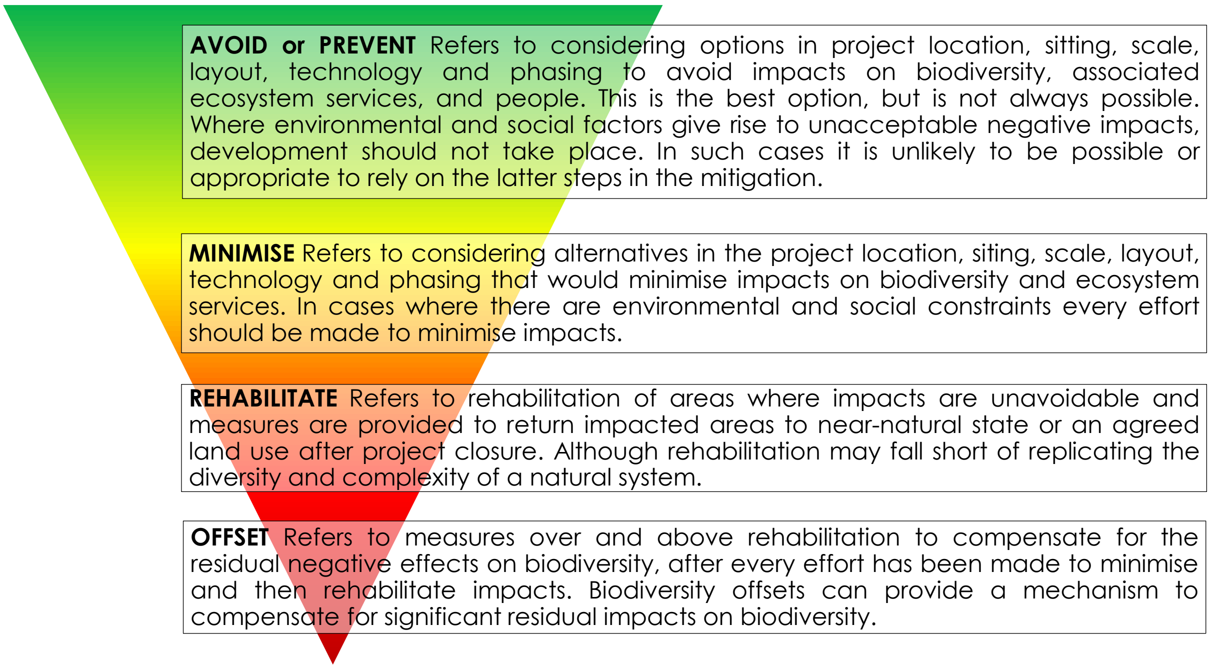

Figure 4. Diagram illustrating the 'mitigation hierarchy' (after DEA *et al*., 2013).

The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives in terms of project location, siting, scale, layout, technology, and phasing until the proposed development can be best accommodated without incurring significant negative impacts to the surrounding environment. Where ecological impacts can be severe, the guiding principle should generally be "*anticipate and prevent*" rather than "*assess and repair*". This principle is in line with the recommended management objective for the project and receiving freshwater environment, that being to '*maintain the current status quo of aquatic ecosystems without any further loss of integrity (PES) or functioning*'.

A stepped approach has therefore been followed in trying to minimize impacts, which included:

i. **Firstly, attempting to avoid/prevent impacts through appropriate project design and location:** *Provision of watercourse road crossing design recommendations.*

ii. **Secondly, employing mitigation measures aimed at minimizing the likelihood and intensity of potential risks/impacts**: *Provision of construction and operation phase mitigation measures to avoid any unnecessary direct or indirect impacts to watercourses.*

iii. **Thirdly, addressing residual impacts to freshwater habitat:** *Not applicable to this project*.

iv. **Lastly, compensating for any remaining/residual impacts associated with permanent habitat transformation:** *Not applicable to this project.*

6.1 Road Crossing Design Recommendations

6.1.1 Culvert Crossing Design Recommendations

In planning the construction of culverts over watercourses attention must be paid to the following:

- Culverts must be placed perpendicular to flow direction where possible.
- Structures must be designed to allow for natural through flows without impeding flows behind road crossings or concentrating flows within downstream reaches of watercourses (which can lead to scouring and erosion).
- Culverts must be designed considering the expected flow volumes for a particular crossing.
- Selection of culvert size should be based on water depth, roadway embankment height, hydraulic performance.
- Appropriate measures to dissipate flow velocity below culverts must be considered where necessary (e.g., Reno-mattresses).
- Culverts should ideally be installed during the dry season to reduce the risk of erosion and sedimentation during construction. If timed correctly during no flow conditions erosion/sedimentation risks will be greatly reduced.
- Culverts should be installed such that their invert levels match the natural stream bed levels that existed prior to construction.
- Culverts should not lower the base level of a watercourse and therefore not result in an increase in longitudinal gradient which could lead to headward erosion and vertical incision.
- Culverts should not be placed above natural bed level which will cause back flooding (damming) upstream of the road crossing.
- Any culverts that must be installed below the natural ground level are to be constructed with an appropriate drop inlet structure.

6.1.2 Bridge Design Recommendations

- The number and spacing of instream piers should not cause long-term flow and sediment impacts.
- Instream disturbances required to install piers must be limited to the pier footprints with no unnecessary disturbances to the river bed outside of the pier locations.
- Pier foundations/ footings must be set below the natural river bed and should not protrude above natural bed level. This will avoid flow impedances and debris becoming trapped. Only the pier column should protrude from the river bed.
- Bridges should be aligned perpendicular to flow to avoid flow deflection by the structure during flood events which may cause bank erosion and scouring.

6.2 Construction Phase Mitigation and Management Measures

The following mitigation measures must be implemented in conjunction with any generic measures provided in the Environmental Management Programme (EMPr) for the project. It is important that the costs of the implementation of such measures are factored into the tender specification and awarded contract. Quantities and costs of measures must be determined by the project engineer in conjunction with the appointed contractor and ECO.

6.2.1 Demarcation of 'No-Go' areas and construction corridors

- Prior to the commencement of any construction activities, the following features must be staked out by a surveyor and demarcated as such:
  - Outer edge of the delineated watercourse (river, streams and wetlands) zones occurring within 10m of the centreline of the proposed road alignment.
  - The outer edges of the entire access road construction corridor (working servitude).
- The demarcation work must be signed off by the Environmental Control Officer (ECO) before any work commences.
- Demarcations are to remain until construction and rehabilitation is complete.
- All areas outside of this demarcated working servitude must be considered no-go areas for the entire construction phase.
- Vegetation removal/stripping must be limited to the construction footprint. No areas outside the construction footprint may be cleared.
- No equipment laydown or storage areas must be located within delineated riparian or wetland areas.
- No equipment laydown or storage areas must be located within 30m of any watercourse.
- All disturbed areas beyond the construction area that are intentionally or accidentally disturbed during the construction phase must be rehabilitated immediately to the satisfaction of the ECO.

6.2.2 Method Statements for working in Watercourses.

A detailed method statement for the construction of watercourse crossings must be compiled and appended to the construction (EMPr) prior to construction commencing. The final method statement must be reviewed by the ECO. The following guidelines should be included in the method statement for the construction of the bridge and low-level crossings at watercourses:

Construction servitude planning:

- Construction must be restricted to as small an area as possible.

Site Setup:

- The location of the topsoil and subsoil stockpile areas, dewatering filtration areas and equipment laydown areas must be agreed upon and demarcated to the satisfaction of the ECO prior to any clearing. These areas must be located at least 30m outside of all watercourses.

Site clearing and stripping:

- Indigenous vegetation within riparian and wetland areas that may be desirable for use in post-construction re-vegetation must be identified upfront before clearing. This vegetation should be removed via sodding so that the sods can be replaced / replanted after the working areas are backfilled and reshaped. The plant sods should be removed taking care to remove the entire sods including root systems and rhizomes.

- For vegetation within riparian and wetland areas that is not desirable for re-vegetation, this vegetation can be stripped or cleared.
- Topsoil and subsoil excavated and stripped must be stored separately.

Construction and Soil Stockpile Corridor Establishment:

- A suitable lining or geotextile/geofabric must be laid down along the soil stockpile corridor. This is to avoid the mixing of foreign material with riparian soils.
- Where applicable, the active channel banks along the construction corridor should be re-graded to a slope that will allow for safe and easy access by workers to the channel bed.

Temporary flow diversion and dewatering:

- Options for temporary flow diversion when working within channels may include:
  - Diversion of the entire watercourse through use of a bypass large diameter pipe.
  - Installation of removable coffer dams.
  - Use of removable sandbags.
- Under no circumstances should loose sediment or boulders be used to create a diversion berm. This increases the risk of sediment related impacts to downstream area.
- Construction within/across watercourses should progress as quickly as practically possible to reduce the risk of exceeding temporary diversion capacity.
- Diversions must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse.
- Under no circumstances must new channels be created for flow diversion and conveyance purposes. Diversions should rather be via piped flow.
- Redirected flows must be discharged back into the watercourses in a manner that does not cause erosion. In this regard, pumped water should be discharged into erosion control and sediment trap structures.
- Upon completion of the construction, diversions must be removed to restore natural flow patterns.

6.2.3 Runoff, erosion, and sediment control

- The unnecessary removal of vegetation groundcover must be avoided.
- If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Once shaped, all exposed/bare surfaces and embankments must be re-vegetated as soon as practically possible.
- If re-vegetation of exposed surfaces cannot take place immediately due to phasing issues, temporary erosion, and sediment control measures (silt fences or hay bale berms) must be installed and maintained until such a time that re-vegetation can commence.

- All temporary erosion and sediment control measures must be monitored for the duration of the construction phase and repaired immediately when damaged. Temporary erosion and sediment control structures must only be removed once vegetation cover has successfully recolonised the affected areas.
- After heavy rainfall events, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and/or silt fences until vegetation has re-colonised the rehabilitated area.

6.2.4 Soil management

- Large soil stockpiles must be established outside of rivers/wetlands and 30m from the edge of watercourses.
- Erosion/sediment control measures, such as silt fences, must be placed around the stockpiles to limit sediment runoff from stockpiles.
- Subsoil and topsoil must be stockpiled separately. Stockpiled soil must be replaced in the reverse order as to which it was removed (subsoil first followed by topsoil).
- Stockpiles of construction materials must be clearly separated from soil stockpiles to limit any contamination of soils.
- Stockpiled soils are to be kept free of weeds and are not to be compacted.
- If soil stockpiles are to be kept for more than 3 months, they must be hydroseeded or covered with a rainproof tarp.

6.2.5 Establishment and Management of Construction Camp, Storage and Laydown Areas

- When locating the construction camps and equipment yard, watercourses, and areas susceptible to soil erosion and/or water contamination must be avoided.
- Attempts must be made to situate the camp on flat ground that is at least 30m away from the edge of the nearest delineated watercourse.
- The location of the camp site should be approved by the appointed Environmental Control Officer (ECO).
- Site camp chemical toilets must be situated at least 50m away from the edge of the nearest watercourse.

6.2.6 Hazardous substances / materials management

- The proper storage and handling of hazardous substances (e.g. fuel, oil, cement, etc.) needs to be administered.
- Mixing and/or decanting of all chemicals and hazardous substances must take place on an impermeable surface and must be protected from the ingress and egress of stormwater.
- Drip trays should be utilised at all dispensing areas.
- No refuelling, servicing or chemical storage should occur within 50m of any watercourse.

- Hazardous storage and refuelling areas must be bunded prior to their use on site during the construction period. Bund walls should be high enough to contain at least 110% of any stored volume. The surface of the bunded surface should be graded to the centre so that spillage may be collected and satisfactorily disposed of.
- An emergency spill response procedure must be formulated for the site, and staff are to be trained in spill response.
- All necessary equipment for dealing with spills of fuels/chemicals must be available at the site. Spills must be cleaned up immediately and contaminated soil/material disposed of appropriately at a registered site.
- Drums must be kept on site to collect contaminated soil. These should be disposed of at a registered hazardous waste site.
- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.
- Vehicle maintenance should not take place on site unless a specific bunded area with an impermeable surface is constructed for such a purpose.

6.2.7 Water abstraction and use

- No water is to be abstracted from onsite watercourses for use in construction activities without prior approval by the DWS, subject to acquiring a relevant Water Use License in terms of Section 21 (a) of the National Water Act for taking water from a water resource.
- Care is to be taken not to disturb the channel bed of watercourses during abstraction of water using abstraction pumps.
- Employees are not to make use of any natural water sources for the purposes of swimming, bathing, or washing of equipment, machinery, or clothes.

6.2.8 Invasive Alien Plant Control

- All alien invasive vegetation that colonises the construction site must be removed. The contactor should consult the ECO regarding the method of removal.
- All bare surfaces across the construction site must be checked for IAPs every two weeks and IAPs removed by hand pulling/uprooting and adequately disposed. Herbicides should be utilised where hand pulling/uprooting is not possible. ONLY herbicides which have been certified safe for use in aquatic environments by independent testing authority are to be used. The ECO must be consulted in this regard.

6.2.9 Noise, dust, and light pollution minimisation

- Temporary noise pollution due to construction works should be minimized where possible.
- Water trucks will be required to suppress dust by spraying water on affected areas producing dust.

6.2.10 Construction phase monitoring measures

- The ECO must undertake regular compliance monitoring audits. Freshwater ecosystem aspects that must be monitored include:
    - The condition of the temporary runoff, erosion and sediment control measures and evidence of any failures or sediment deposits within watercourses.
    - Evidence of elevated river / stream turbidity levels.
    - Evidence of gully or bed/bank erosion.
    - Visual assessment instream water quality.
    - The condition of waste bins and the presence of litter within the working area.
    - Evidence of solid waste within the no-go areas.
    - Evidence of hazardous materials spills and soil contamination.
    - Presence of alien invasive and weedy vegetation within the working area.
    - Rehabilitation and re-vegetation success and failures.
- Once the construction and rehabilitation has been completed, the ECO should conduct a close out site audit 1 month after the completion of rehabilitation.

6.3 Operational Phase Mitigation and Management Measures

6.3.1 Alien Plant Monitoring and Control

- The control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.
- Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that causes the least possible harm to biodiversity and damage to the environment.
- The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.
- It is recommended that bi-annual alien plant clearing be undertaken by the applicant for the first-year, post-rehabilitation. Thereafter, alien plant clearing should be undertaken annually until such a time that further risks of alien invasion resulting from disturbance factors are considered negligible.

6.3.2 Watercourse Crossing Maintenance

- Regular inspections should be made of watercourse crossings to ensure they are functioning adequately and to inform maintenance/repair requirements, especially following heavy rainfall events that could result in erosion. Inspections should focus on the following aspects:
    - Detection of scour downstream of crossings.
    - Any signs of channel bank erosion.

    - Any debris that has accumulated upstream of crossings should be removed to ensure continued functional success of the structures to transmit flows.
- If crossing maintenance and/or repair require that earthworks or other potentially harmful activities take place within a watercourse, it is imperative that a risk assessment be conducted and a detailed method statement for the repair or maintenance activity be compiled prior to the activity commencing. If the required maintenance/repair activity constitutes a water use under Section 21 of the National Water Act (No. 36 of 1998), this will need to be applied for from the Department of Water and Sanitation (DWS) prior to work commencing.

6.3.3 Freshwater Ecosystem Monitoring

A freshwater ecosystem monitoring plan / programme should be developed for the road upgrade project. Long-term monitoring should involve at least annual monitoring of watercourses upstream and downstream of crossing locations to ensure that potential operational impacts are being effectively managed. This can be achieved through basic visual inspections by the ECO and support staff, documenting issues such as:

- Invasive Alien Plant infestation at the bridge and along the access road route.
- Scouring and deposition downstream of the bridge and low-level crossings.
- Accumulation of debris upstream of the bridge and low-level crossings.

7. CONCLUSION & RECOMMENDATIONS

The results of the baseline aquatic biodiversity assessment revealed that the sampled watercourses are not associated with notably diverse freshwater faunal species. The in-situ water sampling results suggest that water quality is unlikely to be a significant contributing factor for the limited aquatic macroinvertebrate species diversity encountered. It is more likely that the habitat along the sampled watercourses was not suitable for hosting a diverse range of macroinvertebrate types. The only site at which indigenous fish were recorded was T3MZIM-STRYD. Here four (4) specimens of *Enteromius anoplus* were recorded. At T3MZIM-EDNDL, T3MZIM-DSR56, and T3MZIM-ALING only exotic / introduced fish were recorded, namely *Cyprinus carpio* and *Micropterus sp*. Instream habitat condition was assessed as being 'C: moderately modified' for all assessed sites. Notable instream impacts include altered flow regime due to the establishment of dams along many of the watercourses, altered water quality due to runoff from agricultural lands, and channel scour (erosion) associated with altered catchment runoff processes. Riparian habitat condition was assessed as ranging from 'C: moderately modified' to 'D: largely modified'. Key impacts include, altered inundation of macro-bank areas due to the presence of dams along most of the sampled watercourses, bank erosion, and the infestation of macro-channel areas by woody invasive tree species. The instream / aquatic component of assessed reaches of the watercourses associated with sites T3KINI-USMAT, T3MZIM-CMPSN, T3MZIM-EDNDL, T3MZIM-ALING, and T3MZIM-RSTFN were all assessed as being of 'Low' overall EIS. This is due to the prevailing ephemeral / seasonal flow regime of these units with these watercourses having limited aquatic species and habitat diversity and providing limited habitat or refugia for aquatic biota. The assessed reach of the watercourse associated with T3MZIM-STRYD was assessed as being of 'Moderate' EIS. This watercourse was associated with seasonal flow conditions and is considered sensitive to changes in flow. The assessed reach of T3MZIM-DSR56 (Mzimvubu River) was rated as being of 'Moderate' EIS. The perennial nature of this system means that it serves as refuge and a migration corridor for flow dependent taxa.

The impact significance and risk assessment contained in this report are relevant to only the sampled rivers and the proposed construction and operation phase activities in the vicinity of these watercourses. The most notable impacts and risks associated with this project are construction phase direct impacts to watercourses, construction phase alterations to geomorphological and hydrological processes, and operation phase alterations to geomorphological and hydrological processes. Each of these impacts can be managed to acceptable levels through construction phase impact mitigation measures, and through appropriate design of road crossings.

At the request of CES the baseline aquatic assessment focused on the seven (7) watercourses covered in the GIBB (2016) report. No infield sampling or analyses were conducted along any of the other watercourses crossed by the R56 road. This present study should be updated to include these watercourses in order for the full extent of potential impacts to the freshwater environment to be covered and addressed.

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