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AQUATIC BIODIVERSITY IMPACT ASSESSMENT

for the proposed

REMOVAL AND REPLACEMENT OF TWO CAUSEWAYS IN MOSSEL BAY MUNICIPALITY, WESTERN CAPE

DATE: 16 November 2023

PREPARED FOR:

Sharples Environmental Services cc
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Executive Summary

Debbie Fordham of Upstream Consulting has been appointed by Sharples Environmental Services cc, to undertake an aquatic biodiversity impact assessment for the proposed removal and replacement of various existing culverts and pipes along five roads in the Garden Route, Western Cape. For assessment purposes, the various sites proposed for repair by the Garden Route District Municipality have been grouped into the three local municipalities in which they are located. This report focuses on the two causeways situated in the Mossel Bay Local Municipal area. These two sites, referred to as Site 4 and Site 8 in the information provided, are located along the Varings River in the Jonkersberg area, inland of the coastal town of Groot Brak River.

The Varings River at the Site 4 causeway crossing is typical of a perennial upper foothills system within the South Eastern Coastal Belt. It has a relatively narrow channel with a boulder and cobble bed. Sand has deposited on the upstream side of the causeway, which only has one small opening which confines flow. The channel has been scoured by flood waters on the downstream side, resulting in erosion of the bed and banks. A significant area of the floodplain, as well as lateral wetland habitat, has been transformed into grazing pastures. Alien invasive trees (such as *Acacia mearnsii* and *Acacia melanoxylon*) have established within the riparian zone and have contributed to bank erosion. However, there remains a high diversity of habitat types and indigenous instream and riparian plant species. The lower reach, at the Site 8 causeway crossing, supports a large, channelled valley bottom wetland. The wetland has highly organic soils and is dominated by *Cliffortia odorata, Cyperus thunbergii. wachendorfia thyrsiflora, wachendorphia, Todea Barbara, Pteridium aquilinum, Elegia capensis,* and *Juncus lomatophyllus*. However, catchment land transformation, confined flow from road culverts, and flood events have resulted in gully erosion downstream of the causeway. This has resulted in significant wetland habitat loss downstream.

The Varings River falls within the ‘C’ Ecological Category for PES and provides a Very High level of regulatory services to society. The system has a High EIS due to a high diversity of habitat types, plant species, fair ecological condition, and acting as an important corridor in the landscape. The system is critically important for biodiversity maintenance and the provision of water.

The impacts associated with the removal and replacement of the causeways were assessed for significance upon the aquatic biodiversity of the Varings River system. During construction there will be clearance of riparian vegetation, excavations of the bed and bank, infilling, diversion of flows, a bypass road, and potential for cement and fuel spills within the watercourse. These impacts must be mitigated for, and where possible, entirely avoided. The improved design of the causeways, with more openings, may result in positive impacts in the long-term.

Impact assessment was undertaken for the following grouped potential impacts, direct and indirect in nature:

- Impact 1: Disturbance and loss of aquatic habitat and biota
- Impact 2: Sedimentation and erosion, which could also occur into the operational phase
- Impact 3: Hydrological changes
- Impact 4: Potential impact on localised surface water quality

The impact significance upon aquatic biodiversity for the project was determined as Low after mitigation. The causeways are existing structures at both locations and, provided the new footprint is limited to already disturbed areas, there will not be any significant impact upon the watercourse. The impacts can be decreased to acceptable levels provided that mitigation measures are implemented (including No-Go areas) and adhered to. It is critical that there is no unnecessary encroachment or further loss of wetland habitat..

Therefore, from an aquatic perspective, there are no fatal flaws associated with the project, provided all the mitigation measures are strictly adopted.

Specialist Assessment Protocol Index

Report reference to Table 1 - Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity

2. Aquatic Biodiversity Specialist Assessment	
2.1. The assessment must be prepared by a specialist registered with the South African Council for Natural Scientific Professionals (SACNASP), with expertise in the field of aquatic sciences.	Debbie Fordham SACNASP Registration number 119102 (Ecology)
2.2. The assessment must be undertaken on the preferred site and within the proposed development footprint.	Section 1- Introduction 1.1 –Location & Background
2.3. The assessment must provide a baseline description of the site which includes, as a minimum, the following aspects:	
2.3.1. a description of the aquatic biodiversity and ecosystems on the site, including;	Section 6 – Baseline description of the site Section 7 - Results
(a) aquatic ecosystem types; and (b) presence of aquatic species, and composition of aquatic species communities, their habitat, distribution and movement patterns;	Section 6.1 – Catchment characteristics Section 7.1 – Identified aquatic habitat
2.3.2. the threat status of the ecosystem and species as identified by the screening tool;	Very High 1.2 -Screening tool results Section 6.4 – Conservation context Section 6.3 - SAIIAE
2.3.3. an indication of the national and provincial priority status of the aquatic ecosystem, including a description of the criteria for the given status (i.e. if the site includes a wetland or a river freshwater ecosystem priority area or sub catchment, a strategic water source area, a priority estuary, whether or not they are free-flowing rivers, wetland clusters, a critical biodiversity or ecologically sensitivity area); and	Section 6 – Baseline description of the site CBA 1 Aquatic, NWM5 Channelled valley bottom wetland, SWSA
2.3.4. a description of the ecological importance and sensitivity of the aquatic ecosystem including:	Section 7. Identified aquatic habitat Section 6 & 7 – Baseline description of the site & Results
(a) the description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); and	Section 6.1 – Catchment characteristics Section 7.1 – Identified aquatic habitat

(b) the historic ecological condition (reference) as well as present ecological state of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).	Section 6.5 –Historic context
2.4. The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.	Section 7 – Results
2.5. Related to impacts, a detailed assessment of the potential impacts of the proposed development on the following aspects must be undertaken to answer the following questions:	
2.5.1. is the proposed development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Refer to Section 9 – Impact assessment and tables
2.5.2. is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?	
2.5.3. how will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site? This must include:	Section 8 – Identified Impacts
(a) impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); (b) will the proposed development change the sediment regime of the aquatic ecosystem and its sub-catchment (e.g. sand movement, meandering river mouth or estuary, flooding or sedimentation patterns); (c) what will the extent of the modification in relation to the overall aquatic ecosystem be (e.g. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.); and (d) to what extent will the risks associated with water uses and related activities change;	Section 8.2 – Hydrological changes due to erosion 8.2 - Erosion and Sedimentation Section 8.1 – Loss of riparian habitat Section 8.3 Water Quality impacts
2.5.4. how will the proposed development impact on the functioning of the aquatic feature? This must include:	Section 9 – Impact Significance Assessment
(a) base flows (e.g. too little or too much water in terms of characteristics and requirements of the system); (b) quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river); (c) change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland); (d) quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication);	Refer to Section 9 – Impact assessment and tables Section 8 – Identified Impacts Section 9 Impact Assessment

(e) fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and (f) the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.);	
2.5.5. how will the proposed development impact on key ecosystems regulating and supporting services especially:	Low Impact (after mitigation) Section 9 – Impact Significance Assessment
(a) flood attenuation; (b) streamflow regulation; (c) sediment trapping; (d) phosphate assimilation; (e) nitrate assimilation; (f) toxicant assimilation; (g) erosion control; and (h) carbon storage?	Section 8 – discussion of identified impacts
2.5.6. how will the proposed development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 8 and Impact Table of Section 9
2.6. In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: (a) size of the estuary; (b) availability of sediment; (c) wave action in the mouth; (d) protection of the mouth; (e) beach slope; (f) volume of mean annual runoff; and (g) extent of saline intrusion (especially relevant to permanently open systems).	N/A
2.7. The findings of the specialist assessment must be written up in an Aquatic Biodiversity Specialist Assessment Report that contains, as a minimum, the following information:	
2.7.1. contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	Appendix 2 – Specialist curriculum vitae
2.7.2. a signed statement of independence by the specialist;	Below Declaration of Independence –Page vi
2.7.3. a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	4.2 – Site assessment Section 4 – Approach and methodology Section 5 - Assumptions
2.7.4. the methodology used to undertake the site inspection and the specialist assessment, including equipment and modelling used, where relevant;	Section 4 – Approach and methodology

Declaration of Independence

SPECIALIST REPORT DETAILS

This report has been prepared as per the requirements of the Environmental Impact Assessment Regulations and the National Environmental Management Act (Act 107 of 1998), any subsequent amendments and any relevant National and / or Provincial Policies related to biodiversity assessments. This also includes the minim requirements as stipulated in the National Water Act (Act 36 of 1998), as amended in Water Use Licence Application and Appeals Regulations, 2017 Government Notice R267 in Government Gazette 40713 dated 24 March 2017, which includes the minimum requirements for an Aquatic Biodiversity Report.

Report prepared by: Debbie Fordham

Expertise / Field of Study: Debbie is a certified Professional Wetland Scientist (PWS certification number 3683) by the Society for Wetland Scientists (SWS) Professional Certification Program, which is internationally accredited by the Council of Engineering and Scientific Specialty Boards (CESB). She is also a registered SACNASP ecologist (Ecology No. 119102), with over 10 years of working experience, specialising in aquatic ecology. Debbie holds a M.Sc. degree in Environmental Science from Rhodes University, by thesis, entitled: The geomorphic origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She is a member of scientific organisations such as the Society of Wetland Scientists (SWS), the South African Wetland Society (SAWS), and the Southern African Association of Geomorphologists (SAAG).

I, **Debbie Fordham** declare that this report has been prepared independently of any influence or prejudice as may be specified by the National Department of Environmental Affairs Fisheries and Forestry and or Department of Water and Sanitation.

Signed:… .... Date:…16 November 2023………

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1 INTRODUCTION

Debbie Fordham of Upstream Consulting has been appointed by Sharples Environmental Services cc, to undertake an aquatic biodiversity impact assessment for the proposed removal and replacement of various existing culverts and pipes along five roads in the Garden Route, Western Cape. The sites all fall within areas identified as having "Very High" aquatic sensitivity by the National Web based Environmental Screening Tool and therefore require an aquatic specialist study to inform the National Environmental Management Act (NEMA) environmental authorisation process.

For assessment purposes, the various sites proposed for repair by the Garden Route District Municipality have been grouped into the three local municipalities in which the roads are located. This report focuses on the two causeways situated in the Mossel Bay Local Municipal area.

1.1 BACKGROUND AND LOCATION

In the Mossel Bay Local Municipality, there are two causeways which require removal and replacement due to significant structural damage from flood events These two sites, referred to as Site 4 and Site 8 in the information provided, are located along the Varings River in the Jonkersberg area, inland of the coastal town of Groot Brak River (Figure 1).

Site 4 is a causeway on the DR1633 Jonkersberg Road (km 3.35) over the Varings River in Jonkershoek. The causeway has collapsed and requires complete removal and replacement (Plate 1). According to the information provided, it is proposed to replace the existing causeway with another structure, designed to have significantly larger openings, with inlet and outlet apron slabs and wing walls. A temporary deviation road is proposed upstream during construction. The bypass will be 4m in width, 45m in length, covering an area of approximately 80 m², and extend approximately 2.5m beyond the road reserve.

Site 8 is a causeway on the DR1602 Kleinplaas Road (km 3.35), downstream of Site 4, on the Varings River (Plate 2). According to the information provided, it is proposed to remove the existing causeway, realign the road, and construct a new causeway outside of the current road reserve. The new causeway is proposed to have significantly larger openings, with inlet and outlet apron slabs and wing walls. A temporary deviation road is proposed upstream during construction. The bypass will be 4m in width, 60m in length, covering an area of approximately 118m², and extend approximately 2.5m beyond the road reserve. No alternatives have been provided for assessment.

Figure 1: The location of the proposed pipeline upgrades in the suburb of Lawaaikamp, in relation to the N2 National Route, and the Outeniqua Sewage Works, in George

Plate 1: Photograph of the collapsed Site 4 causeway on the DR1633 Jonkersberg Road (km 3.35) over the Varings River in Jonkersshoek

Plate 2: Photograph of the Site 8 causeway on the DR1602 Kleinplaas Road (km 3.35), downstream of Site 4, on the Varings River.

1.2 Site Sensitivity Screening Tool Results

The National Web based Environmental Screening Tool was utilised for this proposal in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended, to screen the proposed site for any environmental sensitivity. The Screening Tool identifies related exclusions and/ or specific requirements including specialist studies applicable to the proposed site. The Screening Tool allows for the generating of a Screening Report referred to in Regulation 16 (1) (v) of the Environmental Impact Assessment Regulations 2014, as amended whereby a Screening Report is required to accompany any application for Environmental Authorisation. Requirements for the assessment and reporting of impacts of development on aquatic biodiversity are set out in the 'Protocol for the assessment and reporting of environmental impacts on aquatic biodiversity published in Government Notice No. 648, Government Gazette 45421, on the 10 of May 2020.

According to the Screening Report, the sites are situated within an area of “Very High” aquatic sensitivity and requires the assessment and reporting of impacts on Aquatic Biodiversity. The sensitivity features included: CBA1 Aquatic, SWSA (SW) Outeniqua, and Wetlands_Eastern Fynbos-Renosterveld Bioregion (Valley-bottom).

The site verification assessment was undertaken and is attached as a Site Verification Report in Appendix 3. The Very High aquatic biodiversity sensitivity rating for parts of the site was confirmed. Therefore, the Aquatic Biodiversity Impact Assessment report was required and has been compiled in accordance with the latest NEMA Minimum Requirements and Protocol for Specialist Aquatic Biodiversity Impact Assessment (10 May 2020).

2 RELEVANT LEGISLATION

The protection of water resources is essential for sustainable development and therefore many policies and plans have been developed, and legislation promulgated, to protect these sensitive ecosystems. The proposed project must abide by the relevant legislative requirements. Table 1 below shows an outline of the environmental legislation relevant to the project.

Table 1: Relevant environmental legislation

Legislation	Relevance
South African Constitution 108 of 1996	The constitution includes the right to have the environment protected
National Environmental Management Act 107 of 1998	Outlines principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state. Chapter 1(4r) states that sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure. Section 24 of NEMA requires that the potential impact on the environment, socio-economic conditions and cultural heritage of activities that require authorisation, must be investigated and assessed prior to implementation, and reported to the authority.
Environmental Impact Assessment (EIA) Regulations	The 2014 regulations have been promulgated in terms of Chapter 5 of NEMA and were amended on 7 April 2017 in Government Notice No. R. 326. In addition, listing notices (GN 324-327) lists activities which are subject to an environmental assessment.
The National Water Act 36 of 1998	Unless authorized by the DWS, the proposed project requires water use authorisation in terms of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998, and this must be secured prior to the commencement of activities. Chapter 4 of the National Water Act addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use of water.
Conservation of Agricultural Resources Act (Act 43 of 1983)	The Conservation of Agricultural Resources Act (CARA) is to provide for the conservation of the natural agricultural resources by the maintenance of production potential of land, by the

	combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants.
National Environmental Management: Biodiversity Act No. 10 of 2004	This is to provide for the management and conservation of South Africa's biodiversity through the protection of species and ecosystems; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits.

3 TERMS OF REFERENCE

- Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information (including but not limited to the South African Inventory of Inland Aquatic Ecosystems (SAIIAE), vegetation, CBAs, Threatened ecosystems, any Red data book information, NFEPA data, broader catchment drainage and protected areas).
- Desktop delineation and illustration of all watercourses within and surrounding the study area utilising available site-specific data such as aerial photography, contour data and water resource data.
- Prepare a map demarcating the respective watercourses or wetland/s, within the study area. This will demonstrate, from a holistic point of view the connectivity between the site and the surrounding regions, i.e. the hydrological zone of influence while classifying the hydrogeomorphic type of the respective water courses / wetlands in relation to present land-use and their current state. The maps depicting demarcated waterbodies will be delineated to a scale of 1:10 000, following the methodology described by the DWS.
- A risk/screening assessment of the identified aquatic ecosystems to determine which ones will be impacted upon and therefore require ground truthing and detailed assessment.
- Ground truthing, identification, delineation and mapping of the aquatic ecosystems in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*.
- Classification of the identified aquatic ecosystems in accordance with the, 'National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa' (Ollis *et al.* 2013) and WET-Ecoservices (Kotze *et al*. 2009).
- Conduct a Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland and riparian habitats.
- Identification, prediction and description of potential impacts on aquatic habitat during the construction and operational phases of the project. Impacts are described in terms of their extent, intensity, and duration. The other aspects that must be included in the evaluation are probability, reversibility, irreplaceability, mitigation potential, and confidence in the evaluation.
- All direct, indirect, and cumulative impacts for each alternative will be rated with and without mitigation to determine the significance of the impacts.

- Recommend actions that should be taken to avoid impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas or ecological processes.
- Rehabilitation guidelines for disturbed areas associated with the proposed project and monitoring.

4 APPROACH AND METHODS

This study followed the approaches of several national guidelines with regards to wetland/ riparian assessment. See Appendix 1. The following approach to the aquatic habitat assessment is undertaken:

4.1 DESKTOP ASSESSMENT METHODS

The contextualization of the study area was undertaken in terms of important biophysical characteristics and the latest available aquatic conservation planning information (i.e. existing data for coastal management lines, NFEPA identified rivers and wetlands, critical biodiversity areas (WBSP 2017), estuaries, vegetation units, ecosystem threat status, catchment boundaries, geology, land uses, etc.) in a Geographical Information System (GIS). A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the National Biodiversity Assessment of 2018 (Van Deventer *et al.* 2018). The SAIIAE offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourses and the coastal dynamic. The conservation planning information aids in the determination of the level of importance and sensitivity, management objectives, and the significance of potential impacts.

Following this, desktop delineation and illustration of all watercourses within the study area was undertaken utilising available site-specific data such as aerial photography, contour data and water resource data. Digitization and mapping were undertaken using QGIS 3.28 GIS software. These results, as well as professional experience, allowed for the identification of sensitive habitat that could potentially be impacted by the project and therefore required ground truthing and detailed assessment.

4.2 BASELINE ASSESSMENT METHODS

A site assessment was conducted on the 4th of November 2023 to confirm desktop findings, gather additional information, and define the boundaries of the aquatic habitat. General observations were made with regards to the vegetation, fauna and current impacts. The identified aquatic ecosystems were classified in accordance with the, '*National Wetland*

Classification System for Wetlands and other Aquatic Ecosystems in South Africa' (Ollis *et al*. 2013) and *WET-Ecoservices* (Kotze *et al*. 2009).

Infield delineation was undertaken with a hand-held GPS, for mapping of any potentially affected aquatic ecosystems, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*. The delineation is based upon observations of the landscape setting, topography, vegetation and soil characteristics (using a hand held soil auger for wetland soils).

Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated river/riparian habitats was undertaken utilising:

- Qualitative Index of Habitat Integrity (IHI) tool adapted from (Kleynhans, 1996) – PES
- DWAF (DWS) River EIS tool (Kleynhans, 1999) - EIS

Determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitat was undertaken utilising:

- The health/condition or Present Ecological State (PES) of the wetland was assessed using the Level 2 WET-Health assessment tool Version 2 (Macfarlane et al. 2020), which is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and the structure and composition of wetland vegetation.
- The WET-Ecoservices tool (Kotze *et al.*, 2020) is utilised to assess the goods and services that the individual wetlands under assessment provide, thereby aiding informed planning and decision-making. Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing).

4.3 IMPACT ASSESSMENT METHODS

The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined. Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood / probability of the impact occurring. Unknown parameters are given the highest score as significance scoring follows the Precautionary Principle. A methodology for assigning scores to the respective impacts is described in Appendix 1.

Cumulative impacts affect the significance ranking of an impact because the impact is taken in consideration of both onsite and offsite sources. For example, pollution making its way into a river from a development may be within acceptable national standards. Activities in the surrounding area may also create pollution which does not exceed these standards. However, if both onsite and offsite pollution activities take place simultaneously, the total pollution level may exceed the standards. For this reason, it is important to consider impacts in terms of their cumulative nature.

4.4 MITIGATION AND MONITORING

Actions are thereafter recommended to prevent and mitigate the identified impacts on aquatic habitat, in alignment with the mitigation hierarchy, as well as any measures necessary to restore disturbed areas or ecological processes. No-Go Areas will be determined, and any necessary monitoring protocol will be developed.

5 ASSUMPTIONS AND LIMITATIONS

- Aquatic ecosystems vary both temporally and spatially. Once-off surveys such as this can miss certain ecological information due to seasonality, thus limiting accuracy and confidence. Despite this, confidence in findings is high.
- The location and nature of the proposed activities was provided by the client.
- While disturbance and transformation of habitats can lead to shifts in the type and extent of aquatic ecosystems, it is important to note that the current extent and classification is reported on here.
- All soil/vegetation/terrain sampling points were recorded using a Garmin Global Positioning System (GPS) and captured using Geographical Information Systems (GIS) for further processing.
- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed activities, while the remaining watercourses were delineated at a desktop level with limited accuracy.
- No detailed assessment of aquatic fauna/biota (e.g. fish, invertebrates, microphytes, etc.) was undertaken, and not deemed necessary.
- The vegetation information provided is based on observation not formal vegetation plots. As such species documented in this report should be considered as a list of dominant and/or indicator wetland/riparian species.
- The scope of work did not include water quality sampling and the water quality characteristics were inferred from the biophysical characteristics of the area and catchment land uses.
- 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 projects. The degree of confidence is considered high.

6 BASELINE DESCRIPTION OF THE SITE

The desktop/ screening study was informed by the available datasets relevant to water resources, as well as historic and the latest aerial imagery, to develop an understanding of the fluvial and geomorphic processes of the study area. The study area for the assessment was defined as the disturbance footprint i.e. the area on which the activity will take place, which includes the area that will be disturbed or impacted, plus any watercourses situated within 500 m of that activity, i.e. the 'regulated zone' of a watercourse as defined by the National Water Act. The desktop study was followed by the detailed site assessment. The general biophysical characteristics of the study area, as well as desktop data, are described below.

6.1 CATCHMENT CHARACTERISTICS

The Garden Route area receives rainfall throughout the year, with the lowest amount in June and the highest amount in November. The average midday temperatures for the area range from 18.2°C in July to 27.6°C in February (Mucina and Rutherford, 2006). Land transformation for agriculture and development, as well as alien tree infestation in this area, have replaced much of the natural vegetation.

The study area is situated within quaternary catchment K20A of the Gouritz Water Management Area (Figure 2). The site falls within the Southern Coastal Belt Ecoregion which is described by Kleynhans *et al.* (2005) as an area of hills and mountains with moderate to high relief and surrounding plains. The area is characterised by gently undulating topography on the coastal plateau between the Outeniqua Mountains and the ocean. The largest rivers in this quaternary catchment include the Varings River and the Groot Brak River to the west. The causeways are both located in the upper foothills zone of the Varings River, which originates in the Outeniqua mountain range, and merges with the Groot Brak River, before forming the estuary on the coast.

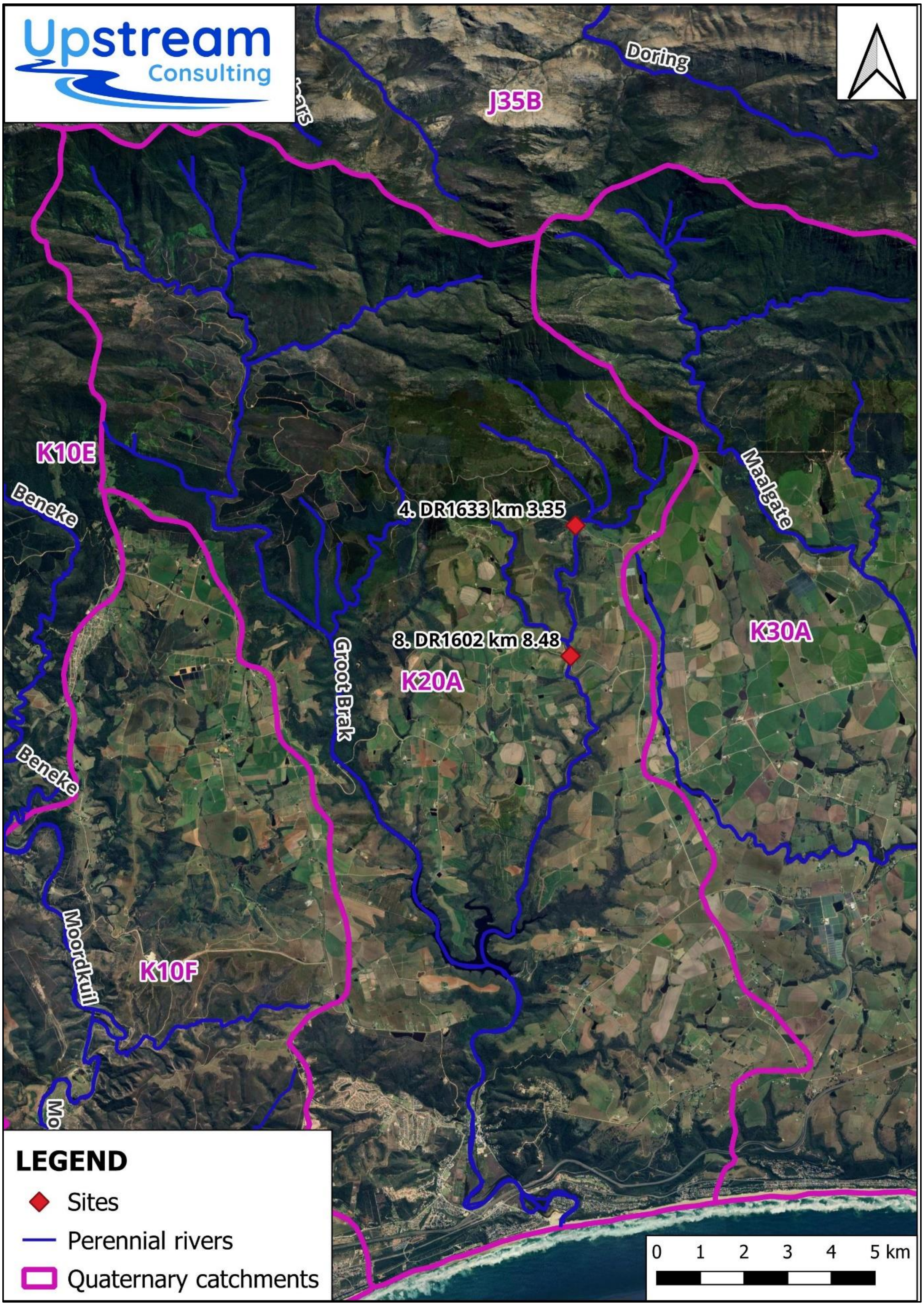

Figure 2: Map of the sites in relation to the main rivers in the K20A quaternary catchment

6.2 STRATEGIC WATER SOURCE AREAS

The study area falls within the Outeniqua Strategic Water Source Area for surface water (Le Maitre *et al.* 2018). Refer to Figure 3. A Strategic Water Source Areas (SWSA) is where the water that is supplied is considered to be of national importance for water security. Surface water SWSAs are found in areas with high rainfall and produce most of the runoff. Groundwater SWSAs have high groundwater recharge and are located where the groundwater forms a nationally important resource. There are 22 national-level SWSAs for surface water (SWSA-sw) and 37 for groundwater (SWSA-gw). The SWSA-sw in South Africa, Lesotho and Swaziland occupy 10% of the land area and generate 50% of the mean annual runoff. They support at least 60% of the population, 70% of the national economic activity, and provide about 70% of the water used for irrigation.

The causeway repairs will not impact any SWSAs as there will be no reduction in water volume and no permanent changes to water quality.

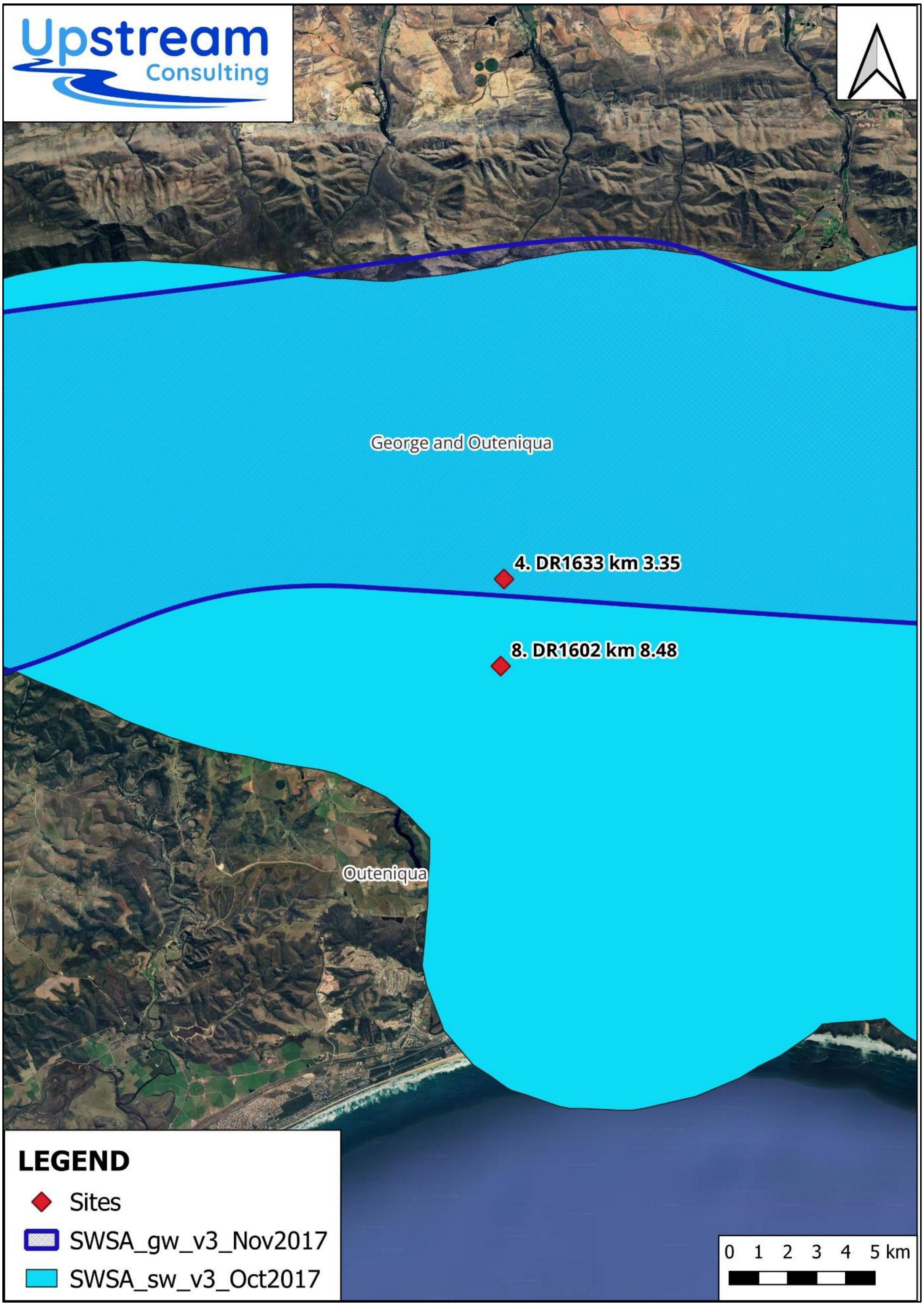

Figure 3: Map of the sites in relation to Strategic Water Source Areas.

6.3 SOUTH AFRICAN INVENTORY OF INLAND AQUATIC ECOSYSTEMS

A significant amount of the latest spatial data has been provided through the products of the 2018 National Biodiversity Assessment (NBA). The NBA is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. It is used to inform policies, strategies and actions in a range of sectors for managing and conserving biodiversity more effectively. A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established during the 2018 National Biodiversity Assessment (Van Deventer *et al.* 2018). The SAIIAE offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands.

The National Wetland Map 5 (NWM5) includes inland wetlands and estuaries, associated with river line data and many other data sets. The NWM5 shows both sites situated within channelled valley bottom wetland habitat along the Varings River (Figure 4).

The NBA 2018 Rivers Map is a GIS layer which summarises the river condition, river ecosystem types, flagship and free-flowing river information (Van Deventer *et al.* 2019). The river lines data set is associated with the National Wetland Map 5 (NWM5) issued with the SAIIAE. The GIS layer of origin is the 1:500 000 rivers data layer that DWAF coded for geomorphological zonations, with added data from the Chief Directorate Surveys and Mapping's (CDSM) 1:50 000 rivers GIS layer, and information generated during the NFEPA project in 2011. The NBA 2018 Rivers data does not identify the Varings River or any other rivers within 500m of the site. The river lines depicted in Figure 4 are from the 1:500000 NGI cadastral rivers data. This shows the perennial Varings River and smaller non-perennial tributary streams.

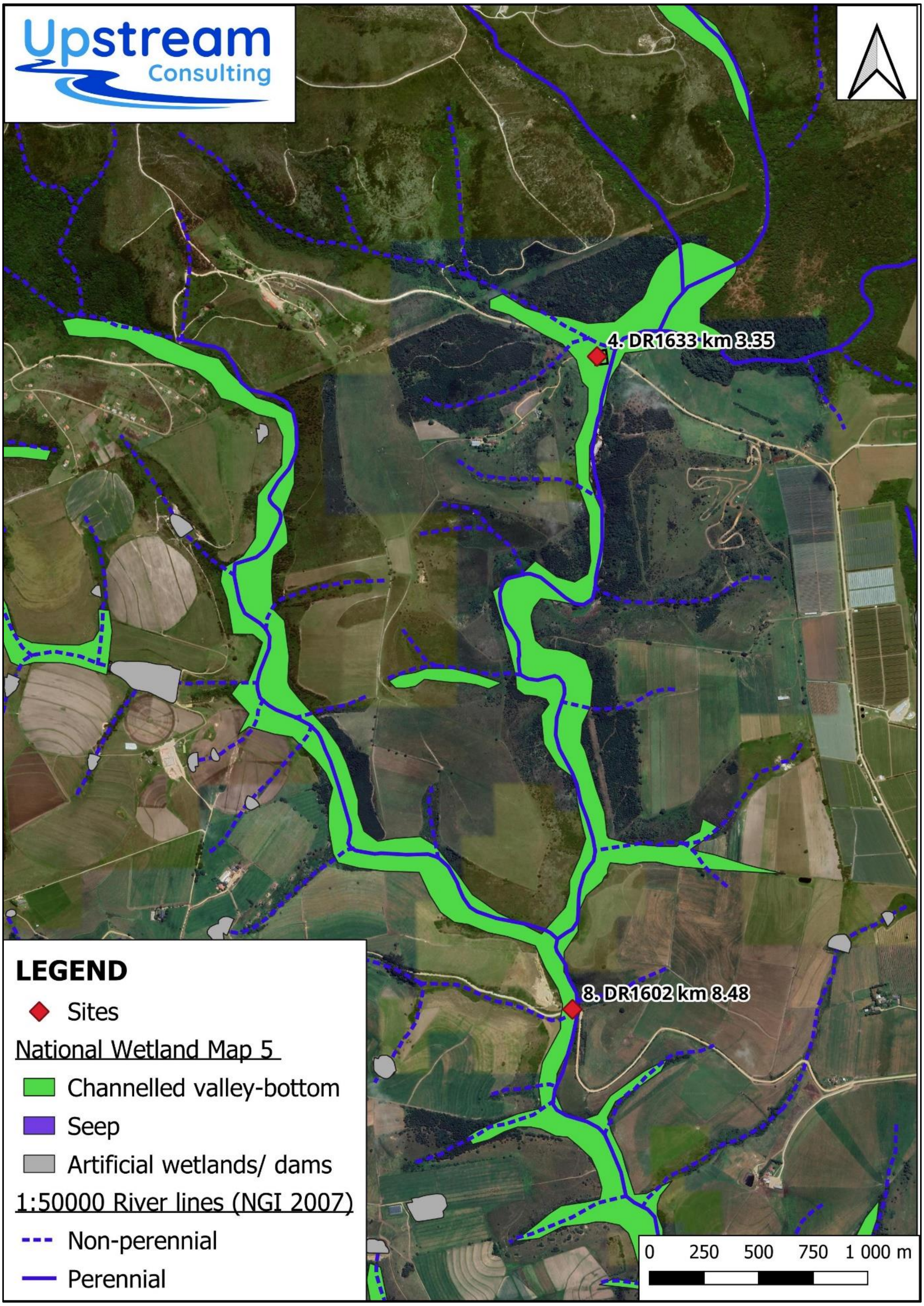

Figure 4: The sites in relation to the national river and wetland inventories (CSIR, 2018)

6.4 CONSERVATION PRIORITY AREAS

The Western Cape Biodiversity Spatial Plan (WCBSP) identifies biodiversity priority areas, CBAs and Ecological Support Areas (ESAs), which, together with Protected Areas, are important for the persistence of a viable representative sample of all ecosystem types and species, as well as the long-term ecological functioning of the landscape as a whole. The primary purpose of a map of Critical Biodiversity Areas and Ecological Support Areas is to guide decision-making about where best to locate development. Critical Biodiversity Areas (CBA's) are required to meet biodiversity targets. According to the WCBSP, these areas have high biodiversity and ecological value and therefore must be kept in a natural state without further loss of habitat or species.

Figure 5 shows that both causeways are located within CBA 1 river habitat and are therefore in a biodiversity priority area for conservation. The project must not result in the deterioration of any CBA habitat.

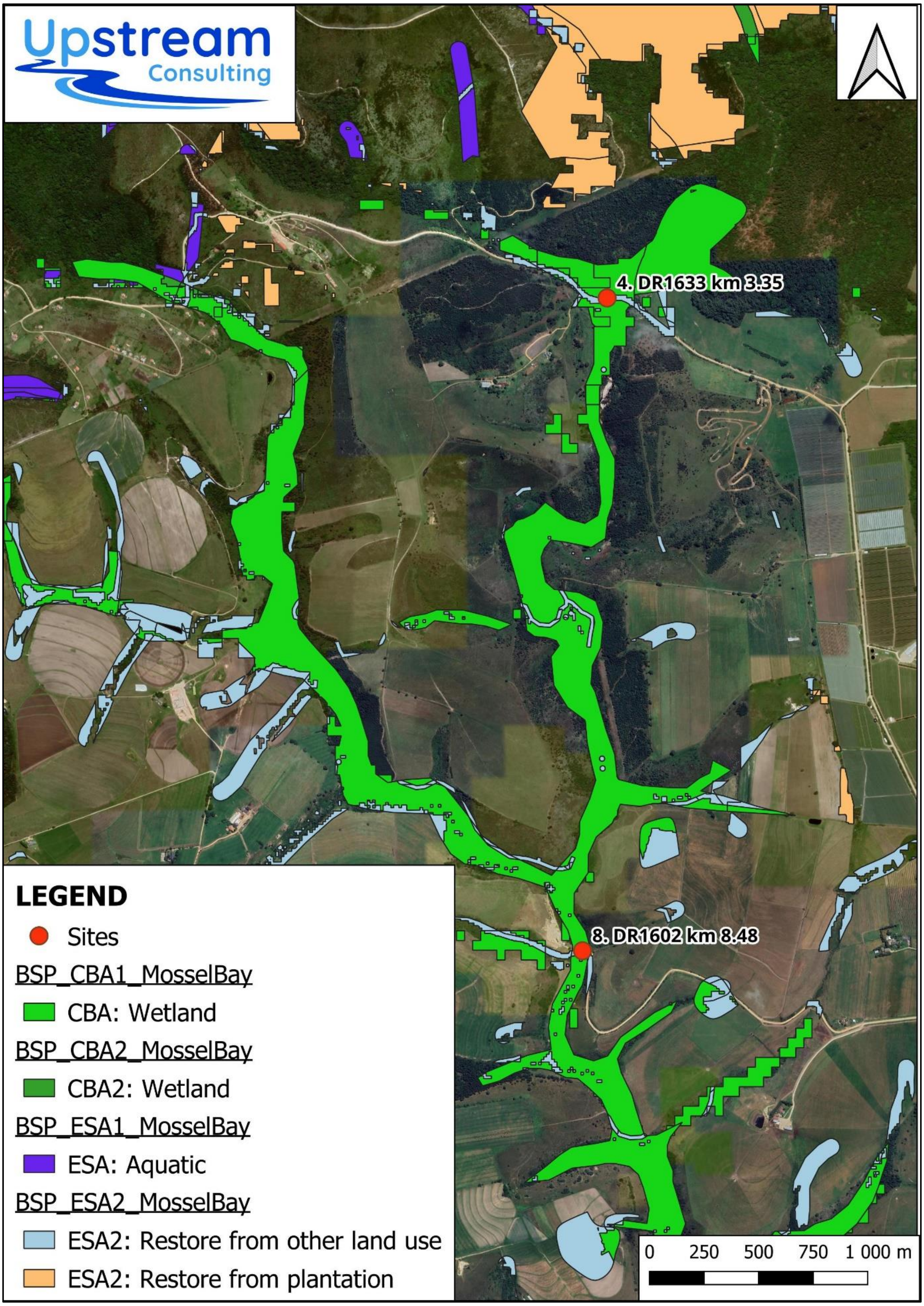

Figure 5: Map of the site in relation to aquatic priority areas identified in the WCBSP (2017)

6.5 HISTORIC CONTEXT

Historic Google satellite imagery was found sufficient to provide an understanding of the various land use and cover changes for the study area. It shows that the area has been significantly modified from the natural condition for many decades due to agricultural land uses and forestry plantation (Figure 6). Additionally, the vegetation of the rivers has become infested with alien invasive tree species. The causeways have been in place for many years and there is evidence of past flood events periodically scouring the system (Figure 7). The culverts have confined flow and straightened the channel. However, ecological form and functioning of the river remains moderately high.

Figure 8 shows the ongoing clearance of riparian vegetation and conversion of land and floodplain for cultivated pastures at Site 4. Figure 9 shows the encroachment of cultivated lands into the riparian are as well as quarrying activities in close proximity to the river. Overall, the historic imagery shows that the river reach has been modified from the natural reference condition over many years.

Figure 6: Historical Google satellite imagery of the area from 1985 showing the existing causeways within farmlands and plantation.

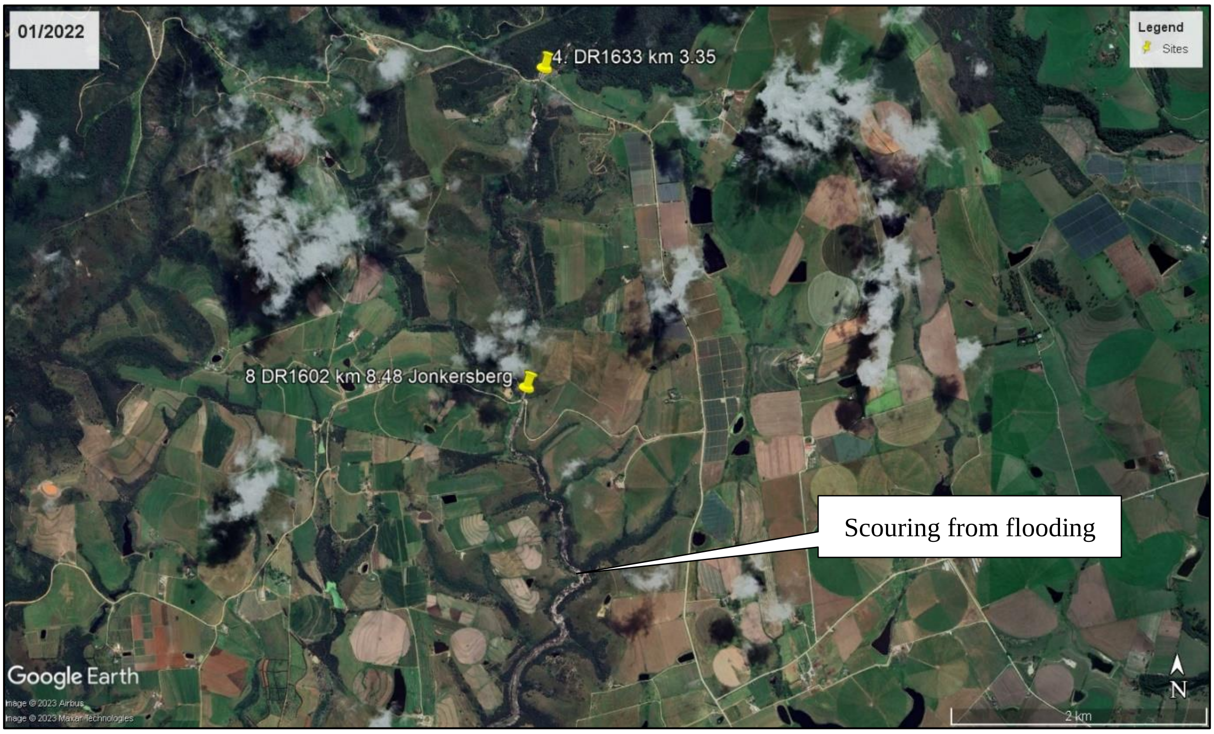

Figure 7: Google satellite imagery of the sites from early 2022 showing the flood scouring of the river during 2021 high rainfall events.

Figure 8: Google satellite imagery of Site 4 in 2014 showing the vegetation clearance in the riparian area of the river

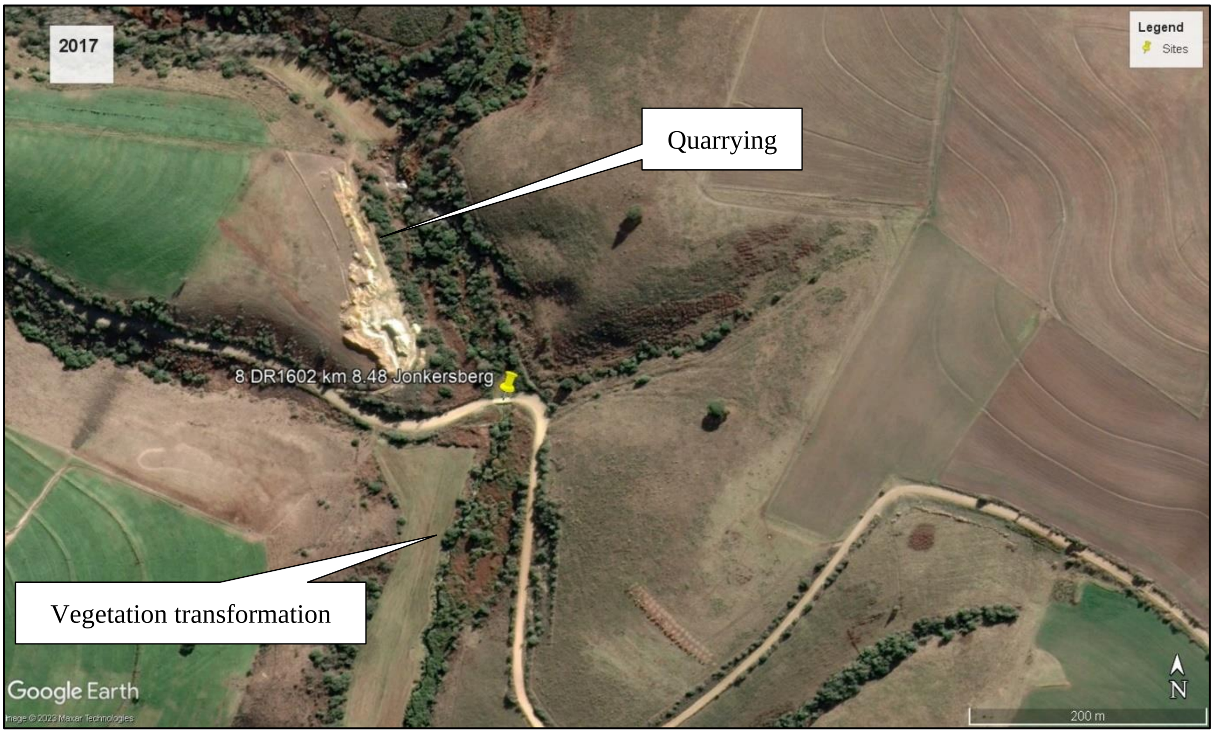

Figure 9: Google satellite imagery of Site 8 in 2017 showing the vegetation clearance in the riparian area of the river and continuation of quarrying activities within the Regulated Area

7 RESULTS

The aquatic habitats within a 500 metre radius of the causeways were identified and mapped on a desktop level utilising available data. In order to identify the wetland/river types, using Kotze *et al.* (2009) and Ollis *et al*. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. Following the desktop findings, the infield site assessment confirmed the location and extent of these systems. Subsequent screening provided an indication of which of these systems may potentially be impacted upon by the project. The findings are detailed in this section below.

7.1 Identified Aquatic Habitats

Following the contextualisation of the study area with the available desktop data, a site visit was conducted to groundtruth the findings and delineate the aquatic habitat and map it within the 500m radius of the disturbance area. The additional information collected in the field allowed for the development of improved baseline aquatic habitat delineation maps for the two sites.

7.1.1 Site 4

Three watercourses were identified and mapped within a 500m radius study area of the Site 4 causeway. For reference purposes, the identified HGM units were named as follows:

HGM1 – Varings River
HGM2 – Tributary
HGM3 – Tributary

The reach of the Varings River (HGM1) at the Site 4 causeway can be classified as an upper foothills perennial river system. HGM2 is a perennial tributary stream which enters the Varings River from the west, directly upstream of the causeway. Both systems contain wetland habitat upstream. The HGM3 tributary, a channelled valley bottom wetland system, merges with the Varings River approximately 500m upstream of the causeway.

Figure 10 shows the above-listed watercourses in relation to the causeway and 500m radius study area.

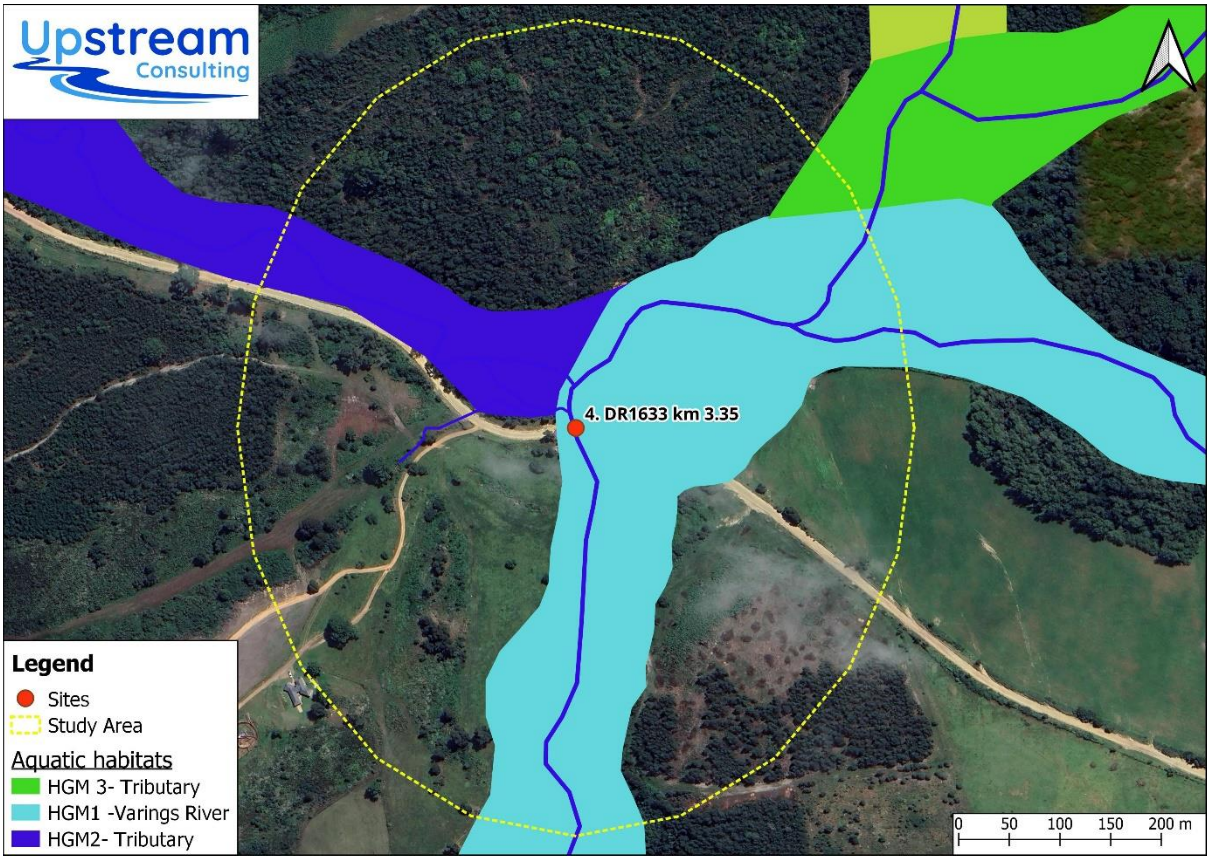

Figure 10: Map of the delineated aquatic habitat within the 500m radius study area of Site 4

7.1.2 Site 8 -

Four watercourses were identified and mapped within a 500m radius of the Site 8 causeway. For reference purposes, the identified HGM units were named as follows:

HGM1 – Varings River
HGM4 – Seep
HGM5 – Seep
HGM6 -Tributary

Both causeways proposed for replacement are within the Varings River (HGM1), however, in this lower reach, a channelled valley wetland has formed. HGM4 and HGM5 are seep wetlands which enter the Varings River wetland from the left and right banks, respectively. These systems have already been modified by the road. HGM6 is a tributary channelled valley bottom wetland which merges with the Varings river approximately 400m upstream of the causeway.

Figure 11 shows the above-listed watercourses in relation to the causeway at Site 8 and within the 500m radius study area.

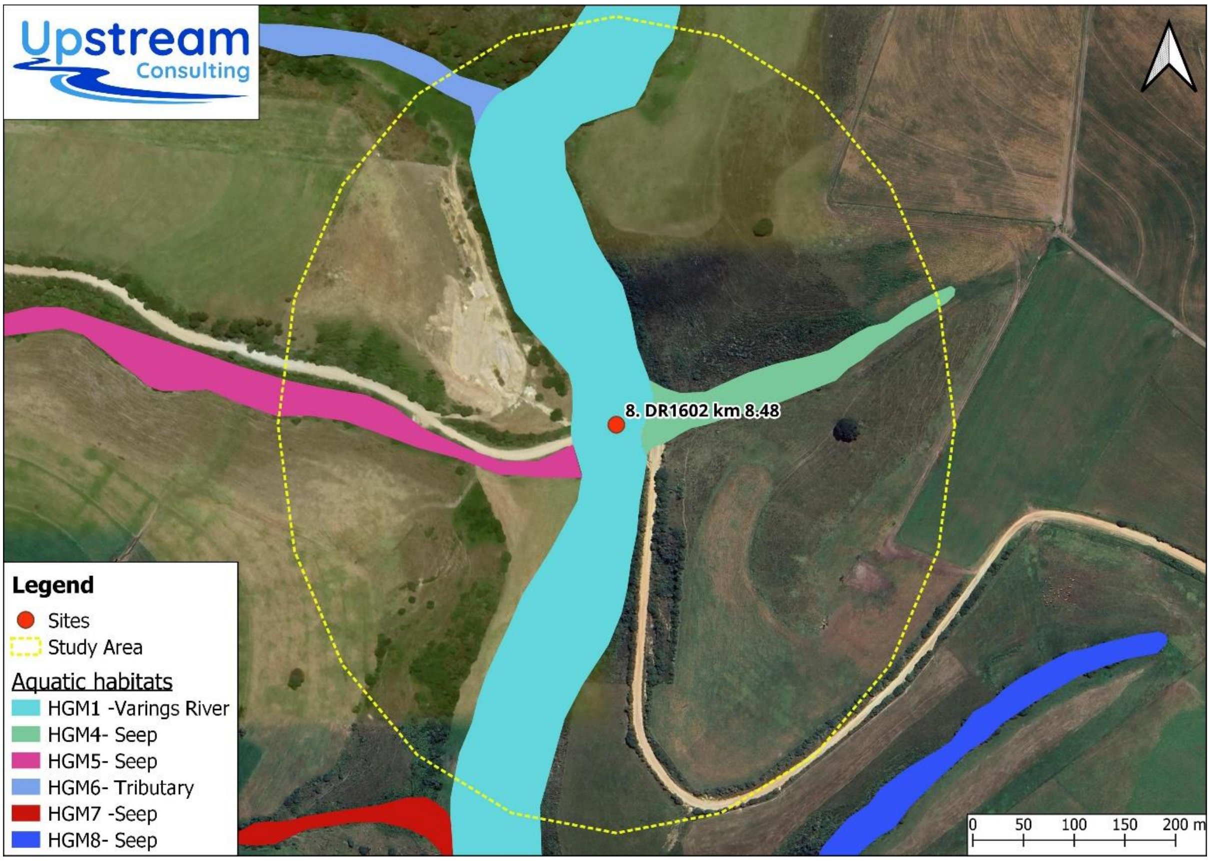

Figure 11: Map of the delineated aquatic habitat within the 500m radius study area of Site 8

7.2 SCREENING/ RISK ASSESSMENT

Subsequent screening provided an indication of which of these systems may potentially be impacted upon by the project and required further assessment. There are a number of factors which influence the level of impact, such as type of system, position of the system in relation to the project and position the system is located in the landscape.

It was determined that the Varings River (HGM1) will be directly impacted by the replacement of the causeways and required detailed assessment, to determine the impact significance and recommend mitigation measures. Further assessment of the other identified watercourses was not deemed as necessary, provided that the activities do not alter these systems.

HGM3 and HGM6 are located more than 300m upstream of the sites and will not be impacted by the project. The HGM2, HGM4, and HGM5 systems are at risk of being impacted should the road be realigned within or near these watercourses. However, no detailed engineering designs, layouts or construction method statements have yet been provided for assessment, and therefore, it is assumed that the disturbance will be restricted to the Varings River and not alter the other watercourses.

7.3 DESCRIPTION OF AFFECTED AQUATIC HABITAT

The Varings River at the Site 4 causeway crossing is typical of a perennial upper foothills system within the South Eastern Coastal Belt (Plate 3). It has a relatively narrow channel with a boulder and cobble bed. Sand has deposited on the upstream side of the causeway, which only has one small opening which confines flow. The channel has been scoured by flood waters on the downstream side, resulting in erosion of the bed and banks (Plate 4). A significant area of the floodplain, as well as lateral wetland habitat, has been transformed into grazing pastures. Alien invasive trees (such as *Acacia mearnsii* and *Acacia melanoxylon*) have established within the riparian zone and have contributed to bank erosion. However, there remains a high diversity of habitat types and indigenous instream and riparian plant species.

Although the bed has been eroded from high flow events, there are clumps of instream vegetation remaining, dominated by *Cliffortia odorata, Brachylaena neriifolia, Todea Barbara, Pteridium aquilinum, Elegia capensis,* and *Juncus lomatophyllus.* The riparian zone, where not invaded by alien trees, is vegetated with shrubs and small trees, such as *Kiggelaria africana, Brachylaena neriifolia, Rapanea melanophloeos, Halleria elliptica, Psoralea aphylla, Virgilia oroboides,* and *Burchellia bubaline.*

The lower reach, at the Site 8 causeway crossing, supports a large, channelled valley bottom wetland. The wetland has highly organic soils and is dominated by *Cliffortia odorata, Cyperus thunbergii. wachendorfia thyrsiflora, wachendorphia, Todea Barbara, Pteridium aquilinum, Elegia capensis,* and *Juncus lomatophyllus. Prionium serratum* was also present in clumps of fast flowing water (Plate 5). However, catchment land transformation, confined flow from road culverts, and flood events have resulted in gully erosion downstream of the causeway. This has resulted in significant wetland habitat loss downstream (Plate 6).

Plate 3: A photograph of the Varings River upstream of the Site 4 causeway

Plate 4: A photograph of the Varings River downstream of the Site 4 causeway

Plate 5: A photograph of the Varings River wetland upstream of the Site 8 causeway

Plate 6: A photograph of the Varings River wetland downstream of the Site 8 causeway

7.3.1 Present Ecological State

The Present Ecological State (PES) of a river, watercourse or wetland represents the extent to which it has changed from the reference or near pristine condition (Category A) towards a highly impacted system where there has been an extensive loss of natural habit and biota, as well as ecosystem functioning (Category E).

As discussed in the section above, the Varings River has been subjected to habitat loss and disturbance from the narrow road culverts, encroachment of agricultural lands, and alien tree species infestation. These impacts upon the watercourse have resulted in a Moderately Modified state from the reference condition. The narrow culvert openings have replaced habitat and confined flow, resulting in sedimentation above structures and erosion below. Alien tree roots in the river banks increase bank erosion and collapse. Transformation of riparian and floodplain vegetation to pasture alters the hydrological inputs and retention patterns to the watercourse. Refer to photo Plates 7 to 11 below. Therefore, the Varings River (HGM1) falls within the ‘C’ Ecological Category for PES (Table 2).

Plate 7: Photograph of the single small culvert at the site 4 causeway resulting in confined flow and scour downstream

Plate 8: Photograph of the bank erosion on the downstream side of the causeway resulting from altered channel morphology and the effect of Wattle Tree roots on river banks

Plate 9: Photograph of road side stormwater drain causing sedimentation of the river

Plate 10: Photograph showing the culvert confining flows resulting in scouring of the river bed downstream and erosion of the banks

Plate 11: Photograph showing the gully erosion downstream initiated by the causeway (due to flow confinement) and land use changes in the catchment.

Table 2: WET-Health (V2) PES Assessment Results

	Wetland PES Summary			
Wetland name	Varings River wetland			
Assessment Unit	HGM1			
PES Assessment	HYDROLOGY	GEOMORPHOLOGY	WATER QUALITY	VEGETATION
Impact Score	1,9	3,0	0,2	3,6
PES Score (%)	81%	70%	98%	64%
Ecological Category	B	C	A	C
Combined Impact Score	2,1			
Combined PES Score (%)	79%			
Combined Ecological Category	C			
Confidence	High: Site assessment based			

7.3.2 Functional assessment

Wetlands and riparian areas are globally threatened ecosystems and are well-recognized for the ecosystem services which they supply. Furthermore, these ecosystems make potentially important ecosystem services contributions to several broad-scale imperatives of government, including: water resource management; biodiversity conservation; human safety and disaster resilience; socio-economic development and poverty elimination; and climate change mitigation and adaptation. Individual wetland/riparian areas differ according to their characteristics, contexts and the particular suite of ecosystem services which they supply to society (Kotze *et al.* 2021). Thus, there is a need to assess and compare wetland/riparian areas in terms of ecosystem services delivery.

A WET-Ecoservices (Version 2) field-based assessment was undertaken to assess the ecosystem services supplied by the HGM unit (Kotze *et al.* 2021). The assessment technique has recently been revised and now distinguishes clearly both ecosystem services' supply and the demand for all ecosystem services. This helps determine the potential of the wetland or river for delivering ecosystem services, by understanding its capacity to produce a service while also considering the societal demand for that service.

The assessment showed that the reach of the river assessed provides a High -Very High level of regulatory services to society (Table 3), such as sediment trapping and erosion control, and has a High EIS. The Varings River has a high diversity of habitat types, plant species, is in fair ecological condition, acts as an important corridor in the landscape. The system is critically important for biodiversity maintenance and the provision of clean water.

Table 3: Ecosystems Services summary for the affected river reach

ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	2,3	2,3	2,0	Moderate
	Stream flow regulation	2,3	3,0	2,3	Moderate
	Sediment trapping	4,0	3,0	4,0	Very High
	Erosion control	3,0	3,0	3,0	High
	Phosphate assimilation	2,6	2,0	2,1	Moderate
	Nitrate assimilation	1,8	2,0	1,3	Moderately Low
	Toxicant assimilation	2,8	0,0	1,3	Moderately Low
	Carbon storage	3,3	2,7	3,1	High
	Biodiversity maintenance	3,7	4,0	4,0	Very High
PROVISIONING SERVICES	Water for human use	3,2	3,3	3,4	Very High
	Harvestable resources	1,5	0,3	0,2	Very Low
	Food for livestock	1,5	1,3	0,7	Very Low
	Cultivated foods	2,5	0,0	1,0	Low
CULTURAL SERVICES	Tourism and Recreation	3,5	0,0	2,0	Moderate
	Education and Research	4,0	0,0	2,5	Moderately High
	Cultural and Spiritual	3,0	0,0	1,5	Moderately Low

8 IDENTIFIED IMPACTS

Aquatic ecosystems are particularly vulnerable to human activities and these activities can often result in irreversible damage or longer term, cumulative changes. The significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed. The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined.

During construction there will be clearance of riparian vegetation, excavations of the bed and bank, infilling, diversion of flows, a bypass road, and potential for cement and fuel spills within the watercourse. These impacts must be mitigated for, and where possible, entirely avoided. In the operational phase, the impacts associated with the project will be very similar to those which occurred during the construction of the existing infrastructure and are unlikely to cause any further deterioration of ecological condition. The improved design of the causeways, with more openings, may result in positive impacts in the long-term. The correct design and placement of culverts and erosion control infrastructure, despite causing freshwater habitat loss on site, has the potential to improve longitudinal flow, sediment dynamics and morphological stability (especially during flood events).

The main risks during construction result from the need to construct a bypass route through the watercourse at both causeways and the expansion of the existing disturbance footprint. Mitigation must focus on limiting the disturbance footprint as far as possible and avoiding the confluence areas of upstream tributaries.

8.1 DISTURBANCE OF AQUATIC HABITAT AND BIOTA

The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance of aquatic habitat caused by earthworks, vegetation clearing, and encroachment and colonisation of habitat by invasive alien plants. During construction the causeway removal and replacement will necessitate the clearance of vegetation for the larger structure and the bypass, and earthworks in the river and on the riverbanks. Post construction, invasive alien plants will colonise any disturbed areas which are not rehabilitated and will out-compete indigenous vegetation. Without mitigation, the impact can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services. Although the bypass road is temporary the impacts of its construction can be permanent, including habitat loss, if not rehabilitated.

8.2 SEDIMENTATION AND EROSION

Sedimentation and erosion refers to the alteration in the physical characteristics of wetlands and rivers as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for aquatic dependent flora & fauna.

During construction, the excavation and infilling in the watercourse will cause soil movement. These activities will negatively impact biota, geomorphology, water quality, and flow within the watercourses as well as downstream habitat. Vegetation clearing, earthworks, and exposure of bare soils within and upslope of the aquatic habitat during construction will decrease the soil binding capacity and cohesion of the upslope soils and thus increase the risk of erosion and sedimentation downslope and in the river. This may cause the burying of aquatic habitat and also cause aquatic faunal fatalities. Ineffective site stormwater management, particularly in periods of high runoff, can lead to soil erosion from confined flows. Formation of rills and gullies from increased concentrated runoff. This increase in volume and velocity of runoff increases the particle carrying capacity of the water flowing over the surface.

Where soil erosion problems and bank stability concerns initiated during the construction phase are not timeously and adequately addressed, these can persist into the operational phase of the project and continue to have a negative impact.

8.3 Hydrological Changes

Hydrological alterations associated with the project include changes in the distribution of water inputs and flows within the watercourse. Possible ecological consequences associated with this impact may include deterioration in freshwater ecosystem integrity, reduction/loss of habitat for aquatic dependent flora & fauna, and a reduction in the supply of ecosystem goods & services.

During construction the flows will be significantly impacted through impoundment and/or flow diversions to replace the structures. However, the hydrological integrity of the systems has already been moderately modified, and flows are currently confined. If the structure design does not allow the through-flow of water and sediment it may continue to damage the systems through flow impoundment and sediment starvation. There will be negative impacts if these structures are not designed and constructed appropriately.

Also during construction, land clearing and earth works adjacent to the river will reduce infiltration rates and increase the surface runoff volume and velocity. Such changes in surface roughness and runoff rates may lead to some rill and gully erosion. Altered water inputs from upslope disturbances as well as modified water distribution and retention patterns will ultimately affect the hydrological integrity of water resources.

Once the construction has been completed and the improved structures have halted erosion, promoted diffuse and unhindered flows (especially in the wetland), improved the longitudinal and cross-sectional profiles, and increased surface roughness through indigenous vegetation, the flow regime of the system will be improved. Although it is unlikely that the natural condition will ever be achieved, there is potential for an improvement in the level of hydrological integrity.

8.4 Changes to surface water quality

Water and/or soil pollution cause negative changes in the physical, chemical and biological characteristics of water resources (i.e. water quality). This can result in possible deterioration in aquatic ecosystem integrity and a reduction in, or loss of, species of conservation concern (i.e. rare, threatened/endangered species). The result is only disturbance tolerant species remaining.

During construction there are a number of potential pollution inputs into the aquatic system (such as hydrocarbons and raw cement). These pollutants alter the water quality parameters such as turbidity, nutrient levels, chemical oxygen demand and pH. These alternations impact the species composition of the systems, especially species sensitive to minor changes in these parameters. Sudden drastic changes in water quality can also have chronic effects on aquatic biota in general and result in localised extinctions. Hydrocarbons including petrol/diesel and oils/grease/lubricants associated with construction activities (machinery, maintenance, storage, handling) may potentially enter the system by means of surface runoff or through dumping by construction workers. Raw cement entering the systems through incorrect batching procedure and/or direct disposal.

8.5 CUMULATIVE IMPACTS

Cumulative impacts on the environment can result from broader, long-term changes and not only as a result of a single activity. They are rather from the combined effects of many activities overtime. Rivers are longitudinal systems where different reaches interact in a continuum along the length of the river. Activities in the upper reaches influence the processes of the lower reaches and it must therefore be viewed as a whole.

Provided there is no significant increase in the disturbance footprint upstream of the causeways, the project is unlikely to have any significant cumulative impacts as it is a replacement of existing infrastructure. Most of the risk is temporary and contained within the construction phase. The application of mitigation measures will prevent any negative residual impacts and will enhance the project benefits (such improved culvert design).

8.5.1 Strategic Water Source Areas

After mitigation is applied, the project is not expected to have residual impacts upon the environment. It should not impact upon the desktop mapped Strategic Water Source Area. The causeway replacement will not reduce the number of benefits gained by society from the water source area. The activity will need to comply with all regulations of the National Water Act (Act 36 of 1998), including the protection of downstream users, and minimise any potential ecological impacts upon water resources. There is currently no legislation directly related to SWSAs but by adhering to the NWA legislation the SWSA will not be compromised.

8.5.2 Conservation priority areas

There will be a negligible impact upon CBAs after mitigation is applied. The area crossed by the causeway is listed as CBA 1 wetland habitat and therefore, as a priority conservation area needed for meeting biodiversity targets, there should be no loss of this habitat. Provided the project footprint is limited as far as possible, there should not be any significant loss of habitat.

8.5.3 Climate change

The project will not reduce the ecological resilience of the river to future climate changes. The improved culvert design will prevent erosion from flooding in future.

9 IMPACT ASSESSMENT

The impact significance upon aquatic biodiversity for the project was determined as Low after mitigation. The causeways are existing structures at both locations and, provided the new footprint is limited to already disturbed areas, there will not be any significant impact upon the watercourse. The impacts can be decreased to acceptable levels provided that mitigation measures are implemented (including No-Go areas) and adhered to. It is critical that there is no unnecessary encroachment or further loss of wetland habitat. A monitoring programme must be in place, not only to ensure compliance with the EMPr throughout the construction phase, but also to monitor any post-construction environmental issues and impacts.

Refer to Tables 4 to 7 for the results of impact assessment.

No alternative was provided for assessment, but it is recommended that one be developed, based on the information generated within this report. An alternative site would have unnecessarily high impacts, but a refined construction method and detailed designs for these sites, will be beneficial and can result in positive impacts in the long-term. There has been no information provided regarding proposed post-construction rehabilitation plans and it is also recommended that such a plan be developed based on the findings of this report.

The No-Go Alternative is not a reasonable option for consideration, as the causeways are severely compromised and require replacement, but was entered into the impact tables below. In theory, this alternative could in any case have negative consequences as the causeways will collapse into the watercourse in an uncontrolled manner. Road users would likely infill to create a crossing, the side-drains will continue to erode and deposit sediment in river, and alien invasive trees will encroach further.

The impact assessment was based on a number of assumptions. At present, there are no detailed layout plans, civil designs, or construction method statements, and it is assumed that there will not be any significant expansion of the disturbed area or changes to road alignment. It is also assumed that the bypass road, and any areas disturbed by construction, will be entirely rehabilitated to a pre-construction state. It is recommended that the aquatic specialist review and approve the final designs and construction plans prior to commencement. It is important that layouts and construction methods consider the recommended aquatic No-Go areas, as far as possible.

It is recommended that another phase be incorporated into this project to rehabilitate the eroded reaches of the watercourse and stop gully erosion, which will also mitigate against flood damage in future.

Table 4: Impact 1 – Disturbance of aquatic habitat and biota

PHASE:	Construction and operation	
Potential impact and risk:	Disturbance of aquatic habitat biota from clearance of vegetation, earthworks, bypass road, and further invasive alien plant infestation, which can result in deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services.	
Nature of impact:	Negative	
Alternative:	**Alternative A**	**No-Go**
Extent and duration of impact:	Regional and long-term	Local and long-term
Magnitude of impact or risk:	Moderate	Low
Probability of occurrence:	Definite	Probable
Degree to which the impact may cause irreplaceable loss of resources:	Partial loss	Partial loss
Degree to which the impact can be reversed:	Partly	Partly
Indirect impacts:	Probable	Probable
Cumulative impact prior to mitigation:	Low	Low
Significance rating of impact prior to mitigation	Medium	Medium
Degree to which the impact can be avoided:	High	Low
Degree to which the impact can be managed:	High	Low
Degree to which the impact can be mitigated:	Can be mitigated	Barely
Proposed mitigation:	• A construction method statement must be compiled and available on site. Use the smallest possible working corridor. Outside the working corridor, all watercourses are to be considered no go areas. • It must consider the No-Go area and include methods to avoid unnecessary disturbance and prevent material being washed downslope into the watercourse. • The final designs, layouts, and construction methods/disturbance area should be approved by the	• Removal of structures and replacement with improved design within existing footprint. • Duty of Care- Alien clearing and

	aquatic specialist prior to commencement. • The agreed-upon construction boundary must be clearly demarcated. • Any contractor found working within No-Go areas must be fined as per fining schedule/system setup for the project. Stay away from tributaries and do not alter their confluences. • Prior to commencement, any instream vegetation in the construction corridor must be moved to a similar location instream, outside of the working area, permanently, or for use in rehabilitation. • Vegetation removal must be avoided as far as possible. Bare areas on the banks must be covered with geotextiles or revegetated to prevent sediments eroding into the watercourse. • Remove any alien plant species within the working corridor and as far as possible along the reach. • Stockpiles must not be located within 50 metres of the riparian zone. The furthest threshold must be adhered to. Erosion control measures including silt fences, low soil berms and/or shutter boards must be put in place around the stockpiles to limit sediment runoff from stockpiles. • Where possible, construction activities should be conducted during the drier months of the year to minimise the possibility of erosion, sedimentation and transport of suspended solids associated with disturbed areas and rainfall events. Planning for such a situation must be undertaken. • Coarse bedding material or geotextile wrapped dump rock must be considered for bypass roads. Or a similar design which	pollution control

	can be easily removed without causing sediment to remain in the watercourse. Consider narrower bypass roads. • Diversions must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse. Sandbags used in any diversion or for any other activity within a watercourse must be in a good condition, so that they do not burst and empty sediment into the watercourse. Upon completion of the construction at the site, the diversions shall be removed to restore natural flow patterns. Under no circumstance shall a new channel or drainage canals be excavated to divert water away from construction activities. • Monitoring should be conducted before commencement to confirm demarcations are in place, every second day during construction within the river, and bi-weekly post-construction for a period of three months or until fully rehabilitated according to ECO.	
Residual impacts:	Very Low	None
Cumulative impact post mitigation:	Negligible	None
Significance rating of impact after mitigation	Low	Very Low

Table 5: Impact 2 – Sedimentation and erosion

PHASE:	Construction and operation	
Potential impact and risk:	Excavation and infilling in the river and sediment laden surface stormwater runoff entering from road side drains. Poorly designed or constructed causeway outlets can cause erosion downstream. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for flora & fauna.	
Nature of impact:	Negative	
Alternative:	**Alternative A**	**No-Go**
Extent and duration of impact:	Regional and long-term	Regional and permanent

Magnitude of impact or risk:	High	Medium
Probability of occurrence:	Probable	Highly probable
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	Marginal loss
Degree to which the impact can be reversed:	Partly	Barely
Indirect impacts:	Probable	Probable
Cumulative impact prior to mitigation:	Medium	Medium
Significance rating of impact prior to mitigation	High	Medium
Degree to which the impact can be avoided:	Moderate	High
Degree to which the impact can be managed:	Moderate	High
Degree to which the impact can be mitigated:	Can be partially mitigated	Partial
Proposed mitigation:	• The longitudinal gradient must not be altered in a way that results in erosion downstream or impoundment of flows upstream. The cross sectional profile of the bed and banks must also be restored as far as possible to pre-erosion state. • The design must allow for unhindered longitudinal flow through the structures and erosion protection downslope with energy dissipaters such as dense baffles. • The stormwater road side drains and outlets should be formalised and stabilised to manage the increase of surface water flows directly into any natural systems. • Sedimentation must be minimised with appropriate measures. Any construction causing bare slopes and surfaces to be exposed to the elements must include measures to protect against erosion using covers, silt fences, sandbags, etc. • All stockpiles must be protected and located in flat areas where run-off will be minimised and sediment recoverable.	Duty of Care- Alien clearing and pollution control

	• Construction must have contingency plans for high rainfall events during construction. • The longitudinal gradient must not be altered in a way that results in erosion downstream or impoundment of flows upstream. The cross sectional profile of the bed and banks must also be restored as far as possible to a more natural state. • Any bypass roads or working areas must be fully rehabilitated to the preconstruction condition at a minimum. • Stormwater infrastructure must be inspected at least once every year (before the onset of rains) to ensure that it is working efficiently. Any evidence of erosion from this stormwater system must be rehabilitated and the volume/velocity of the water reduced through further structures and/or energy dissipaters.	
Residual impacts:	Medium	Medium
Cumulative impact post mitigation:	Low	Low
Significance rating of impact after mitigation	Low	Low

Table 6: Impact 3 – Changes to the hydrological regime

PHASE:	Construction and operation	
Potential impact and risk:	Change in instream flow patterns on hydrological form and function during the construction and into the operational phase. Altered instream flow hydraulics due to different culvert design resulting in form and function changes within aquatic habitat. The impact can result in further deterioration in freshwater ecosystem integrity, and a reduction in the supply of ecosystem services, but positive impacts if designed to mimic more natural flow pattern and channel morphology.	
Nature of impact:	Negative	
Alternative:	**Alternative A**	**No-Go**
Extent and duration of impact:	Regional and permanent	Local and long-term
Magnitude of impact or risk:	Moderate	Moderate
Probability of occurrence:	Definite	Probable

Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	Marginal loss
Degree to which the impact can be reversed:	Barely	Partially
Indirect impacts:	Highly likely	Probable
Cumulative impact prior to mitigation:	Medium	Medium
Significance rating of impact prior to mitigation	Medium	Low
Degree to which the impact can be avoided:	Low	Low
Degree to which the impact can be managed:	Moderate	Low
Degree to which the impact can be mitigated:	Partly	Partly
Proposed mitigation:	• The design must allow for unhindered longitudinal flow through the structures and erosion protection downslope with energy dissipaters such as dense baffles. • Diversions must be temporary in nature and no permanent walls, berms or dams may be installed within a watercourse. • The stormwater management infrastructure, such as road side drains, must be designed to ensure the runoff is not highly concentrated before entering the riparian area. • Effective stormwater management must include effective stabilisation (gabions and Reno mattresses) of exposed soil and side drain outlets. Contingency plans must be in place for high rainfall events which may occur during construction. • The bypass roads must allow for longitudinal flow with no scour at any diversion outlets. The bypass material must be removed, and the channel morphology and substrate be reinstated. • The project will need to comply with all regulations of the National Water Act (Act 36 of 1998), including the protection of downstream users, and minimise	Duty of Care- Alien clearing and pollution control

	any potential ecological impacts upon water resources. Appendix 3 shows the conditions of General Authorisation which must be adhered to for Low impact projects.	
Residual impacts:	Low	Low
Cumulative impact post mitigation:	+ Medium (Positive)	Low
Significance rating of impact after mitigation	+ Low (Positive)	Low

Table 7: Impact 4 –Changes to surface water quality

PHASE:	Construction	
Potential impact and risk:	During construction, earthworks will expose and mobilise earth materials, and a number of materials as well as hydrocarbons/ cement/ chemicals may end up in the surface water. This can result in possible deterioration in aquatic ecosystem integrity and species diversity.	
Nature of impact:	Negative	
Alternative:	**Alternative A**	**No-Go**
Extent and duration of impact:	Local and medium-term	None
Magnitude of impact or risk:	Medium	
Probability of occurrence:	Probable	
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss	
Degree to which the impact can be reversed:	Reversible	
Indirect impacts:	Probable	
Cumulative impact prior to mitigation:	Medium	
Significance rating of impact prior to mitigation	Medium-Low	
Degree to which the impact can be avoided:	High	
Degree to which the impact can be managed:	High	
Degree to which the impact can be mitigated:	Can be mitigated	
Proposed mitigation:	• Spills or leaks from vehicles or machinery must be entirely avoided. Cement/concrete batching is to be located in an area of low environmental sensitivity away from the river channel and pre-approved by the ECO. No batching activities shall occur on unprotected ground. Adequate surface protection will be required. Concrete batching should	Duty of Care- Alien clearing and pollution control

	be restricted to a level and bunded/sealed surface above the riverbanks. • Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered site. • Sedimentation must be minimised with appropriate measures. • Where possible, construction activities should be conducted during the drier months of the year. • All post-construction building material and waste must be cleared in accordance with the EMPr. The solid domestic waste must be removed and disposed of offsite. • Any use of herbicides in removing alien plant species is required to be investigated by the ECO before use, for the necessity, type proposed to be used, effectiveness and impacts of the product on aquatic biota. • Construction must be immediately followed by rehabilitation.	
Residual impacts:	Negligible	
Cumulative impact post mitigation:	Low	
Significance rating of impact after mitigation	Very Low	None

10 RECOMMENDED NO-GO AREAS

It is proposed for the bypass road to be created on the upstream side of the causeways. This is common practice. However, at both locations, it is the upstream areas which are intact and therefore more sensitive in terms of aquatic biodiversity. Additionally, at Site 4, there is a tributary confluence upstream of the causeway, which should not be altered. Therefore, it is recommended that the disturbance footprint on the upstream side be reduced. Construction (and any infilling for the bypass road) on the upstream side will require stringent monitoring and demarcation. Please note the recommended No-Go areas in the flowing maps (Figure 12 and Figure 13).

On the downstream sides of both causeways there has already been significant changes to channel morphology due to modified flow and severe bed and bank erosion. In these downstream areas it is recommended that the eroding banks be re-sloped and stabilised. Especially where road side-drains are directing high velocity (sediment laden) surface runoff into the watercourse. The road side drains and outlets should be formalised (baffles, riprap, gabion boxes, reno-mattress, and/or vegetated swales) to prevent erosion from road runoff and resultant sedimentation of the watercourse, as has occurred under present conditions. It is also recommended that the alien trees be removed along the relevant reach to prevent further long-term bank erosion.

Perhaps as another project phase, consider wetland rehabilitation interventions at intervals along the watercourse, such as resloping eroded banks, installing bed control structures (such as low gabion weirs to prevent further gully erosion and headcutting), slow confined flows, and allow for the wetland to reestablish. This will inadvertently increase the resilience of the ecosystem to provide services such as flood attenuation and the associated protection of downstream infrastructure.

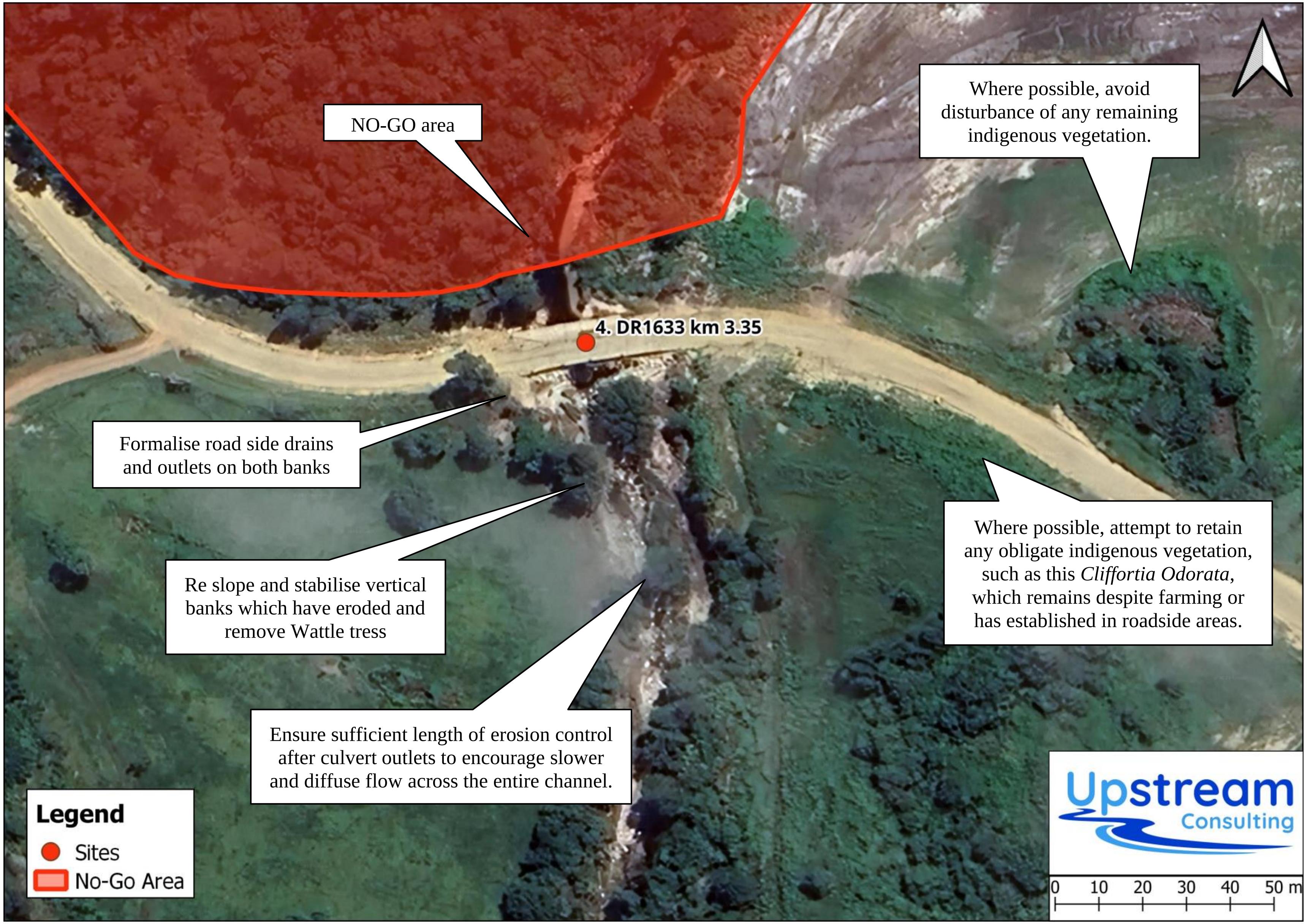

Figure 12: Map of recommended No-Go Area and mitigation for Site 4

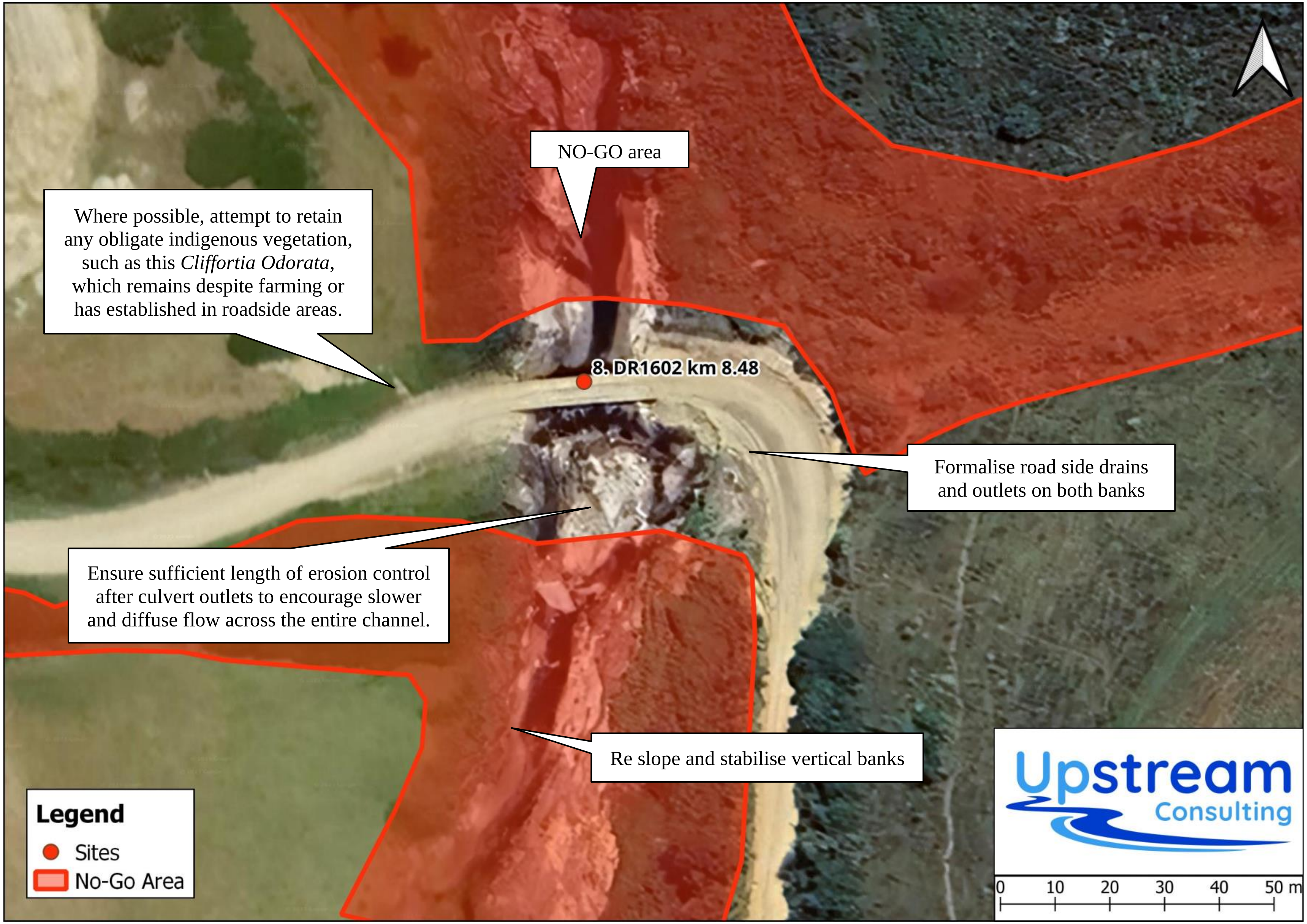

Figure 13: Map of recommended No-Go Area and mitigation for Site 8

11 CONCLUSION

The aquatic habitats within a 500 metre radius of the causeways were identified and mapped on a desktop level utilising available data. In order to identify the wetland/river types, using Kotze et al. (2009) and Ollis et al. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. Following the desktop findings, the infield site assessment on the 4th of November confirmed the location and extent of these systems. Subsequent screening provided an indication of which of these systems may potentially be impacted upon by the project. It was determined that two reaches along the Varings River will be directly impacted. The watercourse was therefore assessed in detail to determine the impact of the project.

Impact assessment was undertaken for the following grouped potential impacts, direct and indirect in nature:

- Impact 1: Disturbance and loss of aquatic habitat and biota
- Impact 2: Sedimentation and erosion, which could also occur into the operational phase
- Impact 3: Hydrological changes
- Impact 4: Potential impact on localised surface water quality

The impact significance upon aquatic biodiversity for the project was determined as Low after mitigation. The impact assessment was based on a number of assumptions. At present, there are no detailed layout plans, civil designs, or construction method statements, and it is assumed that there will not be any significant expansion of the disturbed area or changes to road alignment.

During construction there will be clearance of riparian vegetation, excavations of the bed and bank, infilling, diversion of flows, a bypass road, and potential for cement and fuel spills within the watercourse. The impacts can be decreased to acceptable levels provided that mitigation measures are implemented (including No-Go areas) and adhered to. The improved design of the causeways, with more openings, may result in positive impacts in the long-term. There should be stringent monitoring during construction in the river and post-construction rehabilitation must be appropriately costed for and undertaken in a sensitive manner.

In conclusion, from an aquatic perspective, there are no fatal flaws associated with the project, provided all the mitigation measures are strictly adopted.

The proposed project requires a Water Use License (WUL) in terms of Chapter 4 and Section 21 of the National Water Act No. 36 of 1998, prior to the commencement of activities. Due to the low risk the activities pose, after mitigation, the project falls within the Ambit of General Authorisation for Section 21 (c) and (i) water uses.

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APPENDIX 1 –DETAILED METHODOLOGY

For reference the following definitions are as follows:

- **Drainage line**: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may not be present.
- **Perennial and non-perennial:** Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and thus contains flows for short periods, such as a few hours or days in the case of drainage lines.
- **Riparian**: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).
- **Wetland**: land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al*., 1979).
- **Water course**: as per the National Water Act means -
  (a) a river or spring;
  (b) a natural channel in which water flows regularly or intermittently;
  (c) a wetland, lake or dam into which, or from which, water flows; and
  (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks

12.1 WETLAND DELINEATION AND HGM TYPE IDENTIFICATION

Wetland delineation includes the confirmation of the occurrence of wetland and a determination of the outermost edge of the wetland. The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Wetland indicators were used in the field delineation of the wetlands: position in landscape, vegetation and soil wetness (determined through soil sampling with a soil auger and the examining the degree of mottling).

Four specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.

- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

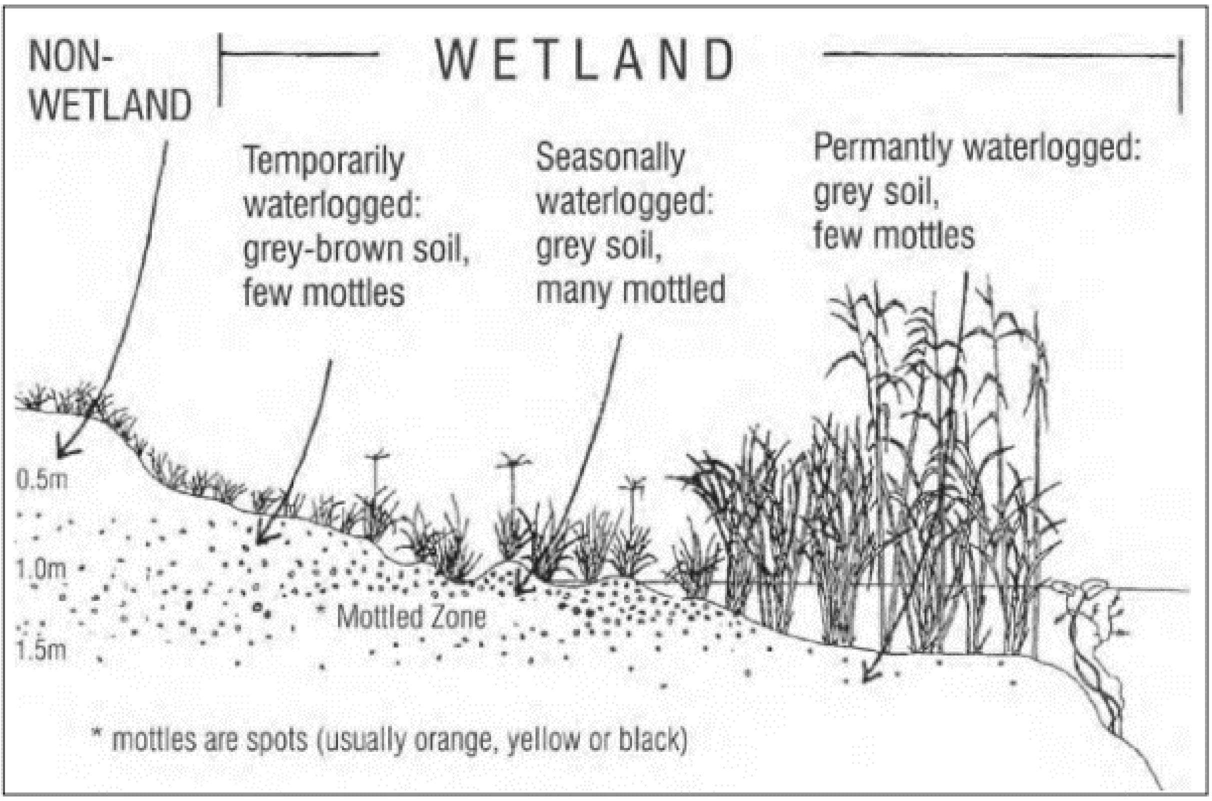

Figure A12.1a: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

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

The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display (Table A12.1a)

A12.1a: Soil Wetness Indicators in the various wetland zones

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (<10%)	Grey matrix (<10%)	Prominent grey matrix

Few high chroma mottles	Many low chroma mottles present	Few to no high chroma mottles
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year round (possible sulphuric odour)

Table A12.1b: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands

Vegetation	Temporary Wetness Zone	Seasonal Wetness Zone	Permanent Wetness Zone
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas.	Hydrophilic woody species restricted to wetland areas	Hydrophilic woody species, which are restricted to wetland areas. Morphological adaptations to prolonged wetness (e.g. prop roots).
Symbol	Hydric Status	Description/Occurrence	
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)	
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas	
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas	
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)	
D	Dryland species	Almost always grow in drylands	

In order to identify the wetland types, using Kotze *et al.* (2009) and Ollie *et al*. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. These have been defined based on the geomorphic setting of the wetland in the landscape (e.g. hillslope or valley bottom, whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated), how water flows through the wetland (diffusely or channelled) and how water exits the wetland (Figure A12.1b).

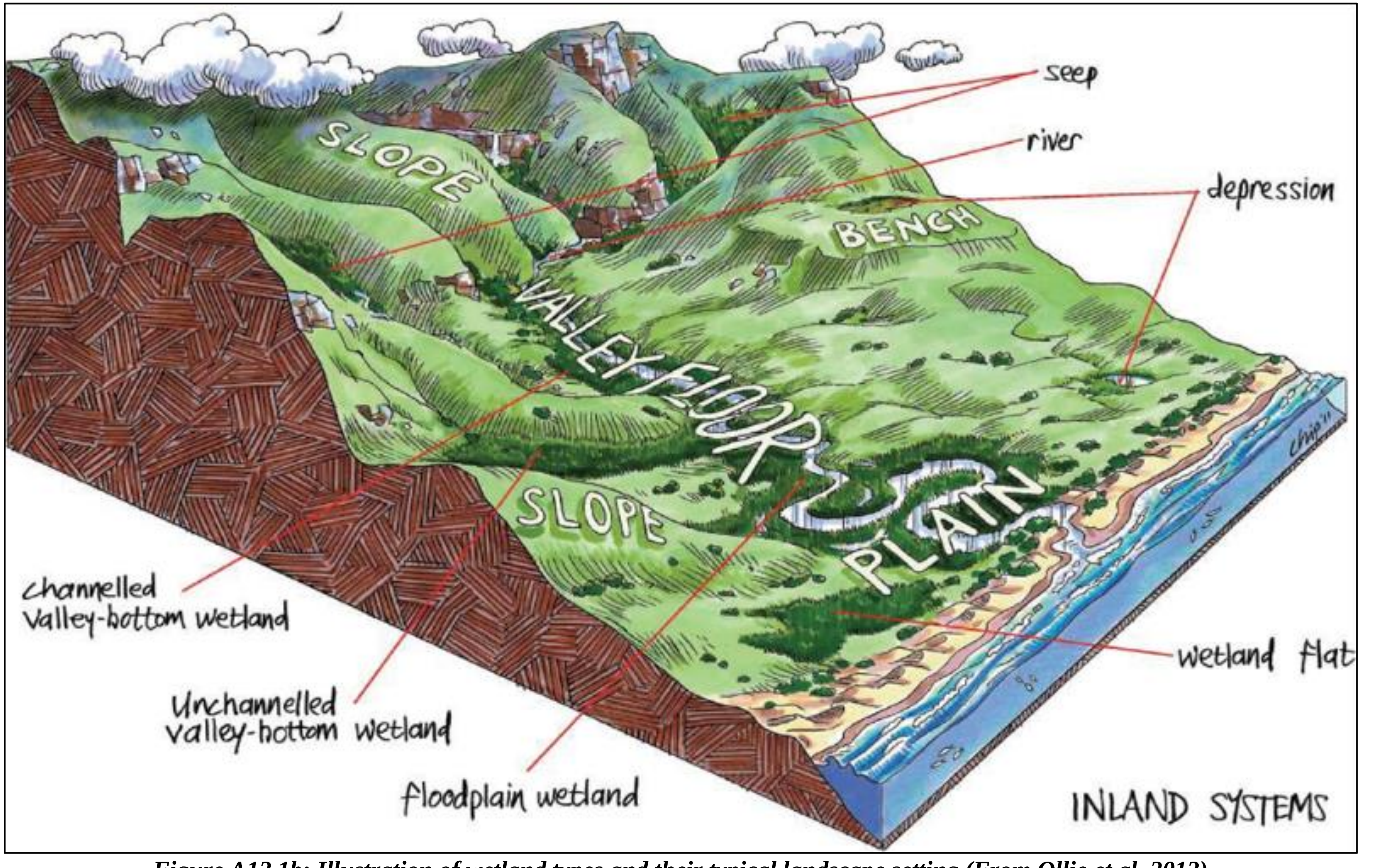

Figure A12.1b: Illustration of wetland types and their typical landscape setting (From Ollie <u>et al.</u> 2013)

12.2 DELINEATION OF RIPARIAN AREAS

Riparian zones are described as “the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas” i , Riparian zones can be thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas (Figure 12.2a). Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel.

Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are: - **Landscape position**; - Alluvial soils and recently deposited material; - **Topography** associated with riparian areas; and - **Vegetation** associated with riparian areas. Landscape Position As discussed above, a typical landscape can be divided into 5 main units), namely the: - Crest (hilltop); - Scarp (cliff); - Midslope (often a convex slope); - Footslope (often a concave slope); and - Valley bottom. Amongst these landscape units, riparian areas are only likely to develop on the valley bottom landscape units (i.e. adjacent to the river or stream channels; along the banks comprised of the sediment deposited by the channel). Alluvial soils are soils derived from material deposited by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators. Quaternary alluvial soil deposits are often indicated on geological maps, and whilst the extent of these quaternary alluvial deposits usually far exceeds the extent of the contemporary riparian zone; such indicators are useful in identifying areas of the landscape where wider riparian zones may be expected to occur.

Topography and recently deposited material associated with riparian areas The National Water Act definition of riparian zones refers to the structure of the banks and likely presence of alluvium. A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised “macro-channels” which are typical of many of southern Africa’s eastern seaboard rivers. Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus the likely presence of wetlands. Vegetation associated with riparian areas unlike the delineation of wetland areas, where redoxymorphic features in the soil are the primary indicator, the identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs: - in species composition relative to the adjacent terrestrial area; and - in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

As with the delineation approach for wetlands, the field delineation method for riparian areas focuses on two main indicators of riparian zones: - **Vegetation Indicators**, and - **Topography** of the banks of the river or stream.

Additional verification can be obtained by examining for any recently alluvial deposited material to indicate the extent of flooding and thus obtain at least a minimum riparian zone width. The following procedure should be used for delineation of riparian zones: A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. The macro-channel is an incised feature, created by uplift of the subcontinent which caused many rivers to cut down to the underlying geology and creating a sort of “restrictive floodplain” within which one or more active channels flow. Floods seldom have any known influence outside of this incised feature. Within the macro-channel, flood benches may exist between the active channel and the top of the macro channel bank. These depositional features are often covered by alluvial deposits and may have riparian vegetation on them. Going (vertically) up the macro channel bank often represents a dramatic decrease in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

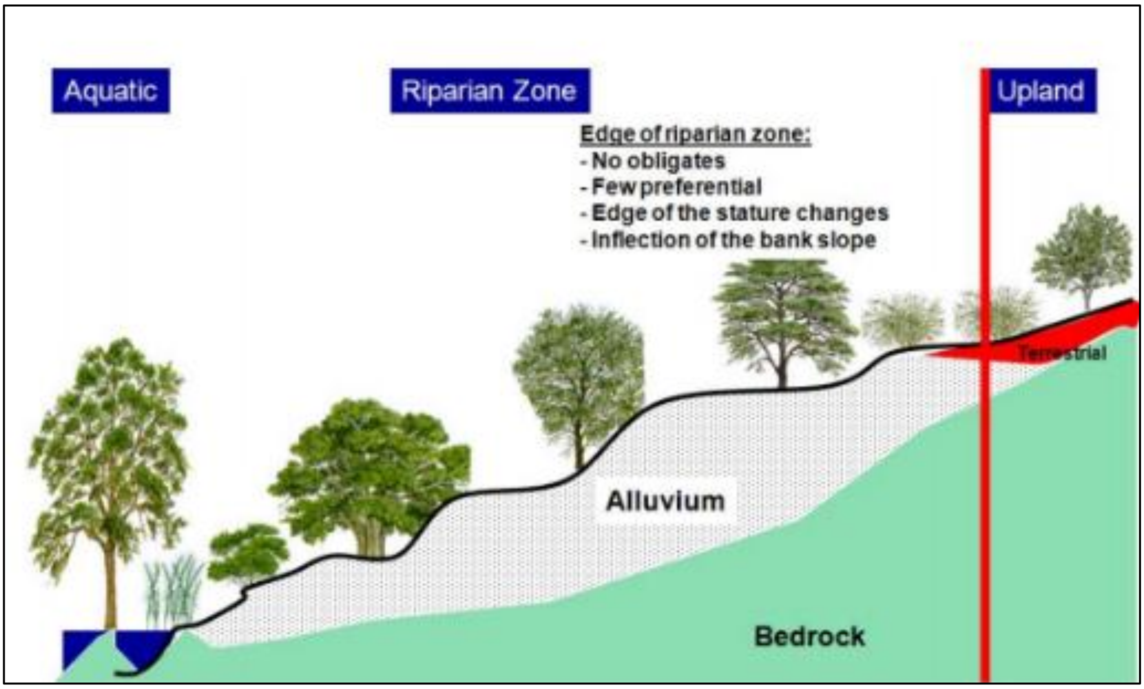

Figure A12.2a: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF 2008).

12.3 FUNCTIONAL IMPORTANCE (GOODS AND SERVICES)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 20 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in Table A12.4a) - that is, the benefits provided to people by the ecosystem.

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits		Flood attenuation	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
				Streamflow regulation	Sustaining streamflow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
				Carbon storage	The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance**[2]			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits		Provision of water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
				Provision of harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
				Provision of cultivated foods	The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits		Cultural heritage	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
				Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
				Education and research	Sites of value in the wetland for education or research

Table A12.4a: Ecosystem services assessed by WET-Ecoservices

12.4 PRESENT ECOLOGICAL STATE (PES) – RIPARIAN

Habitat is one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (in-stream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996). The 'habitat integrity' of a river refers to the "maintenance of a balanced composition of physic-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

DWAF have developed a modified IHI, designed to accommodate the time constraints associated with desktop assessments or for instances where a rapid assessment of river conditions is required. The protocol does not distinguish between instream and riparian habitat and addresses six simple metrics to obtain an indication of Present Ecological State (PES). Each of the criteria are rated on a scale of 0 (close to natural) to 5 (critically modified) (Table A1.1) according to the following metrics:

- Bed modification
- Flow modification
- Inundation
- Bank condition
- Riparian zone condition
- Water quality modification

This assessment was informed by (i) a site visit where potential impacts to each metric were assessed and evaluated and (ii) an understanding of the catchment feeding the river and landuses / activities that could have a detrimental impact on river ecosystems.

Table A1.1: The rating scale for each of the various metrics in the assessment

Rating Score	Impact Class	Description
0	None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
0.5 - 1.0	Low	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.
1.5 - 2.0	Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.
2.5 - 3.0	Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.
3.5 - 4.0	Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.

4.5 - 5.0	Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.

The six metric ratings of the HGM under assessment are then averaged, resulting in one value. This value determines the Habitat Integrity PES category for the HGM (Table A1.2).

Table A1.2: The habitat integrity PES categories

Habitat Integrity PES Category	Description
A: Natural	Unmodified, natural.
B: Good	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C: Fair	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D: Poor	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E: Seriously modified	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F: Critically modified	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

12.5 ECOLOGICAL IMPORTANCE & SENSITIVITY – RIPARIAN

The ecological importance of a wetland/river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Kleynhans & Louw, 2007; Resh et al., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (Table A1.3).

The scores assigned to the criteria in Table A1.3 were used to rate the overall EIS of each mapped unit according to Table A1.4, below, which was based on the criteria used by DWS for river eco-classification (Kleynhans & Louw, 2007) and the WET-Health wetland integrity assessment method (Macfarlane et al., 2008).

Table A1.3: Components considered for the assessment of the ecological importance and sensitivity of a riparian system. An example of the scoring has also been provided.

Ecological Importance and Sensitivity assessment (Rivers)		
Determinants		Score (0-4)
BIOTA (RIPARIAN & INSTREAM)	Rare & endangered (range: 4=very high - 0 = none)	0,5
	Unique (endemic, isolated, etc.) (range: 4=very high - 0 = none)	0,0
	Intolerant (flow & flow related water quality) (range: 4=very high - 0 = none)	0,5
	Species/taxon richness (range: 4=very high - 1=low/marginal)	1,5
RIPARIAN & INSTREAM HABITATS	Diversity of types (4=Very high - 1=marginal/low)	1,0
	Refugia (4=Very high - 1=marginal/low)	1,5
	Sensitivity to flow changes (4=Very high - 1=marginal/low)	1,0
	Sensitivity to flow related water quality changes (4=Very high - 1=marginal/low)	1,0
	Migration route/corridor (instream & riparian, range: 4=very high - 0 = none)	1,0
	Importance of conservation & natural areas (range, 4=very high - 0=very low)	2
MEDIAN OF DETERMINANTS		1,00
ECOLOGICAL IMPORTANCE AND SENSITIVITY CATEGORY (EIS)		LOW, EC=D

Table A1.4: The ratings associated with the assessment of the EIA for riparian areas

Rating	Explanation
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

APPENDIX 2- SPECIALIST CV

CURRICULUM VITAE

Debra Jane Fordham

Cell: 0724448243
Email: debrajanefordham@gmail.com
Date of birth: 26th August 1987
Country of origin: South Africa
ID Number: 8708260094081

Professional profile

Debbie is a registered ecologist (119102), with over 8 years of working experience, largely specialising in aquatic ecology. She has authored over 80 reports and applications and she constantly contributes to the scientific and local community. Most of her projects involve (as a minimum) in-depth wetland and river field delineation (including soil investigations via augering, vegetation identification, and classifying the hydrological characteristics), laboratory analysis (such as water quality and sediment analysis), classification, characterisation, ecological health and ecosystem functioning assessments (using the latest available tools), as well as impact rating, buffer determinations, mitigation recommendations and detailed rehabilitation plans. She is highly proficient using GIS software to incorporate accurate spatial analysis and visual aids (No Go Area maps etc.) into her reports.

Debbie holds a M.Sc. degree in Environmental Science from Rhodes University, by thesis, entitled: The geomorphic origin and evolution of the Tierkloof Wetland, a peatland dominated by Prionium serratum in the Western Cape. She is a member of scientific organisations such as the Society of Wetland Scientists (SWS), the South African Wetland Society (SAWS), the Southern African Association of Geomorphologists (SAAG), and the International Association for Impact Assessment (IAIAsa). Debbie is registered with SACNASP in the field of Ecological Science (Reg Number: 119102).

Tertiary Education

- M.Sc. Environmental Science (Rhodes University):

  Master of Science thesis entitled: The geomorphic origin, evolution and collapse of a peatland dominated by Prionium serratum: a case study of the Tierkloof Wetland, Western Cape.
- BA Hons. Environmental Science (Rhodes University):

  Honours dissertation: The status and use of Aloe ferox. Mill in the Grahamstown commonage, South Africa.

  Courses: Wetland Ecology, Environmental Water Quality /Toxicology, Biodiversity, Non-Timber Forest Products (NTFPs) and Rural Livelihoods, Environmental Impact Assessment (EIA), Statistics
- BA - Environmental Science and Geography (Rhodes University)

Work Experience:
- Ecological specialist (2022/03/01 – present)
- Sharples Environmental Services cc (2016/08/10 – 2022/03/01)

Position: Aquatic Ecologist and WULA Manager
- KSEMS Environmental Consulting (2015/08/10 - 2016/07/31)

Position: Wetland specialist
- AGES EC (Pty) Ltd (2014/10/01 – 2015/08/10)

Position: Aquatic Ecologist and WULA Manager
- Environmental Impact Management Services (2014/02/04-2014/02/07)

Position: Environmental consultant
- Rhodes University Alumni Relations (2010/04/01 – 2010/12/17)

APPENDIX 3: CONDITIONS OF GENERAL AUTHORISATION

Conditions for impeding or diverting the flow of water or altering the bed, banks, course or characteristics of a watercourse (Government Notice R509 of 2016)

(1) The water user must ensure that:

(a) impeding or diverting the flow or altering the bed, banks, course or characteristics of a watercourse do not detrimentally affect other water users, property, health and safety of the general public, or the resource quality;

(b) the existing hydraulic, hydrologic, geomorphic and ecological functions of the watercourse in the vicinity of the structure is maintained or improved upon;

(c) a full financial provision for the implementation of the management measures prescribed in this General Authorisation, including an annual financial provision for any future maintenance, monitoring, rehabilitation, or restoration works, as may be applicable; and

(d) upon written request of the responsible authority, they implement any additional management measures or monitoring programmes that may be reasonably necessary to determine potential impacts on the water resource or management measures to address such impacts.

(2) Prior to the carrying out of any works, the water user must ensure that all persons entering on -site, including contractors and casual labourers, are made fully aware of the conditions and related management measures specified in this General Authorisation.

(3) The water user must ensure that -

(a) any construction camp, storage, washing and maintenance of equipment, storage of construction materials, or chemicals, as well as any sanitation and waste management facilities -

~~(i) is located outside the 1 in 100 year flood line or riparian habitat of a river, spring, lake, dam or outside any drainage feeding any wetland or pan, and~~ (this is not possible as the entire valley floor through the poort will be within the floodline. However, the abovementioned activities must be located in areas outside of riparian habitat and as far as possible, such as at rest stops)

(ii) is removed within 30 days after the completion of any works.

(b) The water user must ensure that the selection of a site for establishing any impeding or diverting the flow or altering the bed, banks, course or characteristics of a watercourse works:

~~(i) is not located on a bend in the watercourse;~~ (this is not possible for this project as some work is on the existing bridges that are located near bends in the river)

(ii) avoid high gradient areas, unstable slopes, actively eroding banks, interflow zones, springs, and seeps;

(iii) avoid or minimise realignment of the course of the watercourse;

(iv) minimise the footprint of the alteration, as well as the construction footprint so as to minimise the effect on the watercourse.

(c) The water user must ensure that a maximum impact footprint around the works is established, clearly demarcated, that no vegetation is cleared or damaged beyond this demarcation, and that equipment and machinery is only operated within the delineated impact footprint.

(d) The water user must ensure that measures are implemented to minimise the duration of disturbance and the footprint of the disturbance of the beds and banks of the watercourse.

(e) The water user must ensure that measures are implemented to prevent the transfer of biota to a site, which biota is not indigenous to the environment at that site.

(f) The water user must ensure that all works, including emergency alterations or the rectification of incidents, start upstream and proceed in a downstream direction, to ensure minimal impact on the water resource.

(g) The water user must ensure that all material excavated from the bed or banks of the watercourse are stored at a clearly demarcated location until the works have been completed, upon which the excavated material must be backfilled to the locations from where it was taken (i.e. material taken from the bed must be returned to the bed, and material taken from the banks must be returned to the banks).

(h) The water user must ensure that adequate erosion control measures are implemented at and near all alterations, including at existing structures or activities with particular attention to erosion control at steep slopes and drainage lines.

(i) The water user must ensure that alterations or hardened surfaces associated with such structures or works -

(i) are structurally stable;

(ii) do not induce sedimentation, erosion or flooding;

(iii) do not cause a detrimental change in the quantity, velocity, pattern, timing, water level and assurance of flow in a watercourse;

(iv) do not cause a detrimental change in the quality of water in the watercourse;

(v) do not cause a detrimental change in the stability or geomorphological structure of the watercourse; and

(vi) does not create nuisance condition, or health or safety hazards.

(j) The water user must ensure that measures are implemented at alterations, including at existing structures or activities, to -

(i) prevent detrimental changes to the breeding, nesting or feeding patterns of aquatic biota, including migratory species;

(ii) allow for the free up and downstream movement of aquatic biota, including migratory species; and

(iii) prevent a decline in the composition and diversity of the indigenous and endemic aquatic biota.

(k) The water user must ensure that no substance or material that can potentially cause pollution of the water resource is being used in works, including for emergency alterations or the rectification of reportable incidents.

(I) The water user must ensure that measures are taken to prevent increased turbidity, sedimentation and detrimental chemical changes to the composition of the water resource as a result of carrying out the works, including for emergency alterations or the rectification of reportable incidents.

(m) The water user must ensure that in- stream water quality is measured on a weekly basis during construction, including for emergency alterations or the rectification of reportable incidents, which measurement must be by taking samples, and by analysing the samples for pH, EC/TDS, TSS/Turbidity, and /or Dissolved Oxygen ("DO ") both upstream and downstream from the works.

(n) The water user must ensure that in- stream flow, both upstream and downstream from the works, is measured ~~on an ongoing basis by means of instruments and devices certified by the South African Bureau of Standards ("SABS "), and that such measurement commences~~ at least one week prior to the initiation of the works, including for emergency alterations or the rectification of reportable incidents.

(o) During the carrying out of any works, the water user must take the photographs and video- recordings referred to in paragraph (p) below, on a daily basis, starting one (1) week before the commencement of any works, including for emergency structures and the rectification of reportable incidents, and continuing for one (1) month after the completion of such works:

(p) The following videos recordings and photographs must be taken as contemplated in paragraph (o) above:

(i) one or more photographs or video -recordings of the watercourse and its banks at least 20 meters upstream from the structure;

(ii) one or more photographs or video -recordings of the watercourse and its banks at least 20 meters downstream from the structure; and

(iii) two or more photographs or video -recordings of the bed and banks at the structure, one of each taken from each opposite bank.

(4) Upon completion of any works, the water user must ensure that the hydrological functionality and integrity of the watercourse, including its bed, banks, riparian habitat and aquatic biota is equivalent to or exceeds that what existed before commencing with the works.

APPENDIX 4 - SITE SENSITIVITY VERIFICATION REPORT

Site verification report – Aquatic Ecology

Government Notice No. 645, dated 10 May 2019, includes the requirement that an Initial Site Sensitivity Verification Report must be produced for a project footprint. As per Part 1, Section 2.3, the outcome of the Initial Site Verification must be recorded in the form of a report that-

- Confirms or disputes the current use of the land and environmental sensitivity as identified by the national web based environmental screening tool;
- Contains a motivation and evidence of either the verified or different use of the land and environmental sensitivity;

Is submitted together with the relevant reports prepared in accordance with the requirements of the Environmental Impact Assessment Regulations.

This report has been produced specifically to consider the aquatic ecology theme and addresses the content requirements of (a) and (b) above. The report will be appended to the respective specialist study included in the Scoping and EIA Reports produced for the projects.

Site sensitivity based on the aquatic biodiversity theme included in the Screening Tool and specialist assessment.

Based on the DFFE Screening Tool, the two causeways are located within areas of Very High Aquatic Biodiversity sensitivity due to CBA 1 Aquatic, SWSA, and Wetland features of Very High Sensitivity.

The site verification specialist findings were informed by a site visit undertaken in November 2023. The photographs within the Plates 1 and 2 below show the aquatic features present on site, namely, the Varings River. This information was then compared to current wetland inventories, 1: 50 000 topocadastral surveys mapping of the site. A baseline map was then developed (Figure 1).

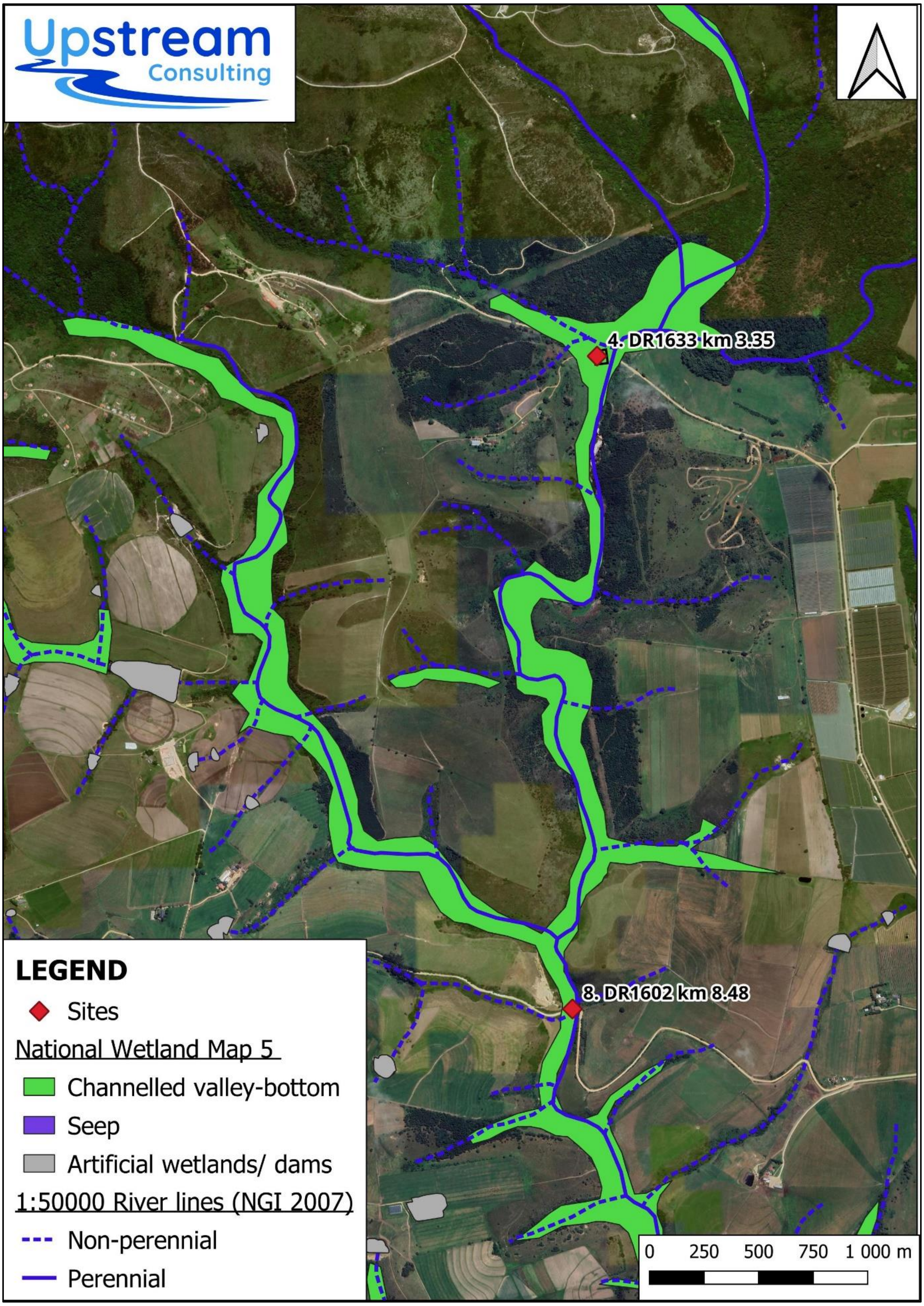

Figure 2: Identified aquatic habitat within the study area

Plate 1: A photograph of the Varings River at the Site 4 causeway

Plate 2: A photograph of the Varings River channel below the Site 8 causeway

Motivation of the outcomes of the sensitivity map and key conclusions:

In conclusion, the DFFE Screening Tool resulted in Very High sensitivity ratings within the site footprint, and surrounding area, due to the CBA 1, wetland and SWSA features. Following site verification, this Very High sensitivity rating is confirmed due to the construction within the Varings River required for the replacement of the causeways.

It is recommended that a full Aquatic Biodiversity Impact Assessment is undertaken for the project.

The environmental sensitivity input received from the aquatic ecology specialist will be taken forward and considered within the formal EA process and the impact to these areas assessed.

Aquatic Specialist Statement:
The replacement of the DR1602 road culvert, Mossel Bay Municipality

Date: 03/08/2026

To whom it may concern,

I have reviewed the latest engineering drawings for the proposed replacement of the DR1602 causeway over the Varings River against the findings and recommendations of the Aquatic Biodiversity Impact Assessment dated 16 November 2023. The proposed structure, with substantially larger hydraulic openings than the existing causeway, is supported in principle from an aquatic perspective.

However, the latest drawings do not clearly demonstrate how some recommendations of the aquatic assessment will be implemented, particularly those relating to erosion control and rehabilitation. It is therefore assumed that these matters are addressed in sufficient detail in the EMPr and final reports.

To re-iterate the recommendations of the aquatic specialist report, mitigation assumes full rehabilitation of the temporary deviation road and all other disturbed areas, reinstatement and stabilisation of the wetland bed and banks, appropriate downstream erosion protection and energy dissipation at the culvert outlets, stabilisation of eroded banks adjacent to the crossing, and formalisation and protection of roadside stormwater outlets (with erosion control below), amongst other measures mentioned in the 2023 report. Rehabilitation and protection of the watercourse should form a key part of the construction and should not be reduced to the minimum necessary for structure completion.

Provided that the final engineering and environmental documentation clearly demonstrates how the aquatic recommendations have been incorporated and implemented, I do not consider an amendment to the Aquatic Biodiversity Impact Assessment necessary and have no objection to the proposed works.

Kind regards
Debbie Fordham

Upstream Consulting (Pty) Ltd
Aquatic Ecologist
Pr.Sci.Nat (119102)