AQUATIC RESOURCES ASSESSMENT

WETLAND -PES, EIS, REC

DIATOM ANALYSIS

IN SITU WATER QUALITY

Vulindlela Bridge Maintenance & Rehabilitation

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DECLARATION OF INDEPENDENCE

Specialist Name	Mr. D. Botha
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 Environmental Impact Assessment (EIA) Regulations, that: • I act as the independent specialist in this application; • I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; • I declare that there are no circumstances that may compromise my objectivity in performing such work; • I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; • I will comply with the Act, Regulations and all other applicable legislation; • I have no, and will not engage in, conflicting interests in the undertaking of the activity; • I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; • All the particulars furnished by me in this form are true and correct; and • I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
Signature	
Date	2019/04/11

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EXECUTIVE SUMMARY

Prism Environmental Management Services was requested by **MDT Environmental (Pty) Ltd** to undertake an aquatic resources assessment to delineate the riparian zone and wetland, conduct a diatom analysis and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the Vulindlela bridges maintenance and associated rehabilitation. This, specifically to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities.

Sasol South Africa (Pty) Ltd (Sasol) proposes to undertake maintenance activities at Vulindlela on behalf of **Emalahleni Local Municipality**. The project is undertaken as part of the Local Economic Development contribution provided by Sasol Mining (Pty) Ltd (Sasol Mining) and is part of the projects committed to in their social and labour plan. The project beneficiaries, and as such project applicants, are Emalahleni Local Municipality.

This project will entail the removal of sediment in the Saalboom / Saalklap Spruit between two existing bridge structures. Further activities will include the construction and rehabilitation of wing and side walls and the installation of sub-soil drainage pipes and coffer dams where required. The work at the bridge crossings is required to minimise sedimentation and debris accumulation of the openings and minimise soil erosion at the river beds and to improve the safety thereof. Upon conclusion, these structures should be maintainable in association with the asset management system of the Local Municipality.

The Vulindlela bridges is located at S26°0’18.03”: E29°2’18.13” and S25°59’55.17”: E29°1’56.67” in the Phola Township within the Emalahleni Local Municipality, Mpumalanga Province (here after referred to as the study site/s). The study site is located in quaternary catchment B20G in the Olifants Water Management Area (WMA 2). The study area falls within the Grassland Biome (Biome 06), the Highveld Level-1 Ecoregion (Ecoregion 11) (Kleynhans *et al*., 2005).

The field investigations concluded that two (2) natural wetland systems (*three wetland units*) could be affected by the activities. Same is draining into the Saalboom Spruit.

The following Hydrogeomorphic wetland units were identified during the site evaluation:

- VBR_CVB1 was found on the valley floor draining towards the North-West into the Saalboom Spruit. This system passes under both bridges.
- VBR_HSS1 was found on the North-Eastern slope associated with VBR_CVB1 draining towards the West into VBR_CVB1 east of Bridge 1.
- VBR_HSS2 was found on the North-Eastern slope North-West of Bridge 1 draining towards the West into VBR_CVB1 and then into the Saalboom Spruit.

The wetlands recorded were assessed and the following results were attained:

- The wetland attained a low overall PES (Present Ecological State)
  - The overall wetland system, inclusive of all wetland units, ecological status was found to be largely modified. A large change in ecosystem processes and loss of natural habitat and biota have occurred, however some of the natural habitat remains intact to some extent. HSS1 still remains largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place. This CVB1 wetland system is impacted by historical channelisation upstream of the system and utilisation of the wetland as grazing pastures and small-scale crop production. It forms part of a larger aquatic system leading into the Saalboom Spruit
- The wetland attained a Low Ecological Importance and Sensitivity (EIS) score.
  - The overall wetland system is considered to be of moderate ecologically importance and sensitive on a regional scale. The biodiversity of this wetland is low with no red data species recorded. It is moderately sensitive to flow and habitat modifications. It plays an intermediate role in moderating the quantity and quality of water of major rivers. The system drains into the Saalboom Spruit. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate.
- The wetland Recommended Ecological Classification (REC) was rated as:
  - The wetlands will be impacted by the proposed remediation activities. This impact will be localised and at the transitional point leading from the base level re-establishment interface to the outer edge and banks of the wetland system. It will in all likelihood regress slightly in terms of its current Ecological Category during the construction period but will regenerate over time due to the resource quality characteristic improvements associated with the project. Stormwater management for the site is required specifically for the construction phase. Rehabilitation of the impacts and maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) will fall into:
    - Category C for the overall wetland system

The diatom assemblages were generally comprised of species characteristic of fresh-brackish, circumneutral to alkaline waters and eutrophic conditions. The pollution levels indicated that all the sites showed some form of pollution. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected *Poor* conditions.

The *in situ* water quality of the Channelled Valley Bottom Wetland (VBR_CVB1) traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium-low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

Concluded from the results presented in this document, the construction activities will impact on the wetland system but can be mitigated to satisfactory standards if all mitigatory actions are implemented with due care. It is key to preserve water quality and supply to the downstream aquatic resources. Hence the actioning of this remediation project.

The rehabilitation of the wetland is vital to recover the required ecological function. The wetland drivers must be enhanced as part of the rehabilitation of the affected areas. In respect of the bridge construction, it is important to ensure that the required erosion protection measures linked to the crossing sections be carefully designed and installed.

The project can be supported should all the mitigation measures be implemented and monitored against.

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1 INTRODUCTION

Prism Environmental Management Services was requested by **MDT Environmental (Pty) Ltd** to undertake an aquatic resources assessment to delineate the wetland, conduct a diatom analysis and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the Vulindlela bridges maintenance and associated rehabilitation. This, specifically to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities.

1.1 Project Description

Sasol South Africa (Pty) Ltd (Sasol) proposes to undertake maintenance activities at Vulindlela on behalf of **Emalahleni Local Municipality**. The project is undertaken as part of the Local Economic Development contribution provided by Sasol Mining (Pty) Ltd (Sasol Mining) and is part of the projects committed to in their social and labour plan. The project beneficiaries, and as such project applicants, are Emalahleni Local Municipality.

This project will entail the removal of sediment in the Saalboom / Saalklap Spruit between two existing bridge structures. Further activities will include the construction and rehabilitation of wing and side walls and the installation of sub-soil drainage pipes and coffer dams where required. The work at the bridge crossings is required to minimise sedimentation and debris accumulation of the openings and minimise soil erosion at the river beds and to improve the safety thereof. Upon conclusion, these structures should be maintainable in association with the asset management system of the Local Municipality.

Siyandiza Consulting Engineers (Pty) Ltd were appointed to undertake designs for the bridge rehabilitation works. The main objective of the proposed activities is to maintain the Vulindlela Bridge crossings and various inherent objectives will be realised as part this project. The key objectives of the project are:

- To establish mechanisms that will minimise sedimentation and debris accumulation at the bridge openings;
- To rehabilitate and clean both bridges in order to improve safety status;
- To improve stormwater control measures;
- To undertake dredging methods that are well investigated to reduce impact on the ecosystem;
- Achieve functional structures, which can be maintained in association with the asset management system for the Local Municipality.

1.1.1 Study Site Location

The Vulindlela bridges (Bridge 1 and Bridge 2)are located at S26°0’18.03”: E29°2’18.13” and S25°59’55.17”: E29°1’56.67”, respectively in the Phola Township within the Emalahleni Local Municipality, Mpumalanga

Province *(here after referred to as the study site/s)* Figure 1-1*,* Figure 1-2 and Figure 1-4. The study site is located in quaternary catchment B20G in the Olifants Water Management Area (WMA 2) (Figure 1-4). The study area falls within the Grassland Biome (Biome 06), the Highveld Level-1 Ecoregion (Ecoregion 11) (Kleynhans *et al.,* 2005) (Figure 1-5).

1.1.2 Alternatives

The alternatives that were investigated are alternatives for erosion control mechanisms.

After investigations and 2D modelling of various flood events routed through the compiled model of the river course way, fifteen areas were identified that were erosion prone and where severe flooding could occur during, specifically a 1 in 20-year flood event. Conceptual erosion protection measures were then designed for these locations and the model re-run to ensure the preservation and protection of the identified areas and to ensure the surrounding properties are not negatively affected during a 1 in 20-year storm event.

Three typical designs were considered as erosion protection structures and would be implemented based on space constraints and practicality.

There are three proposed typical erosion protection structures considered, namely,

(a) **Typical protection structure 1 (Riprap & vegetated berm):** Wide floodplains: Berm with 1:2.5 side slope on both sides, Riprap protection on one side face to river, riprap toe below 1:20 year flood erosion level
(b) **Typical protection structure 2 (Riprap & vertical wall):** Limited space and deep alluvial material: Concrete wall with 1:2.5 bank slope and Riprap protection on one side, riprap toe below 1:50 year flood erosion level
(c) **Typical protection structure 3 (Vertical wall):** Limited space and shallow bedrock: Concrete wall without side slope, toe below 1:50 year flood erosion level or to bedrock.

The activities that will be undertaken as part of these planned alternatives for erosion protection measures are provided in the table below..

Table 1-1: Proposed Erosion Protection Structures

(a) Typical protection structure 1 (Riprap and vegetated berm)	(b) Typical protection structure 2 (Riprap & vertical wall)	(d) Concrete stilling basin (site 2)
1. Site Clearance and establishment. 2. All necessary traffic accommodation and construction warning signage will be erected as necessary. 3. River diversion and dewatering where required. (To be avoided) 4. Surveying and setting out. 5. Removal of failed gabion structures and other debris down to the founding rock embankment 6. Importing and placement of appropriate fill material. 7. Preparation and compaction of the river bank. 8. Riprap installation: a. Ensure correct gradient. b. Provide specified fabric. c. Fabric should be thoroughly stapled to the ground. d. Provide the specified type and size of riprap. e. A rock bucket should be used during the installation of the riprap. f. Place riprap according to engineering specifications and guidelines provided during detailed design. 9. Berm: a. Provide enough material to construct berm to required height. b. Place and compact material according to engineering specifications and guidelines provided during detailed design. c. Ensure that the berm ties in with the riprap to form one structure. 10. Landscaping, shaping of ground, planting of vegetation where required and consideration of green engineering around all structures. 11. Rehabilitation and site de-establishment and Maintenance of the rehabilitated areas	Same as (a) with the exception that a vertical wall is provided **(c) Typical protection structure 3 (Vertical wall)** Same as (a) and (b) with the exception that there is no riprap installation activities	1. Site Clearance and establishment. 2. All necessary traffic accommodation and construction warning signage will be erected as necessary. 3. River diversion and dewatering where required. 4. Surveying and setting out. 5. All existing failed gabion structures and other debris will be removed down to the founding rock embankment with the use of an excavator where possible or by hand. 6. Importing and placement of appropriate fill material. 7. Preparation and stabilisation of the river banks. 8. Concrete stilling basin: a. Excavation into river bank up to bedrock. b. Prepare base with proper compaction of the soil and to the correct level. c. Erect formwork and steel fixing. d. Tie into existing upstream culverts and downstream canal. e. Cast concrete. f. Curing. g. Stripping of shutters. h. Backfill and compact where necessary. 9. Landscaping, shaping of ground, planting of vegetation where required and consideration of green engineering around all structures. 10. Rehabilitation and site de-establishment including the removal of all debris and waste products off the site to an approved and licensed disposal site. 11. Maintenance of the rehabilitated areas

1.2 Scope and Purpose

The aim of this study was to undertake an aquatic resources assessment including a diatom analysis and a wetland assessment to delineate the wetland and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the proposed development. This, specifically to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities.

1.3 Overview of Specialist

Prism EMS has conducted the required aquatic resources specialist assessment on site to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities. The team under lead of Mr. D. Botha has conducted the assessment. The details of the team are tabularised in Table 1-2.

Table 1-2: Details of Specialist

Specialist	Mr. D. Botha – Wetland Specialist
Company:	Prism EMS
Qualifications:	M.A. Environmental Management B.A. Hons. Geography & Environmental Management, B.A. Humanities Post Higher Education Diploma Wetland and Wetland Delineation *(DWAF Accredited Short Course)* Soil Classification and Wetland Delineation – Short Course – *Terrasoil Science* Tools for Wetland Assessment – *Rhodes University* SASS5 Aquatic Biomonitoring Training – *Department of Water Affairs, Ground Truth* Wetland Plant Taxonomy – *Water Research Commission* Hydropedology and Wetland Functioning – *Water Business Academy / Terra Soil Science*
Experience:	16 Years
Affiliation/ Registration	SACNASP Registered Scientist – Pr.Sci.Nat. (119979) Founder Member of Environmental Assessment Practitioners Association of South Africa (EAPASA) Member of the International Association for Impact Assessors (IAIAsa) (1653) Member of the Gauteng Wetland Forum Member of the South African Wetland Society
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Tel:	087 985 0951
Fax:	086 601 4800
Email:	dewet@prismems.co.za

Designation	**Name**	**Qualification**	**Professional Registration**	**Role**
		Specialist Team		
Aquatic Specialist	Mr. P. Singh	MSc Aquatic Health (Cum Laude) BSc.Hons (Biodiversity & Conservation) BSc (Bot & Zoo) Rand Water Water Purification of Drinking Water – *Rand Water Vereeniging* Ecotoxicity Test Methods and Validation - *Golder Associates Research Laboratory* *Wetland Management Course: Ecology, Hydrology, Biodiversity, Legislation, Delineation and Management (University of the Free State)* SASS5 Accredited Practitioner *(DWS and WRC)* 6 Years' Experience	Pr.Sci.Nat. (116822)	Water Quality Analysis Wetland Assessment
Diatomologist	Ms. M Gomes	MSc (Ecology) Wits'15		Diatom Analysis
Aquatic Ecologist	Mr. M Alexandre	M.Sc. (Aquatic Health)	Pr. Sci. Nat. (400079/13)	Diatom Analysis Review

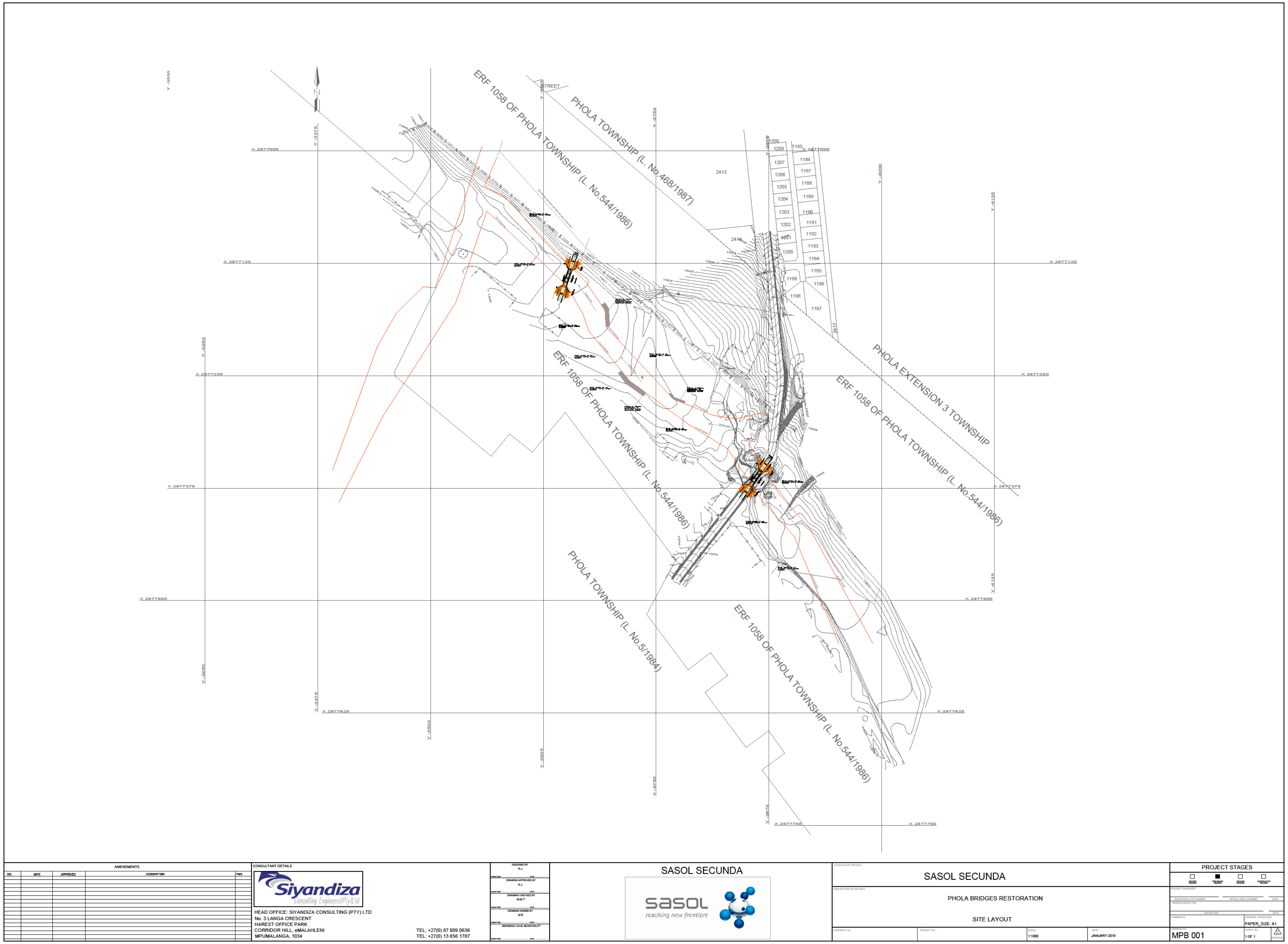

Figure 1-1: Proposed Activities

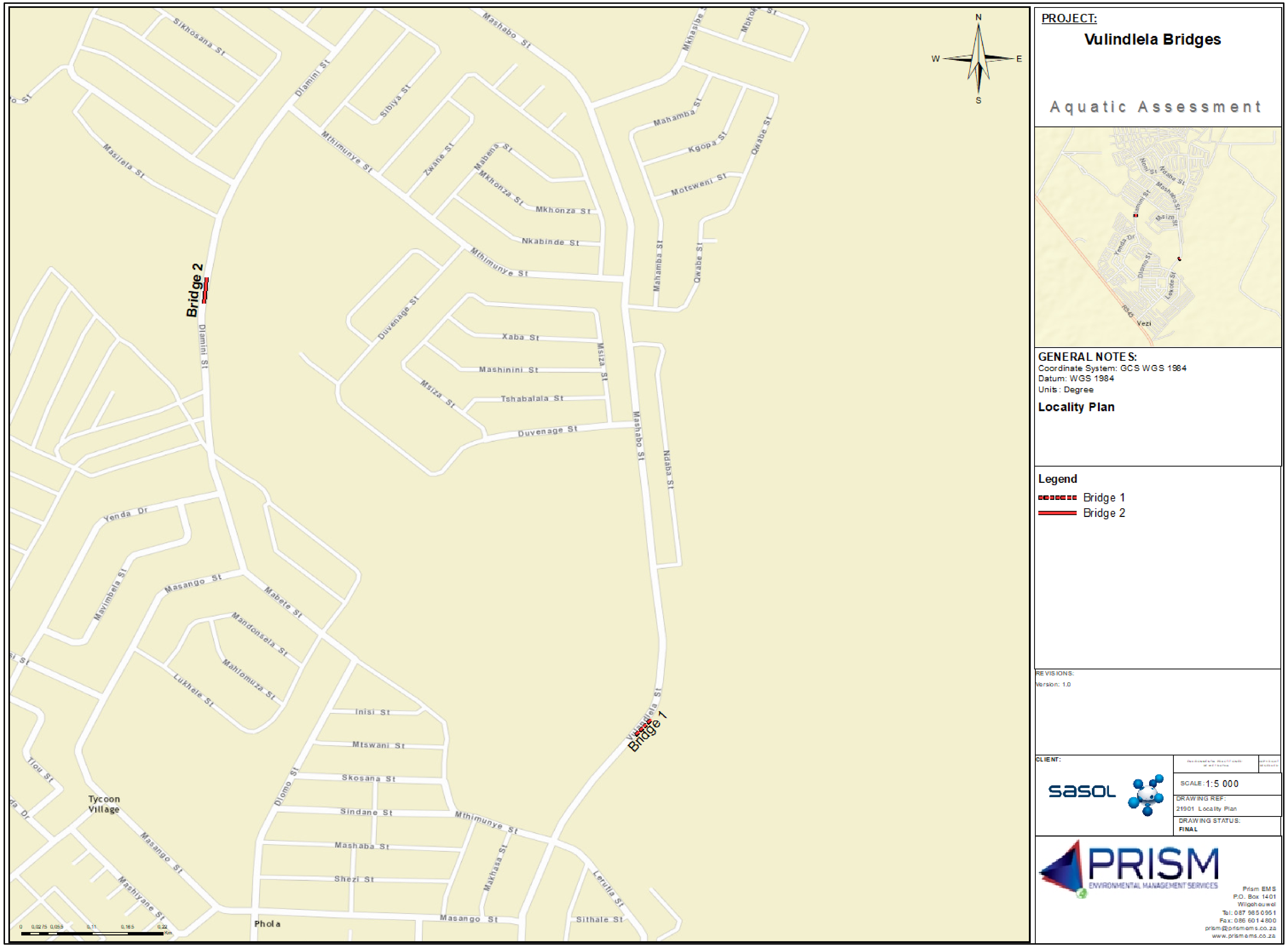

Figure 1-2: Locality Plan

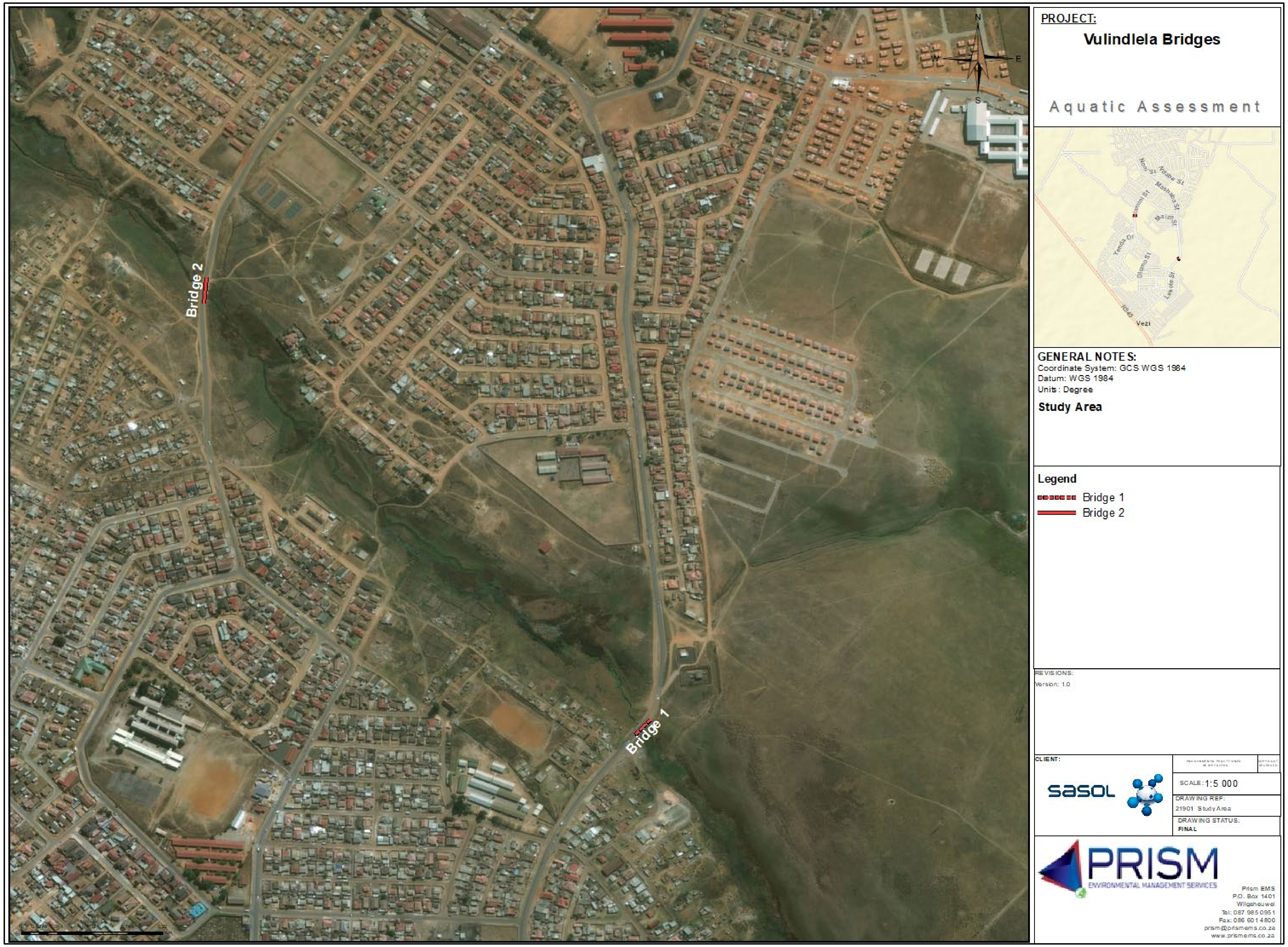

Figure 1-3: Aerial Photograph of Study Area

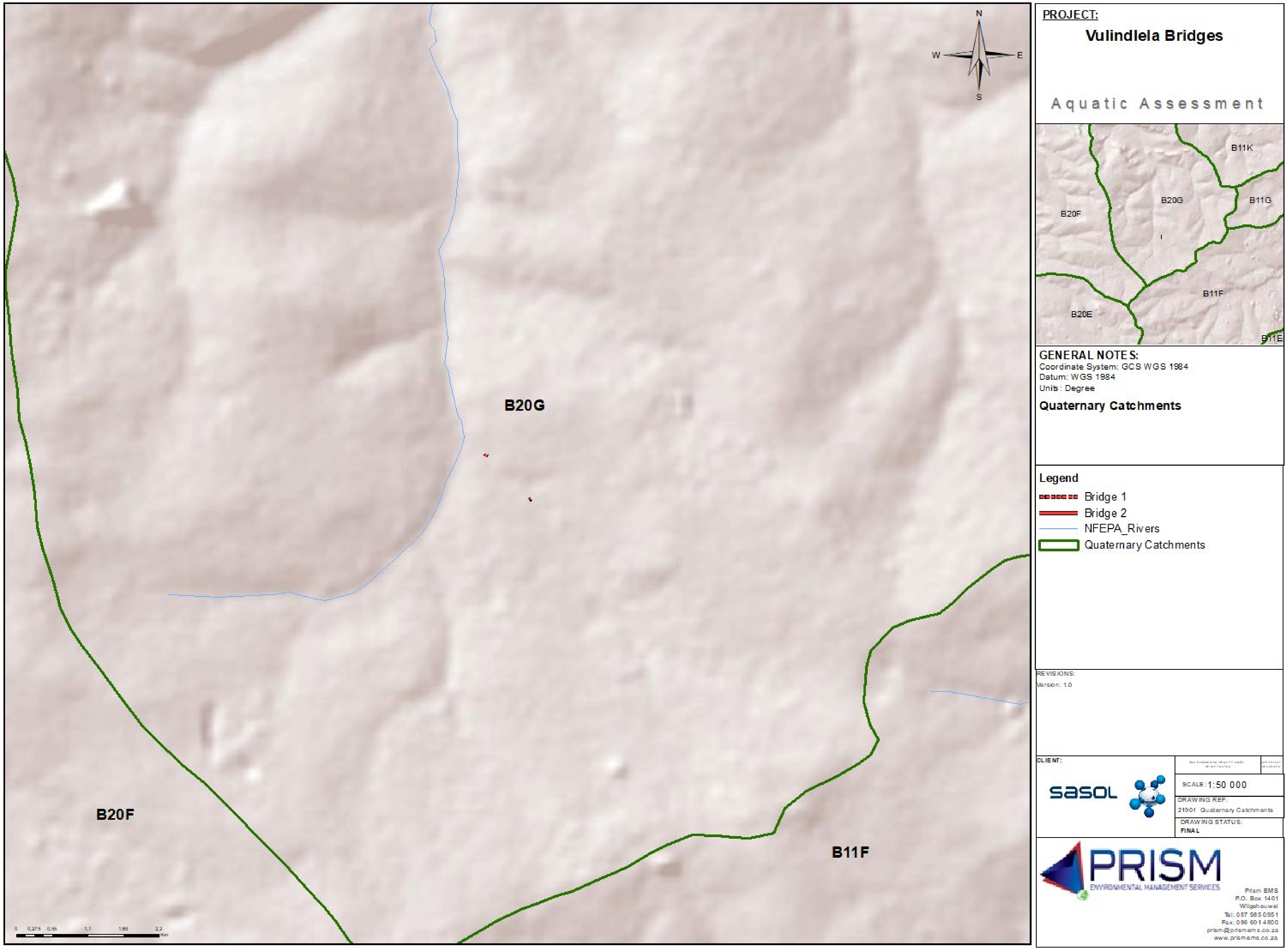

Figure 1-4: Map of the Catchment Areas

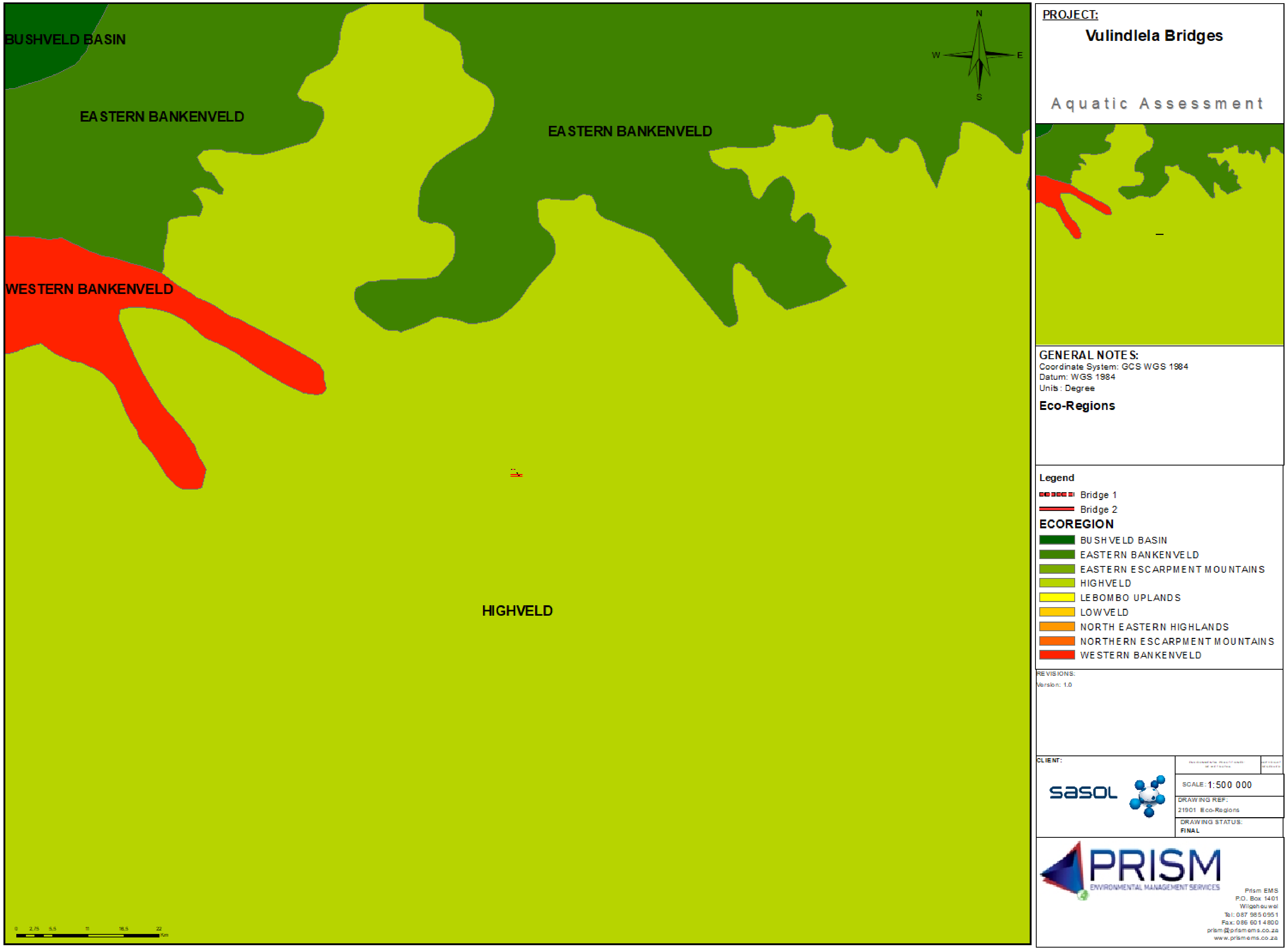

Figure 1-5: Map of the study sites Eco-Regions (DWAF; 2005)

2 REPORT OUTLINE

Appendix 6 of GN 982 of 4 December 2014 provides the requirements for specialist reports undertaken as part of the environmental authorisation process. In line with this, Table 2-1 provides an overview of Appendix 6 together with information on how these requirements have been met.

Table 2-1. Specialist Report Requirements

Requirement from Appendix 6 of GN 982 of 4 December 2014 [as amended]	Chapter
(a) Details of - (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Chapter 1.3
(b) Declaration that the specialist is independent in a form as may be specified by the competent authority	*Declaration of Independence*
(c) Indication of the scope of, and the purpose for which, the report was prepared	Chapter 1.2
(cA) an indication of the quality and age of base data used for the specialist report;	Chapter 6
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Chapter 7
(d) The duration date and season of the site investigation and the relevance of the season to the outcome of the assessment	Chapter 4
(e) Description of the methodology adopted in preparing the report or carrying out the specialised process, inclusive of equipment and modelling used.	Chapter 4
(f) Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives.	Chapter 6
(g) Identification of any areas to be avoided, including buffers	Chapter 6
(h) Map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Chapter 6
(I) Description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 5
(j) Description of the findings and potential implications of such findings on the impact of the proposed activity, or activities.	Chapter 6 Chapter 7
(k) Mitigation measures for inclusion in the EMPr	Chapter 8.1
(l) Conditions for inclusion in the environmental authorisation	Chapter 8 Chapter 9
(m) Monitoring requirements for inclusion in the EMPr or environmental authorisation	Chapter 8

Requirement from Appendix 6 of GN 982 of 4 December 2014 [as amended]	Chapter
(n) Reasoned opinion - (i) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii)if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Chapter 8
(o) Description of any consultation process that was undertaken during the course of preparing the specialist report	Chapter 0
(p) A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q) Any other information requested by the competent authority	N/A

3 LEGISLATION AND GUIDELINES

The generic term 'wetland' is used worldwide and includes specific ecosystems such as bogs, coastal lakes, estuaries, fens, floodplains, mangroves, marshes, mires, moors, pans, peatlands, seeps, sloughs, springs, swamps, vlei and wet meadows (Mays, 1996; DWAF, 2005). Regardless of the local name given to wetlands, the driving force of all wetlands is the interplay between land and water, and the consequent characteristics that reflect both (Cowan, 1999). Any part of the landscape where water accumulates for long enough and often enough to influence the plants, animals and soils occurring in that area, is referred to as a wetland (DWAF, 2005). Wetlands comprise approximately 6% (8.5 km^2 x 103) of the world's land surface and are found in every climate from the tropics to the frozen tundra (Mays, 1996).

Several definitions for wetland and wetland areas exist. Two of the most common wetland definitions used in South Africa is the National Water Act (NWA) (Act 36 of 1998) and the Ramsar definition are provided below:

National Water Act, Act No 36 of 1998:

> *"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."*

South Africa, being a contracting party to Ramsar, also uses the definition accepted by the convention. Article 1.1 of the convention defines wetlands as (Cowan, 1999; Koester, 1989):

> *"Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters*."

Wetlands are defined as those areas that have water on the surface or within the root zone for long enough periods throughout the year to allow for the development of anaerobic conditions. These conditions create unique soil conditions (hydric soils) and support vegetation adapted to these flood conditions.

Hydric soils develop a grey or sometimes greenish or blue-grey colour, as a result of the chemical reduction of iron (gleying). Hydric soils that are seasonally flooded are characterised by the formation of mottles, which are relatively insoluble, enabling them to remain in the soil long after it has been drained. Consequently, it is possible to identify wetland areas on the basis of soil colour, using a standard colour chart, as matrix hue and chroma decrease, while mottle hue and chroma initially increase and then decrease the more saturated the soils become Table 3-1.

Table 3-1: Relationship between degree of wetness (wetland zone), soil-physiochemistry and vegetation (Kotze *et al.*, 1994)

Degree of wetness			
	Temporary	Seasonal	Permanent / Semi-permanent
Soil Depth (0cm – 10cm)	Matrix chroma: 1-3 Few / no mottles Low / intermediate OM Non-sulphuric	Matrix chroma: 0-2 Many mottles Intermediate OM Seldom sulphuric	Matrix chroma: 0-1 Few / no mottles High OM Often sulphuric
Soil Depth (40cm – 50cm)	Few / many mottles Matrix chroma: 0-2	Many mottles Matrix chroma: 0-2	No / few mottles Matrix chroma: 0-1
Vegetation	Predominantly grass species	Predominantly sedges and grasses	Predominantly reeds and sedges

Vegetation distribution within wetlands is related to the flooding regime. Terrestrial plants are not tolerant of flooding within the root zone for periods long enough to cause anaerobic conditions and are thus found on drier soil conditions. The distribution of wetland plants is related to their tolerance of different flooding conditions, and their distribution within a system can be used as an indication of the wetness of an area.

Typically, indicators of soil wetness based on soil morphology correspond closely with vegetation distribution, since hydrology affects soils and vegetation in systematic and predictable ways. However, in systems where the hydrological regime has been modified due to human activities, vegetation distribution will not vary systematically with soil morphology. The response of vegetation to alteration of hydrological conditions is rapid (months / years), whereas the response of soil morphology to such alteration is slow (centuries). Therefore, lowering of the water table or reduction of surface flows, may lead to rapid establishment of terrestrial vegetation, whereas the soil morphology will retain indicators of wetness for a lengthy period. Soil morphology forms the basis of wetland delineation nationally, following international protocols, mainly because it provides a long-term indication of the “natural” hydrological regime. However, soil morphology cannot be considered to necessarily reflect the current hydrological conditions of the site where the hydrological regime has been altered, and in such circumstances, vegetation provides the best indication of the distribution of wetlands as it best reflects current hydrological conditions (Figure 3-1).

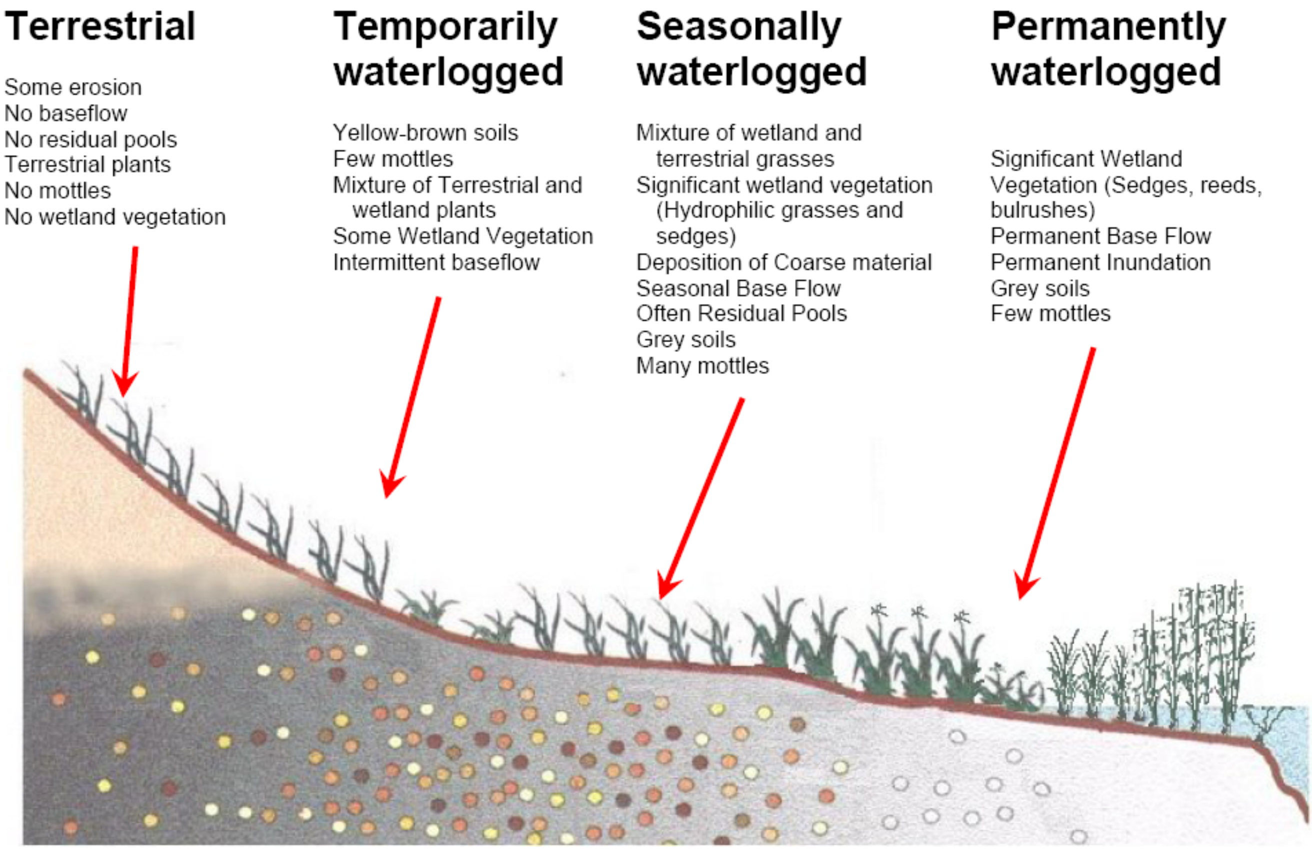

Figure 3-1: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change along a gradient of decreasing wetness, from the middle to the edge of the wetland. (Reproduced by Sivest from Kotze (1996), DWAF Guidelines)

Wetland vegetation is adapted to shallow water table conditions. Due to water availability and rich alluvial soils, wetland areas are usually very productive. Tree growth rate is high and the vegetation under the trees is usually lush and includes a wide variety of shrubs, grasses and wildflowers.

3.1 EIA Applicable Legislation

3.1.1 National Environmental Management Act (Act No. 107 of 1998) (NEMA)

The proposed development triggers a number of activities in terms of NEMA. These are listed in Table 3-2.

Table 3-2: Listed Activities in terms of NEMA

Government Notice Number	Activity and Listing Number	Description
GN 983 of 4 December 2014 as amended	Activity 12 Listing Notice 1	The development of— (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs— (a) within a watercourse;
GN 983 of 4 December 2014 as amended	Activity 19, Listing Notice 1	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse;
GN 985 of 4 December 2014 as amended	Activity 12, Listing Notice 3	The clearance of an area of 300 square metres or more of indigenous vegetation. f. Mpumalanga i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; ii. Within critical biodiversity areas identified in bioregional plans; or

An Environmental Impact Assessment (EIA) [Basic Assessment Process] will be undertaken.

3.2 Water Use Applicable Legislation

3.2.1 National Water Act (Act No 36 of 1998) (NWA)

The NWA is the primary regulatory legislation; controlling and managing the use of water resources as well as the pollution thereof and is implemented and enforced by the Department of Water and Sanitation (DWS[1]).

[1] Previously referred to as the Department of Water Affairs

Section 21 of the NWA lists water uses that must be licensed unless it is listed in the schedule (existing lawful use) and/or is permissible under a general authorisation, or if a responsible authority waives the need for a Water Use Licence.

The following listed water uses according to Section 21 of the NWA are triggered for the proposed project:

- Section 21(c): impeding or diverting the flow of water in a watercourse
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.

These water uses are permissible under a general authorisation and therefore, requires registration with DWS.

4 METHODOLOGY

4.1 Wetland Assessment

4.1.1 Desktop Assessment

A preliminary delineation of the Wetland boundary was undertaken using aerial photograph interpretation. Historical records and reports were consulted. The Department of Water and Sanitation (DWS) database was also consulted to obtain historical data for the study area. The Wetland Freshwater Priority Areas (FEPAs) as presented by South African National Biodiversity Institute (SANBI) was also scrutinised (Nel *et al*, 2011). Historical data and official approvals were also consulted during the assessment.

4.1.2 Field Investigation

The field investigation was undertaken during February 2019 to assess and corroborate the delineated Wetland zones present on the survey area.

The field procedure for the wetland delineation was conducted according to the Guidelines for delineating the boundaries of a wetland set out by the Department of Water Affairs and Forestry (DWAF 2005/8). Due to the transitional nature of wetland boundaries, the different wetland zones are often not clearly apparent. However, the wetland edge can be determined accurately. The delineations are based on scientifically defensible criteria and are aimed at providing a tool to facilitate the decision-making process regarding the assessment of the significance of impacts that may be associated with the proposed developments.

The wetlands were delineated by considering the following wetland indicators (DWAF 2005/8):

- Terrain unit indicator helps identifying those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units: crest, midslope, footslope, and valley bottom;
- Soil wetness indicator identifies the morphological signatures developed in the soil profile as a result of prolonged and frequent saturation; and
- The vegetation indicator identifies hydrophytic vegetation associated with frequently saturated soils.

The following procedure was followed during the delineation of the wetland boundaries and zones:

- A desktop delineation of the larger wetland area was undertaken using satellite imagery of the study site;
- Areas for verification were identified; and
- Identified areas were then assessed in the field with boundaries being recorded using a GPS.

4.1.3 Mapping

Mapping of the wetland boundaries was done by computerised processing utilising GPS tools and GIS modelling.

4.2 Wetland Classification

SANBI's "Further development of a proposed National Classification System for South Africa" was used to verify the classification of the wetlands within the study area (SANBI, 2009). The wetlands were classified up to level four, which includes the system, regional setting, landscape unit and hydrogeomorphic unit.

Table 4-1: Wetland classification level 1 - 4

Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit			
Connectivity to open ocean	Ecoregion	Landscape setting	HGM type	Longitudinal zonation / landform	Drainage - outflow	Drainage - inflow
			A	B	C	D
INLAND	DWAF Level 1 Ecoregions	SLOPE	Channel (river)	Mountain headwater stream	Not applicable	Not applicable
				Mountain stream	Not applicable	Not applicable
				Transitional river	Not applicable	Not applicable
				Rejuvenated bedrock fall	Not applicable	Not applicable
			Hillslope seep	Not applicable	With channel outflow	Not applicable
					Without channel outflow	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
					dammed	With channel inflow
						Without channel inflow
		VALLEY FLOOR	Channel (river)	Mountain stream	Not applicable	Not applicable
				Transitional river	Not applicable	Not applicable
				Rejuvenated bedrock fall	Not applicable	Not applicable
				Upper foothill river	Not applicable	Not applicable
				Lower foothill river	Not applicable	Not applicable

Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit			
				Lowland river	Not applicable	Not applicable
				Rejuvenated foothill river	Not applicable	Not applicable
				Upland floodplain river	Not applicable	Not applicable
			Channelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Unchannelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Floodplain wetland	Floodplain depression	Not applicable	Not applicable
				Floodplain flat	Not applicable	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
					dammed	With channel inflow
						Without channel inflow
			Valleyhead seep	Not applicable	Not applicable	Not applicable
		PLAIN	Channel (river)	Lowland river	Not applicable	Not applicable
				Upland floodplain river	Not applicable	Not applicable
			Floodplain wetland	Floodplain depression	Not applicable	Not applicable
				Floodplain flat	Not applicable	Not applicable
			Unchannelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
			Flat	Not applicable	Not applicable	Not applicable

<table>
<tr><th>Level 1: System</th><th>Level 2: Regional setting</th><th>Level 3: Landscape unit</th><th colspan="4">Level 4: Hydrogeomorphic (HGM) unit</th></tr>
<tr><td rowspan="5"></td><td rowspan="5"></td><td rowspan="5">BENCH (Hilltop/saddle/shelf)</td><td rowspan="4">Depression</td><td rowspan="4">Not applicable</td><td rowspan="2">Exorheic</td><td>With channel inflow</td></tr>
<tr><td>Without channel inflow</td></tr>
<tr><td rowspan="2">Endorheic</td><td>With channel inflow</td></tr>
<tr><td>Without channel inflow</td></tr>
<tr><td>Flat</td><td>Not applicable</td><td>Not applicable</td><td>Not applicable</td></tr>
</table>

The Hydrogeomorphic wetland units identified will be describe individually as per Marneweck and Batchelor (Marneweck & Batchelor; 2002).

4.3 Wetland Present Ecological Status (PES) assessment

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland for purposes of Ecological Reserve determination in terms of the National Water Act, and for environmental impact assessments WET-Health (Macfarlane *et al*, 2008). A level 1 wetland assessment was undertaken to determine the PES of the wetland system.

The PES assessment is concluded by following a 5-step process:

1. Divide the wetland into HGM units;
2. Assess hydrological health of the wetland;
3. Assess geomorphological health;
4. Assess vegetation health of the wetland;
5. Represent the health scores for the overall wetland.

Table 4-2: Outline of steps involved in the Level 1 assessment (Macfarlane *et al*, 2008)

Step 1	**Divide the wetland into HGM units**
↓	
Step 2	**Assess hydrological health of the wetland**
• Step 2A	Evaluate changes to water input characteristics from the catchment
• Step 2B	Evaluate changes to water distribution and retention patterns with the wetland
• Step 2C	Determine the hydrological State of the wetland based on integrating scores from individual HGM Units
• Step 2D	Determine the overall Present Hydrological State of the wetland based on integrating scores from individual HGM Units
• Step 2E	Assess the anticipated trajectory of change of the wetland hydrology
↓	
Step 3	**Assess geomorphological health**
• Step 3A	Determine the Present Geomorphic State of the Individual HGM units
• Step 3B	Determine the overall Present Geomorphic State of the wetland based on integrating scores from individual HGM Units
• Step 3C	Assess the anticipated trajectory of change of the geomorphology of the overall wetland
↓	
Step 4	**Assess vegetation health of the wetland**
• Step 4A	Familiarisation with the general structure and composition of wetland vegetation in the area
• Step 4B	Identify and estimate the extent of disturbance classes
• Step 4C	Assess the changes to vegetation composition in each class, and integrate these for the overall HGM Unit
• Step 4D	Determine the overall Present Vegetation State based on integrating scores from individual HGM Units
• Step 4E	Assess the anticipated trajectory of change of wetland vegetation
↓	
Step 5	**Represent the health scores for the overall wetland**

The Present Ecological State (PES) categories are given in Table 4-3.

Table 4-3: PES categories (Macfarlane *et al*, 2008)

Description of Ecological Category	Combined impact score	PES Category
Unmodified / Natural	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

The determination of the probable Trajectory of Change of the wetland is also evaluated. This is rated and presented as indicated in Table 4-4.

Table 4-4: Trajectory of Change classes, scores and symbols used to represent anticipated changes to wetland integrity (Macfarlane *et al*, 2008)

Trajectory class	Description	Change score	Class Range	Symbol
Improve markedly	Condition is likely to improve substantially over the next five years	2	1.1 to 2.0	↑↑
Improve	Condition is likely to improve over the next 5 years	1	0.3 to 1.0	↑
Remain stable	Condition is likely to remain stable over the next 5 years	0	-0.2 to +0.2	→
Deterioration slight	Condition is likely to deteriorate slightly over the next 5 years	-1	-0.3 to -1.0	↓
Deterioration substantial	Condition is likely to deteriorate substantially over the next 5 years	-2	-1.1 to -2.0	↓↓

4.4 Wetland Ecological Importance and Sensitivity (EIS)

The ecological importance and sensitivity assessment were conducted according to the guidelines as discussed by DWAF (1999). DWAF defines "ecological importance" of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. "Ecological sensitivity", according to DWAF (1999), refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) analysis provides a guideline for the determination of the Ecological Management Class (EMC).

In the method outlined by DWAF (1999) a series of determinants for EIS are assessed for the wetlands on a scale of 0 to 4 (Table 4-5), where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to determine the EIS and EMC of the wetland unit (Table 4-6).

Table 4-5: Score sheet for the determination of ecological importance and sensitivity (DWAF, 1999)

Determinant	Score	Confidence
Primary determinants		
Rare and endangered species		
Species / taxon richness		
Diversity of Habitat types or features		
Migration route / breeding and feeding site for wetland species		
Sensitivity to changes in the natural hydrological regime		
Sensitivity to water quality changes		
Flood storage, energy dissipation and particulate / element removal		
Modifying determinants		
Protected status		
Ecological integrity		

Score guideline: 4 = Very High; 3 = High; 2 = Moderate; 1 = Marginal / Low; 0 = None. Confidence rating: 4 = Very High Confidence; 3 = High Confidence; 2 = Moderate Confidence; 1 = Marginal / Low Confidence.

Table 4-6: Ecological Importance and Sensitivity (EIS) categories and the interpretation of median scores for biotic and habitat determinants (DWAF, 1999)

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

4.5 Wetland Recommended Ecological Category (REC)

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure." (DWAF, 1999).

The Recommended Ecological Category (REC) is determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity (EIS) of the aquatic resource. This is then followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A system may receive the same class for the PES, as the REC if the system is deemed to be in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the riparian system (Table 4-7).

Table 4-7: Recommended Ecological Category (REC) classes

Class (% of total)	Description
A	Unmodified, natural.
B	Largely natural with few modifications.
C	Moderately modified.
D	Largely modified.

4.6 Diatom Analysis (Response Indicators)

Diatoms are the unicellular algal group most widely used as indicators of river and wetland health as they provide a rapid response to specific physico-chemical conditions in water and are often the first indication of change. The presence or absence of indicator taxa can be used to detect specific changes in environmental conditions such as eutrophication, organic enrichment, salinization and changes in pH. They are therefore useful in providing an overall picture of trends within an aquatic system as they show an ecological memory of water quality over a period of time.

4.6.1 Laboratory Procedures

Diatom laboratory procedures were carried out according to the methodology described by Taylor *et al*. (2005). Diatom samples were prepared for microscopy by using the hot hydrochloric acid and potassium permanganate method. Approximately 300 to 400 diatom valves were identified and counted to produce semi-quantitative data for analysis. Prygiel *et al*. (2002) found that diatom counts of 300 valves and above were necessary to make correct environmental inferences. The taxonomic guide by Taylor *et al*. (2007b) and Cantonati *et al*. (2017) was consulted for identification purposes. Where necessary, Krammer & Lange-Bertalot (1986, 1988, 1991 a, b) were used for identification and confirmation of species identification. Environmental preferences were inferred from Taylor *et al*. (2007b) and Cantonati *et al*. (2017) and various other literature sources as indicated in the discussion section to describe the environmental water quality at each site.

4.6.2 Diatom-based Water Quality Indices

There are different diatom-based water quality indices that are used globally and are based on the specific water quality tolerances of diatoms. Most of the indices are based on a weighted average equation by Zelinka and Marvan (1961). Two values are assigned to each diatom species used in the calculations of the indices that reflects the tolerance or affinity of the diatom species to a certain water quality (good or bad); and indicates how strong (or weak) the relationship is (Taylor 2004). These values are then weighted by the abundance of the diatom species in the sample (Lavoie *et al*. 2006; Taylor 2004; Besse 2007). The main difference between indices is in the indicator sets (number of indicators and list of taxa) used in calculations (Eloranta & Soininen

2002). These indices underpin the computer software packages used to estimate biological water quality. One such software package commonly used and approved by the European Union is OMNIDIA (Lecointe *et al.* 1993). The program is a taxonomic and ecological database of 7 500 diatom species, and it contains indicator values and degrees of sensitivity for given species. It allows rapid calculations of indices of general pollution, saprobity and trophic state, indices of species diversity, as well as of ecological systems (Szczepocka, 2007).

4.6.3 The Specific Pollution Sensitivity Index (SPI)

The SPI was used in this diatom assessment (Table 2-1) and is an inclusive index and takes factors such as salinity, eutrophication and organic pollution into account (CEMAGREF, 1982). This index comprises 2035 taxa (Taylor, 2004) and is recognised as the broadest species base of any index currently in use and has been adapted to include taxa endemic to and commonly found in South Africa, thus increasing the accuracy of diatom-based water quality assessments and is known as the South African Diatom Index (SADI) (Harding and Taylor, 2011). The limit values and associated ecological water quality classes adapted from Eloranta and Soininen (2002), in conjunction with the new adjusted class limits that are provided in (Taylor & Koekemoer, in press), were used for interpretation of the SPI scores. The SPI index is based on a score between 0 – 20, where a score of 20 indicates no pollution and a score of zero indicates an increasing level of pollution or eutrophication.

Table 4-8: Adjusted class limit boundaries for the Specific Pollution Index in the evaluation of water quality applied in this study *(adapted from Eloranta & Soininen, 2002; Taylor & Koekemoer, in press)* Interpretation of Index Scores

Ecological Category (EC)	Class	Index Score (SPI Score)
A	High quality	18 - 20
A/B		17 - 18
B	Good quality	15 - 17
B/C		14 - 15
C	Moderate quality	12 - 14
C/D		10 - 12
D	Poor quality	8 - 10
D/E		6 - 8
E	Bad quality	5 - 6
E/F		4 - 5
F		< 4

4.6.4 The Percentage Pollution Tolerant Valves (%PTV)

The %PTV is part of the UK Trophic Diatom Index (TDI) (Kelly and Whitton, 1995) and was developed for monitoring organic pollution (sewage outfall- orthophosphate-phosphorus concentrations), and not general stream quality Table 4-9. The %PTV has a maximum score of 100, where a score above 0 indicates no organic pollution and a score of 100 indicates definite and severe organic pollution. The presence of more than 20% PTVs shows organic impact. All calculations were computed using OMNIDIA ver. 4.2 program (Lecointe *et al*., 1993).

Table 4-9: Interpretation of the percentage Pollution Tolerant Valves scores (adapted from Kelly, 1998)

%PTV	Interpretation
<20	Site free from organic pollution.
20 to <40	There is some evidence of organic pollution.
40 to 60	Organic pollution likely to contribute significantly to eutrophication.
>60	Site is heavily contaminated with organic pollution.

4.7 Water Quality Analysis (Stressor Indicators)

Instream water quality guidelines for aquatic ecosystems were developed by the South African Department of Water Affairs and Forestry (DWAF), now known as the Department of Water and Sanitation (DWS). The guidelines were developed to protect and conserve the health of aquatic ecosystems. The term *water quality* is used to describe the physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses including protection of the health and integrity of aquatic ecosystems. Many of these properties are controlled or influenced by constituents that are either dissolved or suspended in water. In the DWAF guidelines (DWAF, 1996), the Target Water Quality Range (TWQR) was used for this study, but not as a water quality criterion but rather as a management objective which has been derived from quantitative and qualitative criteria. This is the range of concentrations or levels within which no measurable adverse effects are expected on the health of aquatic ecosystems, and should therefore ensure their protection.

Physico-chemical properties of the water samples such as Turbidity were analysed at a SANAS accredited laboratory. During the *in-situ* water quality assessment, the following field instruments were used to measure the water quality parameters:

- Dissolved Oxygen (*EXTECH® ExStik® DO600*);
- Electrical Conductivity (*EXTECH® ExStik® EC500*);
- pH (*EXTECH® ExStik® EC500*); and
- Temperature (EXTECH® ExStik® EC500)

The velocity / flow of the aquatic resource was measured using a *Ground Truth Transparent Velocity Head Rod* (TVHR). The clarity of the aquatic resource was measured using a *Ground Truth Water Clarity Tube*. The South African River Health Program utilises the clarity tube and TVHR to monitor South African rivers.

The instream aquatic assessment was conducted at four (4) sites along the Channelled Valley Bottom Wetland (VBR_CVB1), upstream and downstream of each bridge location. The GPS coordinates are presented in Table 15 below. *In situ* water quality parameters were measured and recorded in the field by means of portable field instruments. The parameters recorded were Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), water temperature, water velocity, turbidity and clarity.

Table 10: GPS coordinates of monitoring points (19 February 2019).

Site Name	GPS Coordinates	Site Description
B1-UP	26° 0'17.53"S 29° 2'18.93"E	Located upstream of Bridge 1.
B1-DS	26° 0'15.97"S 29° 2'18.37"E	Located downstream of Bridge 1.
B2-UP	25°59'55.54"S 29° 1'57.03"E	Located upstream of Bridge 2.
B2-DS	25°59'54.90"S 29° 1'56.47"E	Located downstream of Bridge 2

Water temperature plays a significant role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms. Temperature affects the rate of development, reproductive periods, and emergence time of organisms. Temperature varies with season and the life cycles of many aquatic macroinvertebrates are cued to temperature.

For surface water, pH values typically range between 4 and 11. The relative proportions of the major ions, and in consequence the pH, of natural waters, are determined by geological and atmospheric influences. Most fresh waters, in South Africa, are relatively well buffered and neutral, with pH ranging between 6 and 8 (DWAF, 1996).

Electrical Conductivity (EC) is a measure of the ability of water to conduct an electrical current. This ability is a result of the presence of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium, and magnesium in the water, all of which carry an electrical charge. Many organic compounds dissolved in water do not dissociate into ions (ionise), and consequently do not affect the EC. EC is a rapid and useful surrogate measure of the Total Dissolved Solids (TDS) concentration of waters with a low organic content.

Industrial activities generally cause acidification rather than alkalinisation of rivers. Acidification is normally the result of three distinct types of pollution, namely:

- low-pH point-source effluents from industries, such as pulp and paper and tanning and leather industries;
- mine drainage, which is nearly always acid, leading to the pH of receiving streams dropping to below 2; and
- acid precipitation resulting largely from atmospheric pollution caused by the burning of coal (and subsequent production of sulphur dioxide) and the exhausts of combustion engines (nitrogen oxides). When acid rain falls on a catchment, the strong acids leach calcium and magnesium from the soil and interfere with nutrient availability.

Elevated pH values can be caused by increased biological activity in eutrophic systems. The pH values fluctuate widely from below 6 to above 10 over a 24-hour period because of changing rates of photosynthesis and respiration.

The maintenance of adequate dissolved oxygen (DO) is critical for the functioning of aquatic ecosystems, as it is required for the respiration of all aerobic organisms (DWAF, 1996). The DO can either be measured either as milligrams per litre (mg/ℓ) or as percentage of oxygen saturation concentration (%). The median guideline for DO as set by (Kempster, Hattingh, & Van Vliet, 1980) for the protection of aquatic biota is > 5 mg/ℓ. According to DWAF (1996), concentrations of less than 100% saturation indicate that dissolved oxygen has been depleted from the theoretical equilibrium concentration. Continuous exposure to oxygen concentrations levels of less than 80% will cause physiological stress to the aquatic organisms.

Turbidity is a measure of the light-scattering ability of water and is indicative of the concentration of suspended matter in water. Micro-organisms are often associated with turbidity; hence low turbidity reduces the potential for transmission of infectious diseases. Suspended matter usually consists of a mixture of inorganic matter such as clay and soil particles, and organic matter such as living and / or non-living matter. Sewage and other types of waste discharge can contribute significantly to the turbidity of a water source (DWAF, 1996).

The clarity of a water body refers to the depth to which light can penetrate. It is for this reason that clarity is frequently associated with turbidity. There is also a possible health risk associated with turbid water due to the presence of micro-organisms which may be associated with suspended particulate matter. Clays, organic particles from decomposing plant and animal matter, fibrous particles and suspended soils and sediments constitute most of the particulate matter that contributes to high turbidity and low clarity. Sewage and other wastes may contribute significantly to reduced water clarity.

4.8 Impact Assessment Methodology

As standardised impact assessment methodology was utilised to determine the impacts associated with the proposed installation. A summary of this methodology is provided below.

The **significance** of an impact is defined as the combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The nature and type of impact may be direct or indirect and may also be positive or negative, refer to Table 4-11: below for the specific definitions.

Table 4-11: Nature and type of impact

	Nature and Type of Impact:		
IMPACT	Direct	Impacts that are caused directly by the activity and generally occur at the same time and place as the activity	✓/✗
	Indirect	Indirect or induced changes that may occur as a result of the activity. These include all impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity	✓/✗
	Cumulative	Those impacts associated with the activity which add to, or interact synergistically with existing impacts of past or existing activities, and include direct or indirect impacts which accumulate over time and space	✓/✗
	Positive	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes will benefit significantly, and includes neutral impacts (those that are not considered to be negative	✓
	Negative	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes will be comprised	✗

Table 4-12 presents the defined criteria used to determine the **consequence** of the impact occurring which incorporates the extent, duration and intensity (severity) of the impact.

Table 4-12: Consequence of the Impact occurring

CONSEQUENCE	**Extent of Impact:**	
	Site	Impact is limited to the site and immediate surroundings, within the study site boundary or property (immobile impacts)
	Neighbouring	Impact extends across the site boundary to adjacent properties (mobile impacts)
	Local	Impact occurs within a 5km radius of the site
	Regional	Impact occurs within a provincial boundary
	National	Impact occurs across one or more provincial boundaries
	Duration of Impact:	
	Incidental	The impact will cease almost immediately (within weeks) if the activity is stopped, or may occur during isolated or sporadic incidences
	Short-term	The impact is limited to the construction phase, or the impact will cease within 1 - 2 years if the activity is stopped
	Medium-term	The impact will cease within 5 years if the activity is stopped
	Long-term	The impact will cease after the operational life of the activity, either by natural processes or by human intervention
	Permanent	Where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient
	Intensity or Severity of Impact:	
	Low	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are not affected
	Low-Medium	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are modified insignificantly
	Medium	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are altered
	Medium-High	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes are severely altered
	High	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes will permanently cease

The probability of the impact occurring is the likelihood of the impacts actually occurring and is determined based on the classification provided in Table 4-13.

Table 4-13: Probability and confidence of impact prediction

	Probability of Potential Impact Occurrence:		
PROBABILITY	Improbable	The possibility of the impact materialising is very low either because of design or historic experience	
	Possible	The possibility of the impact materialising is low either because of design or historic experience	
	Likely	There is a possibility that the impact will occur	
	Highly Likely	There is a distinct possibility that the impact will occur	
	Definite	The impact will occur regardless of any prevention measures	

The significance of the impact is determined by considering the consequence and probability without taking into account any mitigation or management measures and is then ranked according to the ratings listed in Table 4-14.

Table 4-14: Significance rating of the impact

	Significance Ratings:	
SIGNIFICANCE	Low	Neither environmental nor social and cultural receptors will be adversely affected by the impact. Management measures are usually not provided for low impacts
	Low-Medium	Management measures are usually encouraged to ensure that the impacts remain of Low-Medium significance. Management measures may be proposed to ensure that the significance ranking remains low-medium
	Medium	Natural, cultural and/or social functions and processes are altered by the activities, and management measures must be provided to reduce the significance rating
	Medium-High	Natural, cultural and/or social functions and processes are altered significantly by the activities, although management measures may still be feasible
	High	Natural, cultural, and/or social functions and processes are adversely affected by the activities. The precautionary approach will be adopted for all high significant impacts and all possible measures must be taken to reduce the impact

The level of confidence associated with the impact prediction is also considered as low, medium or high (Table 4-15:).

Table 4-15: Level of confidence of the impact prediction

	Level of Confidence in the Impact Prediction:		
CONFIDENCE	Low	Less than 40% sure of impact prediction due to gaps in specialist knowledge and/or availability of information	
	Medium	Between 40 and 70% sure of impact prediction due to limited specialist knowledge and/or availability of information	
	High	Greater than 70% sure of impact prediction due to outcome of specialist knowledge and/or availability of information	

Once significance rating has been determined for each impact, management and mitigation measures must be determined for all impacts that have a significance ranking of Medium and higher in order to attempt to reduce the level of significance that the impact may reflect.

The EIA Regulations, 2014 specifically require a description is provided of the degree to which these impacts:

- can be reversed;
- may cause irreplaceable loss of resources; and
- can be avoided, managed or mitigated.

Based on the proposed mitigation measures, the mitigation efficiency is also determined (Table 4-16) whereby the initial significance is re-evaluated and ranked again to effect a significance that incorporates the mitigation based on its effectiveness. The overall significance is then re-ranked and a final significance rating is determined.

Table 4-16: Mitigation efficiency

	Mitigation Efficiency		
MITIGATION EFFICIENCY	None	Not applicable	
	Very Low	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact. Positive impacts will remain the same	
	Low	Where the significance rating reduces by one level, after mitigation	
	Medium	Where the significance rating reduces by two levels, after mitigation	
	High	Where the significance rating reduces by three levels, after mitigation	
	Very High	Where the significance rating reduces by more than three levels, after mitigation	

The reversibility is directly proportional to the “Loss of Resource” where no loss of resource is experienced, the impact is completely reversible; where a substantial “Loss of resource” is experienced there is a medium degree of reversibility; and an irreversible impact relates to a complete loss of resources, i.e. irreplaceable (Table 4-17).

Table 4-17: Degree of reversibility and loss of resources

DEGREE REVERSABILITY & LOSS OF RESOURCES	**Loss of Resources:**		
	No Loss	No loss of social, cultural and/or ecological resource(s) are experienced. Positive impacts will not experience resource loss	
	Partial	The activity results in an insignificant or partial loss of social, cultural and/or ecological resource(s)	
	Substantial	The activity results in a significant loss of social, cultural and/or ecological resource(s)	
	Irreplaceable	The activity results in the complete and irreplaceable social, cultural and/or ecological loss of resource(s)	
	Reversibility:		
	Irreversible	Impacts on natural, cultural and/or social functions and processes are irreversible to the pre-impacted state in such a way that the application of resources will not cause any degree of reversibility	
	Medium Degree	Impacts on natural, cultural and/or social functions and processes are partially reversible to the pre-impacted state if less than 50% resources are applied	
	High Degree	Impacts on natural, cultural and/or social functions and processes are partially reversible to the pre-impacted state if more than 50% resources are applied	
	Reversible	Impacts on natural, cultural and/or social functions and processes are fully reversible to the pre-impacted state if adequate resources are applied	

4.9 Consultation Process

Consultation as part of the overall environmental authorisation process is being undertaken by MDT Environmental (Pty) Ltd (EAP). Prism EMS, aquatic resources specialist consulted with:

- The EAP;

5 ASSUMPTIONS, GAPS AND LIMITATIONS

The study was limited to a snapshot view during one site assessment. The field investigation was undertaken on 19 February 2019 to assess and confirm the delineated Wetland zones present on the survey area. Weather conditions during the survey were favourable for recordings. The delineations were recorded by hand held GPS.

It must be noted that, during the process of converting spatial data to final output drawings, several steps are followed that may affect the accuracy of areas delineated. Due care has been taken to preserve accuracy. Printing or other forms of reproduction may also distort the scale indicated in maps. It is therefore suggested that the wetland areas identified in this report be pegged in the field in collaboration with the surveyor for precise boundaries.

A total assessment of all probable scenarios or circumstances that may exist on the study site was not undertaken. No assumptions should be made unless opinions are specifically indicated and provided. Data presented in this document may not elucidate all possible conditions that may exist given the limited nature of the enquiry.

It is unlikely that more surveys would alter the outcome of this study radically.

6 RESULTS AND FINDINGS

6.1 Wetland Delineation

6.1.1 Desktop Assessment

During the desktop investigation, one (1) possible area where wetlands could occur was identified on or in close proximity to the study site that would be affected by the proposed development activities. The NFEPA wetlands were also consulted and one wetland area was identified on or in close proximity to the study site that could be affected by the proposed activities.

6.1.2 Field Assessment

The field investigations were undertaken on the 19th February 2019 to assess and confirm the delineated Wetland zones present on the survey area.

The field investigations concluded that two (2) natural wetland systems (three wetland units) could be affected by the activities. Same is draining into the Saalboom Spruit.

6.1.2.1 Wetland Indicators

6.1.2.1.1 Terrain Unit Indicator

Terrain unit indicator helps identify those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units:

- Crest;
- midslope;
- footslope; and
- valley bottom.

The hydrogeomorphic wetland units identified were also assessed in respect to its location in the landscape. The wetland units found:

- VBR_CVB1 was found on the valley floor draining towards the North-West into the Saalboom Spruit. This system passes under both bridges.
- VBR_HSS1 was found on the North-Eastern slope associated with VBR_CVB1 draining towards the West into VBR_CVB1 east of Bridge 1.
- VBR_HSS2 was found on the North-Eastern slope North-West of Bridge 1 draining towards the West into VBR_CVB1 and then into the Saalboom Spruit.

Refer to Table 6-1 and section 4.2 Wetland Classification for the classification of the terrain unit.

Table 6-1: Wetland Classification

Identified Wetland	Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
	Connectivity to open ocean	Ecoregion	Landscape setting	HGM type	Longitudinal zonation / landform
				A	B
VBR_CVB1	INLAND	DWAF Level 1 Ecoregions	VALLEY FLOOR	Channelled valley-bottom wetland	Valley-bottom flat
VBR_HSS1	INLAND	DWAF Level 1 Ecoregions	SLOPE	Hillslope seep	
VBR_HSS2	INLAND	DWAF Level 1 Ecoregions	SLOPE	Hillslope seep	

6.1.2.1.2 Soil Form and Soil Wetness Indicator

Soil erodibility in hydrologically transformed environments contributes to the difficulties to precisely determine wetland boundaries. This investigation focussed on the delineation of the wetland features based on soil hydro-morphology and landscape hydrology as observed in the catchment and on the study site.

Soils were found to be of a low clay content in general. Mostly sandy soils were present especially in the top 250mm. The wetland seasonal and permanent zones reflected clayey soils. (Figure 6-1).

Figure 6-1: Soil samples

6.1.2.1.3 Vegetation Indicator

Upon the assessment of the area, the various wetland vegetation components were assessed and recorded. Dominant species were characterised as either wetland species or terrestrial species. Hydrophytic vegetation species were observed. Predominantly grass, rushes and sedge species were recorded. This unit was predominantly utilised to delineate the wetland (Figure 6-2).

Figure 6-2: Wetland vegetation

Table 6-2: Wetland indicator species noted during the assessment

Riparian / Wetland vegetation
Typha species
Paspalum species
Cyperus species
Juncus species
Andropogan species
Berkheya radula

**Not all species listed, only most common indicators*

6.1.3 Mapping

Figure 6-3 indicates the National Freshwater Ecosystem Priority Areas (NFEPA) Wetlands. No NFEPA wetlands are indicated on the Geographic Information Systems (GIS) layers that are in close proximity to the study site.

Figure 6-4 serves to conceptually present the location of the wetlands that could be affected by the proposed remediation activities on the site.

Figure 6-5 presents the wetland buffer zones that are applicable and should be considered during the development to ensure appropriate mitigation and management of the activities.

A 32m buffer was applied to VBR_CVB1 and VBR_HSS2 wetlands and a 100m buffer area to the VBR_HSS1 wetland that is in line with the National Environmental Management Act (NEMA) listed activities and the bio-diversity and mapping requirements. These VBR_CVB1 and VBR_HSS2 wetlands are fairly disturbed due to historical impacts (mostly upstream) and are of low ecological importance. VBR_HSS1 wetland is more sensitive and of medium-high ecological importance and must be protected, hence the extended buffer area. Rehabilitation of the buffer area is required. This conservation buffer should be utilised as the control area and will be adequate to assist with management and mitigation during the construction and operation phase.

Also, refer to the associated digital files presenting the wetland boundaries.

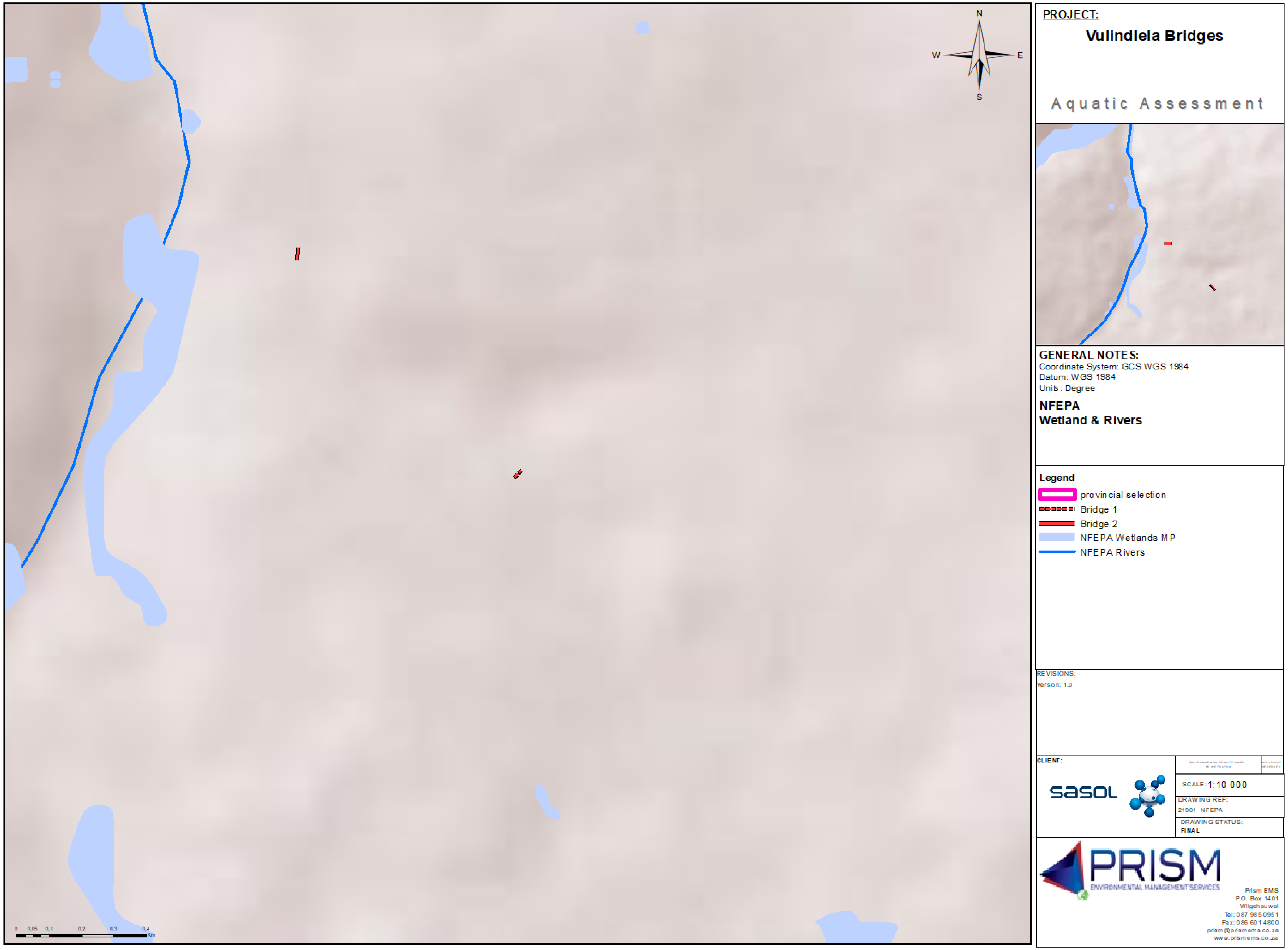

Figure 6-3: NFEPA Wetlands (Nel, 2011)

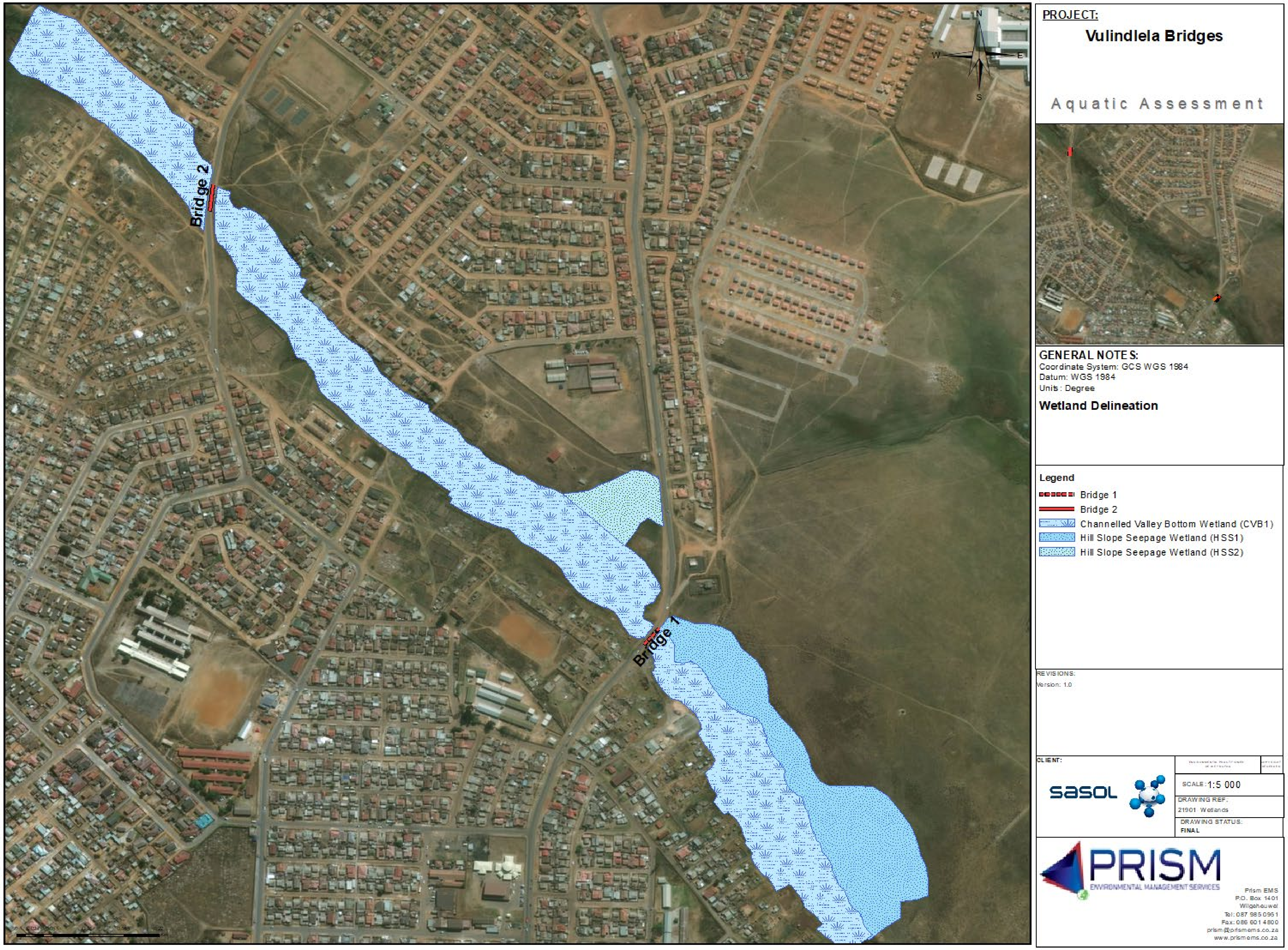

Figure 6-4: Aquatic Resource Delineation

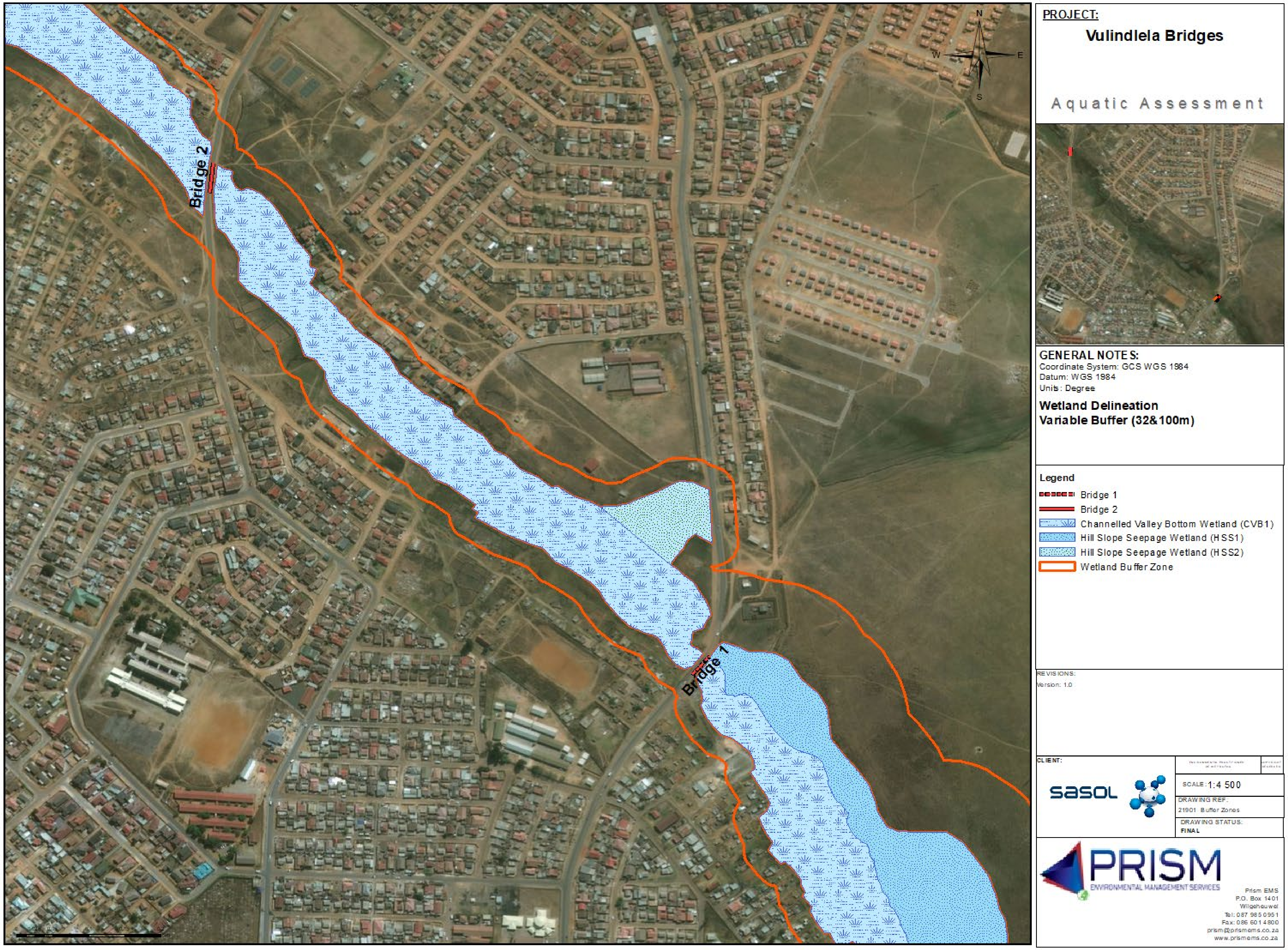

Figure 6-5: Aquatic Resource Buffer Zones

6.2 Wetland Classification

SANBI's classification for wetlands was used to classify the wetland units within the study area (SANBI, 2009). The wetland units were classified up to level four, which includes the system, regional setting, landscape unit and Hydrogeomorphic (HGM) unit. Figure 6-6 conceptually present the HGM units (Marneweck and Batchelor, 2002).

Three natural wetland entities were identified during the field investigation.

The following Hydrogeomorphic wetlands were identified during the site evaluation:

- VBR_CVB1 –Channelled Valley Bottom Wetland
- VBR_HSS1 – Hill Slope Seepage Wetland
- VBR_HSS2 – Hill Slope Seepage Wetland

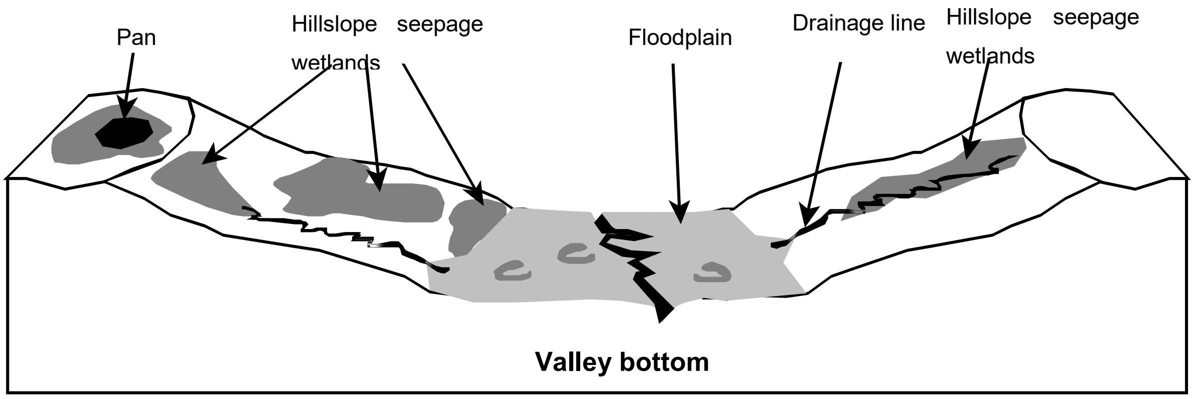

Figure 6-6: Wetland hydrogeomorphic (HGM) classification (Marneweck and Batchelor, 2002)

6.2.1 Channelled Valley Bottom Wetland

One Channelled Valley Bottom Wetland Unit was identified (VBR_CVB1) in the study area. Figure 6-7 diagrammatically illustrates the HGM unit.

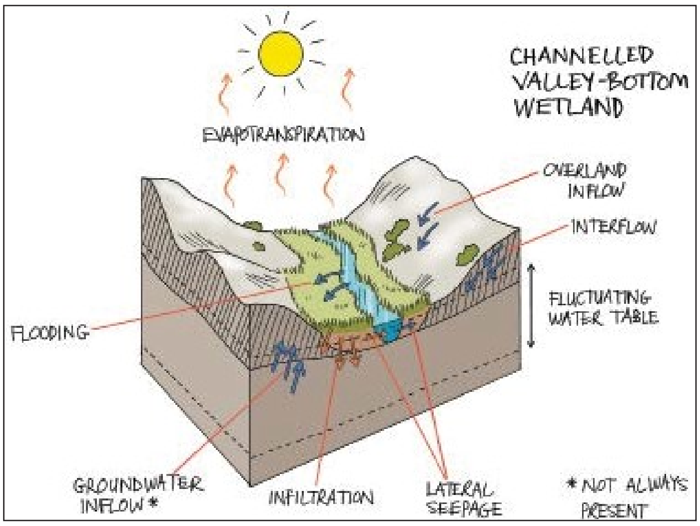

Figure 6-7: Channelled Valley Bottom Wetland (SANBI; 2013)

6.2.2 Hillslope Seepage Wetland

Two (2) Hillslope Seepage Wetland Units were identified (VBR_HSS1&2) in the study area. Figure 6-8 diagrammatically illustrates the HGM unit.

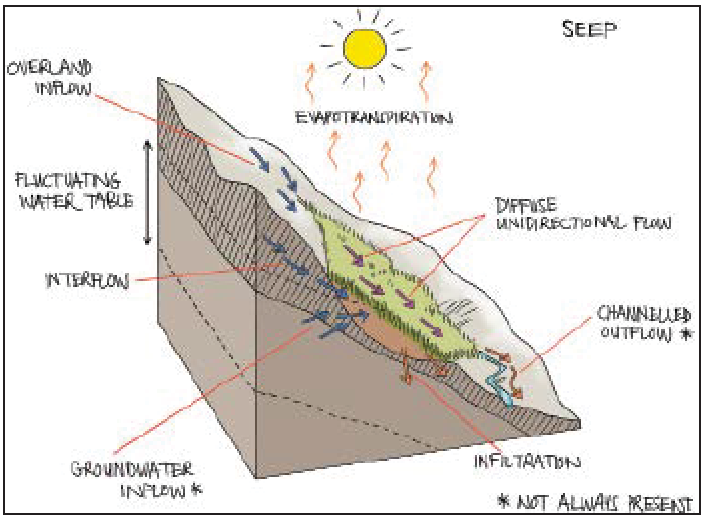

Figure 6-8: Hillslope Seepage Wetland (SANBI; 2013)

6.2.3 Wetland Unit classification

SANBI's "Further development of a proposed National Classification System for South Africa" was used to verify the classification of the wetlands within the study area (SANBI, 2009). The wetlands were classified up to level four, which includes the system, regional setting, landscape unit and hydrogeomorphic unit (Table 4-1).

The wetlands were classified as per Table 6-3.

Table 6-3: Wetland Units classification

Unit	System	Regional setting	Landscape unit	Hydrogeomorphic unit
VBR_CVB1	Inland	Highveld	Valley Floor	Channelled Valley Bottom Wetland
VBR_HSS1	Inland	Highveld	Slope	Hillslope Seepage Wetland
VBR_HSS2	Inland	Highveld	Slope	Hillslope Seepage Wetland

6.3 Wetland Present Ecological Status (PES)

A level 1 WET-health wetland assessment was undertaken to determine the PES of the wetland system.

6.3.1 Overall wetland

The overall wetland, inclusive of all wetland units, ecological status was found to be largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred, however some of the natural habitat remains intact to some extent. HSS1 still remains largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place. (Table 6-4). This CVB1 wetland system is impacted by historical channelisation upstream of the system and utilisation of the wetland as grazing pastures and small-scale crop production. It forms part of a larger aquatic system leading into the Saalboom Spruit. The trajectory of change of the wetland ecological status is predicted to decline over the next 5 years without major intervention (Table 6-5).

Table 6-4: Overall Wetland PES

Description	Combined impact score	PES Category
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	5.2 (range 4-5.9)	D (low)

*HSS1 – PES = B

Table 6-5: Trajectory of change of the Overall Wetland

Trajectory class	Description	Change score	Class Range	Symbol
Deterioration substantial	Condition is likely to deteriorate substantially over the next 5 years	-1,2	-0.2 to +0.2	↓↓

6.4 Wetland Ecological Importance and Sensitivity (EIS)

The ecological importance and sensitivity assessment were conducted according to the guidelines as discussed by DWAF (1999). DWAF defines "ecological importance" of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. "Ecological sensitivity", according to DWAF (1999), refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) analysis provides a guideline for the determination of the Ecological Management Class (EMC).

6.4.1 Overall Wetland Ecological Importance and Sensitivity

The Overall Wetland is considered to be ecologically important and sensitive on a regional scale. The biodiversity of this wetland is low with no red data species recorded. It is moderately sensitive to flow and habitat modifications. It plays an intermediate role in moderating the quantity and quality of water of major rivers. The system drains into the Saalboom Spruit. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate (Refer to Table 6-6).

Table 6-6: Overall Wetland EIS

Score	EIS Category	Category Description	Ecological Management Class
Score =1,5 ***Range*** ***(>1 and <=2)***	**Moderate**	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	**C**

HSS1 – EIS = B

6.5 Wetland Recommended Ecological Category (REC)

The Recommended Ecological Category (REC) is determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity (EIS) of the aquatic resource. This is then followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

6.5.1 Overall – REC

The wetlands will be impacted by the proposed remediation activities. This impact will be localised and at the transitional point leading from the base level re-establishment interface to the outer edge and banks of the wetland system. It will in all likelihood regress slightly in terms of its current Ecological Category during the construction period but will regenerate over time due to the resource quality characteristic improvements associated with the project. Stormwater management for the site is required specifically for the construction phase. Rehabilitation of the impacts and maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) will fall into:

- Category C for the overall wetland (Table 6-7).

Table 6-7: REC

Wetland	Class (% of total)	Description
Overall Wetland	**C**	Moderately modified.

HSS1 – REC = B

6.6 Diatom Results and Discussion

6.6.1 Diatom Assessment

The diatom assessment is divided into two sub-sections: (i) Discussion of the ecological classification of water quality for each site according to the diatom assemblage during this assessment. (ii) Analyses and discussion of the dominant species and their ecological preference at each site. Thus, allowing spatial variation analyses of ecological water quality between sites.

6.6.2 Ecological Classification for Water Quality

The ecological classification for water quality according to Van Dam *et al*. (1994) and Taylor *et al*. (2007), includes the preferences of 948 freshwater and brackish water diatom species in terms of pH, nitrogen, oxygen, salinity, humidity, saprobity and trophic state as provided by OMNIDIA (Le Cointe *et al*., 1993) (Table 6-8). The overall diatom assemblages comprised of species with a preference for:

- Fresh brackish (<500 µS/cm), circumneutral (pH 6.5- 7.5) to alkaline (pH >7) waters and eutrophic conditions.
- The nitrogen requirements for both sites ranged from N-Autotrophic tolerant indicating a tolerance for elevated concentrations of organically bound nitrogen to N-Heterotrophic facultative indicating a requirement of periodically elevated concentrations of organically bound nitrogen.
- The dissolved oxygen saturation requirements were low (<30%) for all the sites.
- The pollution levels indicated that there was some form of pollution evident at all the sites (α- meso-polysaprobic- heavily polluted waters).

Table 6-8: Ecological descriptors for the sites based on the diatom community (Van Dam *et al.*, 1994 and Taylor *et al.*, 2007)

Site	pH	Salinity	Organic Nitrogen uptake	Oxygen Levels	Pollution Levels	Trophic State
BS-US	Alkaline	Fresh-brackish	N-Heterotrophic facultative	Low	α-meso-polysaprobic	Eutrophic
BP-DS	Circumneutral	Fresh-brackish	N-Heterotrophic facultative	Low	α-meso-polysaprobic	Eutrophic
B1-US	Circumneutral	Fresh-brackish	N-Heterotrophic facultative	Low	α-meso-polysaprobic	Eutrophic
B1-DS	Alkaline	Fresh-brackish	N-Autotrophic tolerant	Low	α-meso-polysaprobic	Eutrophic

6.6.3 Diatom Spatial Analysis

A total of 23 diatom species were recorded at the four sites and the dominant species recorded included, *Nitzschia sp.* and *Gomphonema parvulum* (Table 6-9). These species are cosmopolitan in nature and have wide ecological amplitudes. Thus, caution must be taken when analysing the predominance of these species at specific sites and it is important to consider the diatom assemblage in conjunction with focusing on the dominant species. The occurrence of *Nitzschia sp.* indicated α- mesosaprobic to polysaprobic freshwater and is commonly found in untreated waste water and in habitats that are strongly impacted by industrial sewerage. The occurrence of *G. parvulum* indicated oligosaprobic and mesosaprobic, oligo- to eutrophic freshwater and points to impacts associated with agricultural run-off. *G parvulum* is adapted to withstand physical disturbance and benefits from organic enrichment.

Additional information is provided for the sub-dominant species in order to make ecological inferences for the four (4) sites assessed (Taylor *et al*., 2007, Cantonati *et al*., 2017):

- **Site B1-US**: This site was dominated by *G. parvulum* which indicated oligo- to eutrophic freshwater and pointed to impacts associated with agricultural run-off and organic enrichment. The subdominance of *Nitzschia sp.* indicated α-mesosaprobic to polysaprobic freshwater and is commonly found in untreated waste water and in habitats that are strongly impacted by industrial sewerage. The presence of *Ulnaria ulna* pointed to slightly alkaline, medium conductivity, oligosaprobic, and moderately eutrophic conditions. The presence of *Navicula erifuga* pointed to brackish waters and electrolyte-rich freshwaters habitats.
    - The results indicated by the diatom assemblage suggested that this site has been impacted and disturbed to some extent and that the ecological water quality was characterized as eutrophic freshwater with high electrolyte content. The %PTV score was high indicating that there was an impact associated with organic enrichment/anthropogenic pollution which was possibly associated with distal

upstream point source pollution or runoff from the surrounding land-use. The overall ecological water quality was considered *Poor* (Table 6-10)

- **Site B1-DS:** The dominance of *Nitzschia sp.* indicated α-mesosaprobic to polysaprobic freshwater and is commonly found in untreated waste water and in habitats that are strongly impacted by industrial sewerage. The subdominance of *Achnanthidium sp.,* which is cosmopolitan in nature, can be found in both clean and polluted waters and species from this genus are usually the first colonisers in electrolyte-poor conditions after acidification pulses. However, it is absent from strongly-acidic environments. The presence of *C. minusculoides* pointed to eu- to polytrophic, electrolyte-rich to salinized waters. The presence of *G. parvulum* indicated potential agricultural run-off and organic enrichment. The presence of *Hippodonta capitata* pointed to eutrophic to polytrophic freshwater and this taxon is tolerant to polluted conditions.
    - The results indicated by the diatom assemblage indicated that the ecological water quality was α-mesosaprobic to polysaprobic freshwater suggesting that this site was impacted and disturbed by some form of pollution. This impact may be associated with either distal upstream point source pollution or runoff from the surrounding land-use. The %PTV score was relatively low suggesting that some other source of pollution aside from organic enrichment was impacting this site. The overall ecological water quality was considered *Poor* (Table 6-10).
- **Site B2-US:** This site was dominated by *G. parvulum* which indicated impacts associated with agricultural run-off and organic enrichment. The subdominance of *Nitzschia sp*. indicated untreated waste water and industrial sewerage. The presence of *Craticula accomoda* pointed to strongly saprobically-impacted running waters, in particular waste water of sewage works. The presence of *C. minusculoides* pointed to eu- to polytrophic, electrolyte-rich to salinized waters. The presence of *P. frequentissimum* suggested alkaline, polysaprobic freshwaters with no acidic conditions.
    - The results indicated by the diatom assemblage suggested that this site has been impacted and that the ecological water quality was characterized as eutrophic, polysaprobic freshwater with high electrolyte content. The %PTV score was high indicating that there was an impact associated with organic enrichment/anthropogenic pollution which was possibly associated with distal upstream point source pollution or runoff from the surrounding land-use. The overall ecological water quality was considered *Poor* (Table 6-10).
- **Site B2-DS:** The dominance of *G. parvulum* pointed to impacts associated with agricultural run-off and organic enrichment. The subdominance of *Navicula sp*. suggested electrolyte-rich eutrophic freshwaters habitats. Species from this genus is often dominant in industrial waste water and polluted conditions. The presence of *Nitzschia sp*. pointed to α-mesosaprobic to polysaprobic freshwater and species from this genus is commonly found in untreated waste water and habitats that are strongly impacted by industrial sewage. The presence of *Craticula accomoda* and *C. minusculoides* pointed to strongly saprobically-impacted running waters, in particular waste water of sewage works and electrolyte-rich waters.

- The results indicated by the diatom assemblage indicated that the ecological water quality was α-mesosaprobic to polysaprobic freshwater, suggesting that this site was impacted by organic/anthropogenic pollution. This impact may be associated with upstream point or non-point source pollution. This notion is further supported by the very high %PTV score for this site. The overall ecological water quality was considered *Poor* (Table 6-10).

In conclusion, all the sites appeared to be impacted to some degree by organic enrichment/anthropogenic pollution, which may be associated with distal upstream point source pollution or runoff from the surrounding land-use. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected Poor conditions.

Table 6-9: Species and their abundances for the Vulindlela bridge repair sites.

Taxa	**B1-US**	**B1-DS**	**B2-US**	**B2-DS**
Achnanthidium exiguum (Grunow) Czarnecki		18	23	
Achnanthidium sp.	5	100	26	3
Amphora veneta		4		
Craticula accomoda (Hustedt) Mann			50	50
Craticula minusculoides (Hustedt) Lange-Bertalot	12	94	40	33
Cyclotella meneghiniana Kützing			22	
Frustulia crassinervia (Breb.) Lange-Bertalot et Krammer	3			
Gomphonema parvulum (Kützing)	160	50	135	155
Gomphonema species	15	8	25	6
Gyrosigma acuminatum (Kützing)Rabenhorst		4		
Hippodonta capitata (Ehr.) Lange-Bert.Metzeltin & Witkowski	8	48	26	13
Navicula erifuga Lange-Bertalot	53		25	7
Navicula rostellata Kützing	55	30		6
Navicula sp.	45	24		95
Nitzschia palea (Kützing) W.Smith				68
Nitzschia sp.1	74	110	75	26
Pinnularia gibba Ehrenberg	2			25
Planothidium frequentissimum(Lange-Bertalot)Lange-Bertalot		3	26	
Planothidium rostratum (Oestrup) Lange-Bertalot				10
Pseudostaurosira brevistriata (Grun.in Van Heurck) Williams & Round				3
Sellaphora mutatoides Lange-Bertalot & Metzeltin	3			
Sellaphora pupula (Kützing) Mereschkowksy	20	3	27	
Ulnaria ulna (Nitzsch.) Compère	45	4		
Total	500	500	500	500
Nutrients				
Organics				
Salinity				
Other dominant				

Table 6-10: Diatom index scores for the study sites indicating the ecological water quality

Site	%PTV	SPI	Ecological Category (EC)	Class
B1-US	32	7.6	D/E	Poor
B1-DS	10	9.2	D	Poor
B2-US	27	6.3	D/E	Poor
B2-DS	44.6	6.3	D/E	Poor

6.7 Water Quality Results and Discussion

6.7.1 Water Quality Results

The instream aquatic assessment was conducted at four (4) sites along the Channelled Valley Bottom Wetland (VBR_CVB1), upstream and downstream of each bridge location. The results from the February 2019 survey are presented in Table 6-11. Although only a 'snapshot' of what the water quality is, results obtained are still an important consideration as water quality has a direct influence on aquatic life. Data will be compared to the Target Water Quality Range (TWQR) guidelines for aquatic ecosystems (DWAF, 1996b), allowable concentrations to support aquatic life (Chapman & Kimstach, 1996), and the recommended values to support diverse aquatic life (Behar, 1996).

Table 6-11: *In situ* water quality recorded during February 2019.

Site	DO (mg/ℓ)	DO (%)	pH	EC (µS/cm)	Temperature (°C)	Flow (m/s)	Clarity (cm)	Turbidity (NTU)
	5.0-9.5[a]	80-120	6.0 - 9.0[a]	150 – 500[b]	5 - 30	-	-	
B1-UP	4.70	49.64	7.82	607	17.2	0.41	50	6.8
B1-DS	5.40	57.04	7.87	602	17.2	0.41	51	7.1
B2-UP	6.00	63.37	7.79	602	18.7	0.41	57	8.3
B2-DS	5.70	60.2	7.87	602	18.5	0.41	47	7.2

Target Water Quality Range ; [a] *Chapman and Kimstach* (1996); [b] *Behar* (1996)
DO – *Dissolved Oxygen;* EC – *Electrical Conductivity*

6.7.2 Dissolved Oxygen

The maintenance of adequate dissolved oxygen (DO) is critical for the survival and functioning of aquatic ecosystems as it is required for the respiration of all aerobic organisms (DWAF, 1996). Therefore, the DO concentration provides a useful measure of the health of an ecosystem (DWAF, 1996). The median guideline for DO as set by Kempster *et al*. (1980) for the protection of aquatic biota is > 5 mg/ℓ. Repeated exposure to reduced concentrations may lead to physiological and behavioural stress (DWAF, 1996).

The TWQR for the DO saturation in aquatic ecosystems is 80% to 120% under ideal conditions, with sub-lethal effects to aquatic biota occurring below 60% and lethal effects below 40%. During the February 2019 survey, none of the percentage oxygen observations met the TWQR for dissolved oxygen. Fish and invertebrate species may show varying sensitivities to changes in DO concentrations depending on their life stages (eggs, larvae or adult) and state of behaviour (feeding and/or reproduction). Juvenile stages are more sensitive to oxygen depletion showing physiological stress leading to increased vulnerability to predation and disease. All aquatic biota will, where possible, avoid oxygen depleted zones to better their chances of survival (DWAF, 1996). The oxygen concentration at all sites downstream of the Bridge 1 met the allowable limit requirements (> 5 mg/ℓ) and may therefore not have a limiting effect on aquatic biota, whilst the oxygen concentration at B1-UP was slightly below the limit. Based on the percentage oxygen observations, the water in this channelled valley bottom wetland may have a slight limiting effect on aquatic organisms depended on dissolved oxygen.

6.7.3 pH

Most fresh waters are usually relatively well buffered and more or less neutral, with a pH range from 6.5 to 8.5, and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals (Barbour, *et al*., 1996). The pH target for fish health ranges between 6.5 and 9.0 (Alabaster & Lloyd, 1982). The DWAF (1996) guidelines state that pH values should not be allowed to vary from the range of the background pH values for a specific site and time of day, by > 0.5 of a pH unit. The difference between the two sites was <0.5 pH units, therefore meeting this requirement. An optimal range of 6.0 - 9.0 is prescribed by Chapman and Kimstach (1996).

The pH at all four (4) sites met this requirement, within the optimal range according to Alabaster and Lloyd (1982) and Chapman and Kimstach (1996). The pH values recorded were therefore considered to not have a limiting effect on aquatic biota.

6.7.4 Electrical Conductivity (EC)

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current (DWAF, 1996). This ability is a result of the presence in water of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge (DWAF, 1996). Many organic compounds dissolved in water do not dissociate into ions (ionise), and consequently they do not affect the EC (DWAF, 1996).

The EC at all four (4) sites exceeded the limit of 150-500 µS/cm, as specified by (Behar, 1996). The EC may therefore have a limiting effect on aquatic biota, as the values obtained during the February 2019 survey did not meet the recommended value to support a diversity of aquatic life. Elevated EC values were observed upstream of the proposed development, indicating that water entering the site boundary is already of reduced quality that may pose a risk to aquatic biota. Electrical conductivity in this reach of the channelled valley bottom wetland may therefore be a contributing factor to the presence of aquatic biota.

6.7.5 Water Temperature

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms. Temperature affects the rate of development, reproductive periods and emergence time of organisms. Temperature varies with season and the life cycles of many aquatic macro invertebrates are cued to temperature (DWAF, 1996).

The water temperatures recorded during the February 2019 survey were between 17.2°C and 18.7°C. These temperatures are considered to be normal seasonal temperatures for South African waters and are within the guideline values. Therefore, temperature of this reach of the aquatic resource may pose no risk to aquatic biota.

6.7.6 Water Velocity (Flow)

The velocity of the channelled valley bottom wetland traversing the study site did not decrease between the four (4) sites. A constant medium flow rate of 0.41 m/s was observed. This was expected as the survey was conducted during the wet season. The slow and shallow water may favour the presence of aquatic macroinvertebrates but prove unfavourable for most fish species.

6.7.7 Water Clarity and Turbidity

The clarity of the aquatic resource traversing the Bridge 1 increased slightly between the upstream and downstream site, and decreased between the upstream and downstream sites at Bridge 2. As the water sampled and observed was relatively clear, it may be favoured by both fish and macroinvertebrates due to low turbidity.

6.7.8 *In situ* Water Quality Conclusion

The *in situ* water quality of the Channelled Valley Bottom Wetland traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium-low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

7 IMPACT ASSESSMENT

	IMPACTS			CONSEQUENCE			PROBABILITY	RANKING WITHOUT MITIGATION	IMPLEMENTATION OF MANAGEMENT MEASURES		RANKING WITH MITIGATION	DEGREE REVERSABILITY & LOSS OF RESOURCE	
	Type	Description	Nature	Extent (A)	Duration (B)	Intensity (C)	Probability (P)	Significance (A + B + C) X P	Mitigation and/or Management Measures	Mitigation Effectiveness	Significance	Loss of Resources	Reversibility
CONSTRUCTION PHASE													
Wetland	Direct	Water quality	Negative	*Local*	*Medium-term*	*Medium-High*	*Definite*	*Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*Medium*	*Low-Medium*	*Substantial*	*Medium Degree*
	Indirect	Silt	Negative	*Neighbouring*	*Medium-term*	*Medium*	*Highly Likely*	*Low-Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*Medium*	*Low*	*Partial*	*High Degree*
	Direct	Surface water run-off	Negative	*Local*	*Medium-term*	*Low-Medium*	*Highly Likely*	*Low-Medium*	Storm water management.	*Medium*	*Low*	*Partial*	*High Degree*
	Indirect	Contamination of water from hazardous substances	Negative	*Neighbouring*	*Incidental*	*Medium*	*Possible*	*Low*	Limited use of machinery in the wetland area. No servicing of vehicles and equipment on site.	*High*	*Low*	*Partial*	*High Degree*
	Direct	Disturbance of natural system	Negative	*Local*	*Medium-term*	*Medium*	*Definite*	*Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*Medium*	*Low-Medium*	*Substantial*	*Medium Degree*
	Direct	Disturbance/pollution of sub-surface flow	Negative	*Local*	*Medium-term*	*Medium*	*Highly Likely*	*Medium*	Stormwater management, dry season construction, coffer damming, filtration, sub-surface drains.	*High*	*Low-Medium*	*Partial*	*High Degree*
	Direct	Disturbance of aquatic ecological systems	Negative	*Local*	*Medium-term*	*Medium*	*Highly Likely*	*Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*High*	*Low-Medium*	*Partial*	*High Degree*

	IMPACTS			CONSEQUENCE			PROBABILITY	RANKING WITHOUT MITIGATION	IMPLEMENTATION OF MANAGEMENT MEASURES		RANKING WITH MITIGATION	DEGREE REVERSABILITY & LOSS OF RESOURCE	
	Type	Description	Nature	Extent (A)	Duration (B)	Intensity (C)	Probability (P)	Significance (A + B + C) X P	Mitigation and/or Management Measures	Mitigation Effectiveness	Significance	Loss of Resources	Reversibility
OPERATIONAL PHASE													
Wetland	Direct	Water quality	Positive	*Neighbouring*	*Long-term*	*Medium*	*Highly Likely*	*Medium*	Rehabilitation of construction impacted area, continuous monitoring.	*Medium*	*Medium*	*No Loss*	*Reversible*
	Indirect	Silt	Positive	*Local*	*Long-term*	*Medium*	*Definite*	*Medium*	Rehabilitation of construction impacted area, continuous monitoring and maintenance.	*Medium*	*Medium*	*No Loss*	*Reversible*
	Direct	Surface water run-off	Positive	*Local*	*Long-term*	*Low-Medium*	*Highly Likely*	*Medium*	Rehabilitation of construction impacted area, continuous monitoring, storm water management.	*High*	*Medium*	*No Loss*	*Reversible*
	Indirect	Contamination of water from hazardous substances	Negative	*Site*	*Incidental*	*Low-Medium*	*Possible*	*Low*	Rehabilitation of construction impacted area, continuous monitoring, storm water management.	*High*	*Low*	*Partial*	*High Degree*
	Direct	Disturbance of natural system	Negative	*Neighbouring*	*Long-term*	*Low*	*Likely*	*Low*	Rehabilitation of construction impacted area, continuous monitoring.	*High*	*Low*	*Partial*	*High Degree*
	Direct	Disturbance/pollution of sub-surface flow	Negative	*Neighbouring*	*Long-term*	*Low*	*Likely*	*Low*	Rehabilitation of construction impacted area, continuous monitoring and silt management.	*High*	*Low*	*Partial*	*High Degree*
	Direct	Disturbance of aquatic ecological systems	Negative	*Neighbouring*	*Long-term*	*Low*	*Highly Likely*	*Low-Medium*	Rehabilitation of construction impacted area, continuous monitoring and silt management.	*High*	*Low*	*Partial*	*High Degree*

8 REASONED OPINION AND RECOMMENDATIONS

The Present Ecological Status (PES) for the wetland scored in the lower ranges as the wetland is largely modified and impacted on by historical activities and current anthropogenic activities. The Ecological Importance and Sensitivity (EIS) falls in the moderate range and has some functionality in respect of moderating water quality before it reaches the Saalboom Spruit. The Recommended Ecological Category (REC) for the wetland was categorised to remain in the category of moderately modified wetlands. This to ensure sustainability of the system. It will thus require some rehabilitation to enhance the ecological function of the system. It is considered to be moderately sensitive wetlands, more specifically in respect of flow and water quality.

The diatom assemblages were generally comprised of species characteristic of fresh-brackish, circumneutral to alkaline waters and eutrophic conditions. The pollution levels indicated that all the sites showed some form of pollution. In conclusion, all the sites appeared to be impacted to some degree by organic enrichment/anthropogenic pollution, which may be associated with distal upstream point source pollution or runoff from the surrounding land-use. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected *Poor* conditions.

The *in situ* water quality of the Channelled Valley Bottom Wetland (VBR_CVB1) traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

For this reason, it can be supported that the remediation activities may go-ahead if the required buffers are maintained (in specific the hill slope seepage wetlands) and the resource drivers preserved. The rehabilitation of the wetland is vital to recover the required ecological function. The wetland drivers must be enhanced as part of the rehabilitation of the affected areas. In respect of the construction phase, it is important to ensure that the required erosion protection measures linked to the bridge crossing sections be carefully designed and installed. Silt transportation to the downstream system must also be carefully managed.

The project can be supported, should all the mitigation measures be implemented and monitored against to ensure compliance. This will ensure mitigation to acceptable levels.

8.1 Mitigation and Monitoring Requirements

Monitoring programmes can measure the success of mitigation implementations, monitor unforeseen impacts, and can be used as a feedback system to adjust or correct management of the wetlands.

The following are recommended:

- It is recommended that a Water Use registration and GA be submitted to the Department of Water Affairs, as the proposed activities will trigger sections of Section 21 of the National Water Act [NWA], 1998 (Act No. 36 of 1998) that will require such an application;
- Together with the GA, a rehabilitation and monitoring plan will have to be compiled as supporting documents to the application;
    - These documents must be incorporated as part of the Environmental Management Programme (EMPr).
- A wetland monitoring programme should be developed based on this baseline assessment and audited against post the rehabilitation activities. Feedback from the monitoring should be used to measure and mitigate further negative impacts, if found;
- The wetland monitoring occurring on a quarterly basis should be conducted by a skilled professional qualified in assessing and understanding the complex nature of wetlands and their associated drivers;
- It should be attempted to preserve complete wetland function (current status) if at all possible.
    - Wetland drivers should be protected as far as possible.
    - Wetland release into downstream aquatic resources should be rehabilitated, enhanced and monitored.
    - Water quality preservation is key. Monitoring should take place during the construction phase as per the General Authorisation (GA) requirements.
- Mitigation measures for the proposed development activities should be implemented, managed and monitored according to:
    - The following wetland ecosystem impact assessment conclusions, based on the results of the baseline survey:
        - Runoff from the construction areas may result in contamination of wetland and downstream aquatic habitat;
        - On site storm water management, must be implemented.
    - The following impacts may result in changes to the soil structure:
        - Heavy construction vehicles moving within the wetland areas;
            - Ingress and Egress must be managed to minimise impacts in respect of compaction of the wetland soils.
            - Single entry and exit points must be established.
        - Stock piling;
            - As first option - Stockpiling must be located outside the delineated wetland and buffer boundaries.

- As second option – Stockpiling must be located on the south and western banks or in the dedicated areas.
- Dedicated laydown and stockpiling areas have been identified. Some might be within the buffer areas, but same is associated with already transformed areas. Special management rules will apply for same.

    - Spills from machinery;
    - The mixing of concrete; and
    - Clearing of vegetation for construction, and associated sedimentation and siltation.

  - The following aspects may result in reduction of ecosystem habitat integrity:
      - Dust and sediment runoff from construction activities;
      - Diesel and oil spill from equipment and machinery; and
      - Higher and faster water flow from the site that could cause soil erosion.
  - The following aspects may result in sedimentation of the associated aquatic systems:
      - Sedimentation due to increase runoff and dispensed soil particles and runoff from the affected areas; and
      - Increase in the velocity of the runoff from the exposed soil, due to construction.
  - The proposed activities must be initiated and constructed in such a way to prevent the reduction of natural water flow into the wetland and downstream which, in essence, is the driving factor in terms of water provision.
      - An approved stormwater management plan must be implemented.
      - Subsurface drains must be installed to assist in the aquatic driver sustainability across the full width of the wetland.
      - Velocity dissipation structures (such as reno mattresses) must also be installed to prevent water flowing through culverts to gain velocity. An increase in velocity will lead to channelisation of the wetland and soil erosion.

- The wetland integrity should be improved during the rehabilitation phase. This may entail the following:
  - Removal of alien and invasive plant species during the construction and operational phases.
  - Re-vegetation and landscaping the wetland and buffer areas with indigenous wetland plant species.
  - Stabilisation of gullies and drainage lines to prevent erosion.
  - Planting of indigenous herbaceous plants on shallow banks and indigenous woody vegetation on steep banks to increase stability of banks, thereby preventing erosion.
  - Implementation of topsoil management (stockpiling, topography shaping) and erosion control (berms, geotextiling, silt fences, hay bales and gabion structures).

9 CONCLUSION

The field investigations concluded that two (2) natural wetland systems (*three wetland units*) could be affected by the activities. Same is draining into the Saalboom Spruit.

The following Hydrogeomorphic wetland units were identified during the site evaluation:

- VBR_CVB1 was found on the valley floor draining towards the North-West into the Saalboom Spruit. This system passes under both bridges.
- VBR_HSS1 was found on the North-Eastern slope associated with VBR_CVB1 draining towards the West into VBR_CVB1 east of Bridge 1.
- VBR_HSS2 was found on the North-Eastern slope North-West of Bridge 1 draining towards the West into VBR_CVB1 and then into the Saalboom Spruit.

The wetlands recorded were assessed and the following results were attained:

- The wetland attained a low overall PES (Present Ecological State)
  - The overall wetland system, inclusive of all wetland units, ecological status was found to be largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred, however some of the natural habitat remains intact to some extent. HSS1 still remains largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place. This CVB1 wetland system is impacted by historical channelisation upstream of the system and utilisation of the wetland as grazing pastures and small-scale crop production. It forms part of a larger aquatic system leading into the Saalboom Spruit
- The wetland attained a Moderate Ecological Importance and Sensitivity (EIS) score.
  - The overall wetland system is considered to be of moderate ecologically important and sensitive on a regional scale. The biodiversity of this wetland is low with no red data species recorded. It is moderately sensitive to flow and habitat modifications. It plays an intermediate role in moderating the quantity and quality of water of major rivers. The system drains into the Saalboom Spruit. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate.
- The wetland Recommended Ecological Classification (REC) classification was rated as:
  - The wetlands will be impacted by the proposed remediation activities. This impact will be localised and at the transitional point leading from the base level re-establishment interface to the outer edge and banks of the wetland system. It will in all likelihood regress slightly in terms of its current Ecological Category during the construction period but will regenerate over time due to the resource quality characteristic improvements associated with the project. Stormwater management for the site is required specifically for the construction phase. Rehabilitation of the impacts and

maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) will fall into:

- Category C for the overall wetland system

The diatom assemblages were generally comprised of species characteristic of fresh-brackish, circumneutral to alkaline waters and eutrophic conditions. The pollution levels indicated that all the sites showed some form of pollution. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected *Poor* conditions.

The *in situ* water quality of the Channelled Valley Bottom Wetland (VBR_CVB1) traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

Concluded from the results presented in this document, the construction activities will impact on the wetland system but can be mitigated to satisfactory standards if all mitigatory actions are implemented with due care. It is key to preserve water quality and supply to the downstream aquatic resources. Hence the actioning of this remediation project.

The rehabilitation of the wetland is vital to recover the required ecological function. The wetland drivers must be enhanced as part of the rehabilitation of the affected areas. In respect of the bridge construction, it is important to ensure that the required erosion protection measures linked to the crossing sections be carefully designed and installed.

The project can be supported should all the mitigation measures be implemented and monitored against.

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