Nkomati Nickel Mine

PROPOSED WATER TREATMENT PLANT AT THE NKOMATI JOINT VENTURE MINE

Aquatic Biodiversity and Impact Assessment Report

JUNE 2024

CONFIDENTIAL

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CONTENTS

EXECUTIVE SUMMARY

1 INTRODUCTION 1

2 METHODOLOGY 5

3 AQUATIC BIODIVERSITY DESKTOP ASSESSMENT 9

4 RESULTS AND DISCUSSION 17

5 SCREENING OF POTENTIAL IMPACTS 28

6 CUMULATIVE IMPACTS 36

7 CONCLUSION AND SPECIALIST OPINION 38

8 REFERENCES 40

TABLES

Table 2-1 - Location of the sampling points and brief descriptions 6

Table 3-1: Mpumalanga Biodiversity Sector Plan Categories Associated with the proposed Project, as well as recommended Land Management Objectives 13

Table 3-2 – Expected aquatic macroinvertebrates and their tolerance ratings to water quality and velocity conditions 15

Table 3-3 – Expected fish species, their conservation status and tolerance to water quality and flow conditions 16

Table 4-1 - Sources for the recommended water quality guidelines for aquatic ecosystems 19

Table 4-2 – *In situ* water quality data 20

Table 4-3 - Reach-based Index of Habitat Integrity scores obtained during the current survey 21

Table 4-4 - Integrated Habitat Assessment System scores 22

Table 4-5 – SASS5 data for the current survey 22
Table 4-6 – MIRAI data for the current survey 23
Table 4-7 - Fish habitat potential assessment metric groups 25
Table 4-8 - FRAI results for the assessed river reaches 27
Table 4-9 – Integrated EcoStatus categories for the current study – EcoStatus version 1.02 (Kleynhans and Louw, 2007) 27
Table 5-1 – Project activities per phase 28
Table 5-2 – Impact assessment ratings for the construction phase 32
Table 5-3 – Impact assessment ratings for the operational phase 35
Table 6-1 – Proposed aquatic biomonitoring programme. RQOs for EWRG1 Mngubhudle 36

FIGURES

Figure 1-1 - Project locality Map 2
Figure 2-1 - Locations of the Aquatic Ecology sampling points 8
Figure 3-1 - Quaternary catchments and freshwater resources associated with the proposed Project 10
Figure 3-2 - Project Areas relative to the NFEPA features Map 12
Figure 3-3 - Mpumalanga Biodiversity Sector Plan Map for freshwater resources 14
Figure 4-1 - Predominant flow conditions at the assessed Mngubhudle River upstream site UP. Moderate flows (left) and fast flows (right) 18
Figure 4-2 - Predominant flow conditions at the assessed Adit Stream site D. Fast flows (left) and moderate flows (right) 18
Figure 4-3 - Predominant flow conditions at the assessed Mngubhudle River downstream site G. Moderate flows (left) and fast flows (right) 19
Figure 4-4 - Photograph of *Chiloglanis pretoriae* taken during the current survey. Bottom photo showing the mouth parts 24
Figure 4-5 - Fish habitat metric group abundances at each site 26
Figure 5-1 - Project Layout Map 29

APPENDICES

APPENDIX A

METHODOLOGY

APPENDIX B

SITE PHOTOGRAPHS

APPENDIX C

AQUATIC MACROINVETEBRATES DATA

APPENDIX D

DOCUMENT LIMITATIONS

ACRONYMS, ABBREVIATIONS AND DEFINITIONS

ASPT	Average Score Per Taxa
CBA	Critical Biodiversity Area
CSIR	Council for Scientific and Industrial Research
DO	Dissolved Oxygen
DWS	Department of Water and Sanitation
EC	Ecological Category
EMPr	Environmental Management Programme
FRAI	Fish Response Assessment Index
IHAS	Invertebrate Habitat Assessment System
IHI	Index for Habitat Integrity
MIRAI	Macro-Invertebrate Response Assessment Index
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
REMP	River EcoStatus Monitoring Programme
RHP	River Health Programme
SAIAB	South African Institute of Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SASS5	South African Scoring System version 5
SQR	Sub-Quaternary Reach
TWQR	Target Water Quality Range
WMA	Water Management Area
WRC	Water Research Commission
WTP	Water Treatment Plant
WUL	Water Use Licenses

EXECUTIVE SUMMARY

WSP was appointed by Nkomati Mine to undertake the necessary ecological baseline surveys and impact assessment reports, in support of the environmental regulatory process required to authorise their development of the Water Treatment Plant (WTP) (*hereafter the Project*).

The Nkomati Mine operations ceased in February 2021. The mine is currently under care and maintenance, being managed towards closure. The mine impacted water emanating from mining areas is diverted through to Pit 3 for containment. This is considered a feasible short-term option to avoid decant of the High Sulphide Return Water Dam (HS RWD), Onverwacht RWD and Pit 2 to the environment. The mine however currently now faces the challenge of Pit 3 decanting to the environment. The WTP presents a solution for the treatment and discharge of acceptable quality water into the Adit Stream in the vicinity of the Nkomati Mine site.

The Nkomati Mine is located approximately 30 km east of the town eNtokozweni (Machadodorp) at the edge of the escarpment within the Mpumalanga Province, South Africa and situated under the jurisdiction of the Albert Luthuli Local Municipality, which is in the Gert Sibande District Municipality.

This interim report describes the high flow baseline aquatic biodiversity within areas that will be impacted by the proposed Project. Potential impacts, positive or negative, were assessed and practical mitigation/management measures developed for inclusion in the Environmental Management Programme (EMPr). A low flow assessment is tentatively scheduled in May 2024, thereafter a consolidated report encompassing results from low flow and high flow seasons will be completed.

The proposed Project falls within the primary drainage region X of the Inkomati-Usuthu Water Management Area (WMA) and the X11J quaternary catchment. The Sub-Quaternary Reach (SQR) of focus is the Mngubhudle River (X11J-01106). This is a first order stream with an approximate length of 38 km.

The following key findings are highlighted as part of the current aquatic biodiversity and impact assessment study:

Findings from the aquatic macroinvertebrate community indicated *Critically Modified* ecological integrity at all sampled sites due to the low diversity of taxa. Based on the fish community assessment, the ecological integrity was determined to be *Critically Modified* at the Adit Stream and Mngubhudle upstream site (due to the absence of fish) whilst the Mngubhudle downstream site (where a single species was collected) was determined to be *Seriously Modified*. The integrated ecostatus were determined to be *Seriously Modified* at the two former sites and *Largely to Seriously Modified* at the latter site.

The low aquatic biodiversity within the assessed systems was likely attributed to cumulative impacts associated with historical and present land use activities, mainly mining and forestry plantations. Furthermore, the collected macroinvertebrate assemblages were dominated by pollution-tolerant taxa,

thus indicating that water quality modifications have influenced instream aquatic biota over long periods.

Based on the findings of the current aquatic biodiversity and impact assessment study, potential negative impacts due to activities of the proposed Project are likely to occur upon the main receiving receptor (the Mngubhudle catchment). The significance of impacts is predicted to be *Moderate* during the construction phase and reduced to *Very Low* upon implementation of mitigation measures; similarly, *Moderate* during the operational phase and reduced to *Low* and *Very Low* upon implementation of mitigation measures.

The WTP presents a solution for the treatment and discharge of acceptable quality water into the Adit Stream in the vicinity of the Nkomati Mine site. The WTP therefore has the benefit of providing a solution to the mine's stored water issue whilst ensuring that the water quality is acceptable for discharge resulting in maintaining of the health of the river system. Therefore, the predicted negative impacts of the WTP upon the receptors are out-weighed by the positive impacts. Thus no fatal flaws were identified during the current study and the proposed Project may proceed. Immediate implementation of the mitigation measures and the aquatic biomonitoring programme must be adhered to pre-construction, and throughout the operation phase to ensure that no deterioration of the associated watercourses occurs. The proposed Project should adopt a water and habitat quality preservation mindset throughout the life of the Project to prevent the deterioration of the aquatic ecosystems.

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1 INTRODUCTION

The Nkomati Mine operations ceased in February 2021. The mine is currently under care and maintenance, being managed towards closure. Since cessation of mining operations, the ability to reuse water has been severely curtailed. Due to the high rainfall within the catchment area, the mine has a positive water balance. The mine impacted water emanating from mining areas is diverted through to Pit 3 for containment. This is considered a feasible short-term option to avoid decant of the High Sulphide Return Water Dam (HS RWD), Onverwacht RWD and Pit 2 to the environment. The mine however currently now faces the challenge of Pit 3 decanting to the environment. Nkomati is therefore proposing to develop and install a mine Water Treatment Plant (WTP) (*hereafter the Project*)) with a proposed maximum daily treatment volume flow rate of 13 000 m^3/day.

The Project will consist of the following major components:

- Reverse osmosis WTP with a proposed maximum daily treatment volume flowrate of 13 000 m3/day;
- Collection system (pipelines) to pump water from the Pit to the WTP; and
- Distribution system (pipelines) for discharge of treated mine water into the Adit Stream.

WSP was appointed by Nkomati Mine to undertake the necessary ecological baseline surveys and impact assessment reports, in support of the environmental regulatory process required to authorise the proposed Project.

1.1 PURPOSE OF THE REPORT

This interim report describes the high flow baseline aquatic biodiversity within areas that will be impacted by the proposed Project. Potential impacts, positive or negative, were assessed and practical mitigation/management measures developed for inclusion in the Environmental Management Programme (EMPr). A low flow assessment is tentatively scheduled in May 2024, thereafter a consolidated report encompassing results from low flow and high flow seasons will be completed.

1.2 PROJECT LOCATION AND EXTENT

The Nkomati Mine is located approximately 30 km east of the town eNtokozweni (Machadodorp) at the edge of the escarpment within the Mpumalanga Province, South Africa and situated under the jurisdiction of the Albert Luthuli Local Municipality, which is in the Gert Sibande District Municipality. The Project area is surrounded by forest plantations operated by Mondi and Sappi. The project locality map is provided in Figure 1-1.

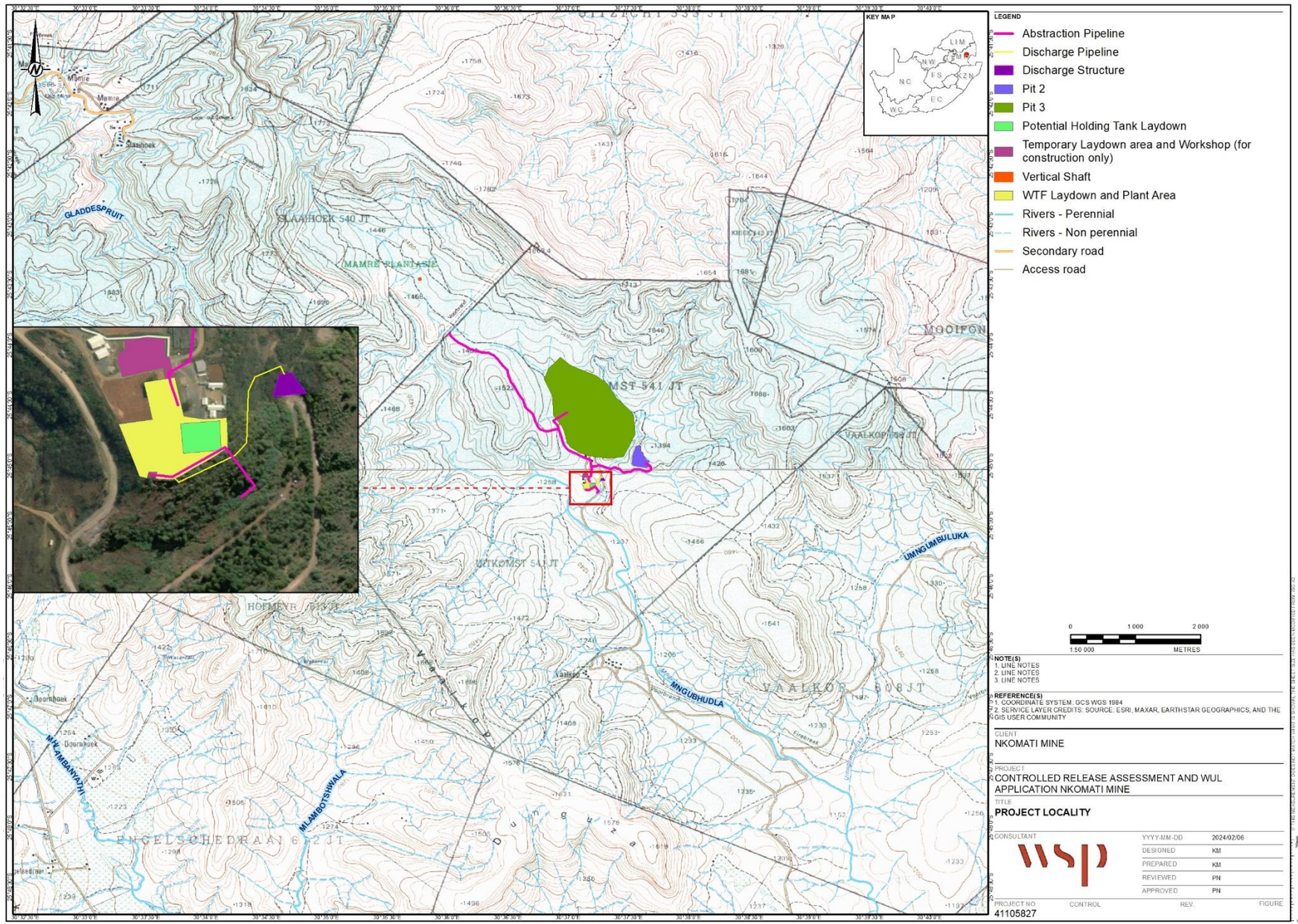

Figure 1-1 - Project locality Map

1.3 LEGAL REQUIREMENTS, STANDARDS AND GUIDELINES

The legislative context for aquatic ecology studies which applies to the proposed project are listed and discussed below.

- **National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)** – Section 24 (1)(a) and (b) states that "the potential impact on the environment and socio-economic conditions of activities that require authorisation or permission by law and which may significantly affect the environment must be considered, investigated and assessed before their implementation and reported to the organ of state charged by law with authorizing, permitting, or otherwise allowing the implementation of an activity.
- **National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA)** – The NEM:BA regulates the management and conservation of the biodiversity of South Africa within the framework provided under NEMA. This Act regulates the protection of species and ecosystems that require national protection and considers the management of alien and invasive species.
- **National Water Act (Act No. 27 of 2014) (NWA)** – The NWA aims to protect, use, develop, conserve, manage and control water resources including rivers, dams, wetlands, the surrounding land, groundwater, as well as human activities that influence them. The NWA intends to protect these water resources against over exploitation and to ensure that there is water for social and economic development and water for the future.
- **Mpumalanga Nature Conservation Management Act (Act No. 10 of 1998)** – aims to consolidate and amend the laws relating to nature conservation within the Province and to provide for matter connected therewith.

1.4 STUDY LIMITATIONS AND EXCLUSIONS

The following limitations and exclusions were expressed as part of the current assessment:

- A reference site upstream of the proposed WTP site could not be accessed due to the dense vegetation along the banks of the Adit Stream.
- Based on the DWS PESEIS data (DWS, 2014), the mainstem river within the Nkomati Mine catchment is named as the Mngubhudle River and not the Gladdespruit as reported in the previous aquatic biomonitoring report (SAS, 2023). The current report therefore refers to this river reach as the Mngubhudle.
- The PESEIS data for the Adit Stream was not available at the time of writing, therefore data for the Mngubhudle River was referred to.

1.5 DETAILS OF THE SPECIALIST

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Qualification:	M.Sc. Biodiversity and Conservation
Professional Affiliations:	**South African Council for Natural Scientific Professions (SACNASP)** *Pr.Sci.Nat*. – 119651 (Aquatic Science) **DWS accreditation** South African Scoring System (SASS5)

DECLARATION OF INDEPENDENCE BY SPECIALIST

I, Tebogo Khoza, declare that I –

- Act as the independent specialist in this application;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed;
- Do not have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity; and

Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document.

2 METHODOLOGY

This aquatic biodiversity and impact assessment took cognisance of Government Notice No. 320, published in 2020 under the National Environmental Management Act (1998) concerning 'Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Theme in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (1998), when applying for Environmental Authorisation'.

In line with the assessment and reporting requirements set out in the protocol, this report includes two main study components; a desktop literature review, supplemented by a field survey within the proposed development footprint and extended areas of influence. The objectives and tasks associated with these components are described below.

2.1 LITERATURE REVIEW AND GAP ANALYSIS

The aim of the desktop literature review component was to collate and review the extensive available ecological information related to important biodiversity and conservation features in the project area, key ecological processes and function, and the likely composition and structure of local aquatic fauna communities (specifically macroinvertebrates and fish).

The following sources were consulted for the desktop literature review:

- The Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Compiled by RQIS-RDM (DWS, 2014);
- Aquatic Biomonitoring of the Gladdespruit and its tributaries in the vicinity of the Nkomati Nickel mine (SAS, 2023);
- National spatial planning datasets were consulted to provide a regional/national context for assessing the biodiversity significance of the site, namely
    - The Mpumalanga Biodiversity Sector Plan (MBSP)
    - National Freshwater Ecosystem Priority Areas (NFEPA)
    - National Wetland Map 5 (NWM5)
    - Strategic Water Sources (SWS)
    - National Environmental Management Biodiversity Act (NEMBA) Threatened Ecosystems
    - National Protected Area Expansion Strategy (NPAES).

2.2 FIELD SURVEY

This section provides a brief description of the aquatic biodiversity study approach and methodologies utilised during the field surveys and the locations wherein the assessments were undertaken.

2.2.1 STUDY APROACH

To enable an adequate description of the aquatic environment and the determination of the present ecological state, the following stressor, habitat and response indicators were evaluated:

2.2.1.1 Water Quality

- *In situ* water quality assessment including temperature, pH, electrical conductivity, dissolved oxygen and comparison to applicable guideline values and identification of variables of potential concern.

2.2.1.2 Habitat Indicators

- General habitat assessment including site location (GPS coordinates), site photographs (for future identification of major changes and documentation of habitat conditions); and surrounding features such as land uses, potential sources of pollution, erosion etc;
- Index for Habitat Integrity (IHI): a rapid, visual assessment of modifications to a number of pre-selected biophysical drivers and used to determine the PES or Ecological Category of associated instream and riparian habitats; and
- Integrated Habitat Assessment System (IHAS, Version 2.2): This index evaluates habitat suitability specifically for aquatic macroinvertebrates and is used in conjunction with the South African Scoring System Version 5 (SASS5) index.

2.2.1.3 Response Indicators

- Aquatic macroinvertebrate assessment, including the determination of ecological condition through the South African Scoring System (SASS Version 5) and the Macro-Invertebrate Response Assessment Index (MIRAI);
- Ichthyological assessment, including the evaluation of reference conditions and determination ecological condition through the Fish Response Assessment Index (FRAI); and
- Determination of the integrated EcoStatus (EcoStatus 4, Version 1.02).

A detailed description of the aquatic biomonitoring methodologies used for the survey is provided in Appendix A.

2.2.2 MONITORING SITES

Selection of the monitoring sites was largely based on the previously undertaken aquatic biomonitoring assessment undertaken by Scientific Aquatic Services (SAS, 2023). A total of three sites were selected, a single site along the Adit Stream and two along the Mngubhudle River (formerly referred to as the Gladdespruit).

Site names, GPS coordinates and brief descriptions are provided in Table 2-1 and a map of the study area showing the location of the sampling sites is presented in Figure 2-1. Photographs showing the upstream and downstream views at each monitoring location are provided in Appendix B.

Table 2-1 - Location of the sampling points and brief descriptions

River	Site	GPS Co-ordinates	Site Description
Adit Stream	Site D	25°45'20.13"S 30°37'3.73"E	Located at a river crossing downstream of open pits and existing high sulphide tailings dam. Site serves as a downstream stream reference site for the proposed Project.

River	Site	GPS Co-ordinates	Site Description
Mngubhudle (formerly referred to as the Gladdespruit).	Site UP	25°45'14.56"S 30°37'0.79"E	Located at a river crossing approximately 250 m upstream of the confluence with the Adit Stream. Site serves as an upstream reference site for the proposed Project.
	Site G	25°45'30.53"S 30°37'10.62"E	Located at a river crossing approximately 400 m downstream of the confluence with the Adit Stream. Site serves as a downstream reference site for the proposed Project.

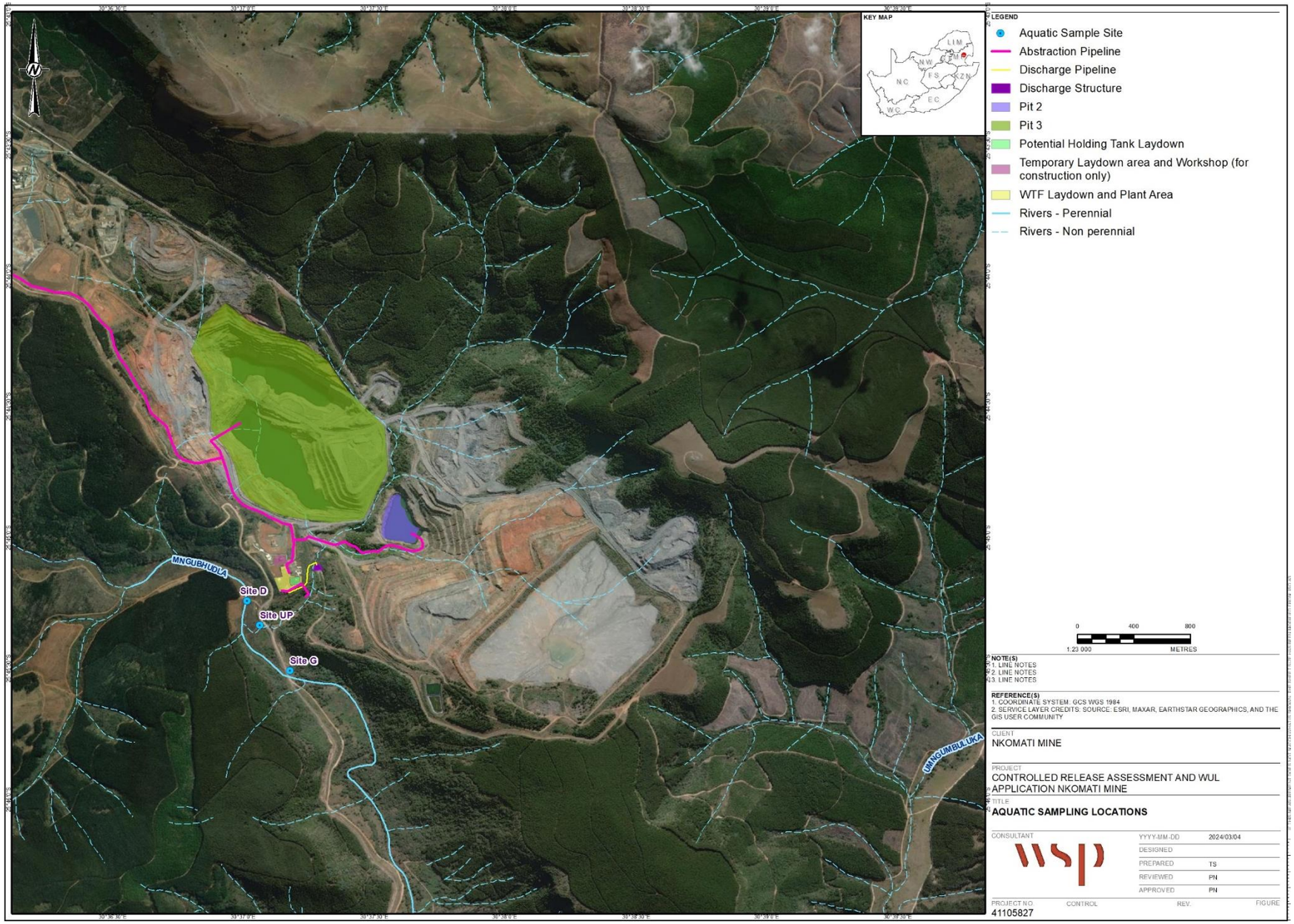


Figure 2-1 - Locations of the Aquatic Ecology sampling points

3 AQUATIC BIODIVERSITY DESKTOP ASSESSMENT

The following sections describe the physical and biological characteristics for the region within which proposed Project is located.

3.1 ASSOCIATED WATER RESOURCES

The proposed Project falls within the primary drainage region X of the Inkomati-Usuthu Water Management Area (WMA) and the X11J quaternary catchment. The Sub-Quaternary Reach (SQR) of focus is the Mngubhudle River (X11J-01106). This is a first order stream with an approximate length of 38 km. Figure 3-1 presents the quaternary catchments and freshwater resources associated with the proposed Project.

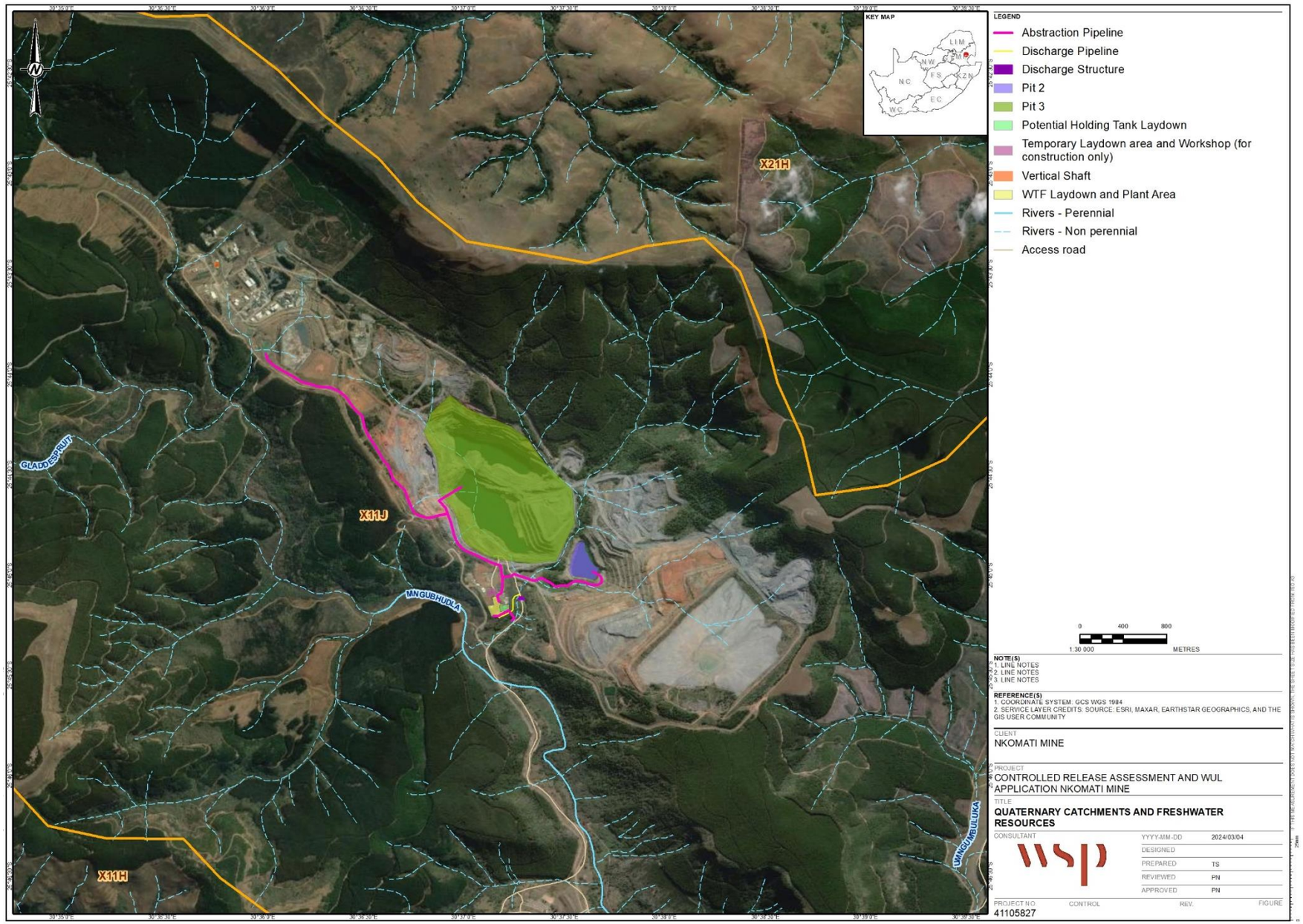


Figure 3-1 - Quaternary catchments and freshwater resources associated with the proposed Project

3.2 REGIONAL BIODIVERSITY CONTEXT

3.2.1 FRESHWATER ECOREGIONS

Ecoregions are regions characterised by a relative similarity in the type of ecosystems and ecosystem components, i.e. biotic and abiotic. The project area is located within the Zambezian Lowveld freshwater ecoregion. This ecoregion is defined by low-lying portions of the coastal rivers south of the Zambezi Delta to Lake St Lucia (Abell *et al*., 2008; Darwall *et al.* 2009).

3.2.2 NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREAS

The National Freshwater Ecosystem Priority Areas (NFEPA) project represents a collaboration of multiple organisations including the South African National Biodiversity Institute (SANBI), Council for Scientific and Industrial Research (CSIR), Water Research Commission (WRC), Department of Environmental Affairs (DEA), Department of Water and Sanitation (DWS), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). (Water Research Commision, 2011).

The project is aimed to "*provide guidance on how many rivers, wetlands and estuaries, and which ones should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998), the National Environmental Management: Biodiversity Act (Act 10 of 2004) and the National Environmental Management: Protected Areas Act (Act 57 of 2003)*" (Water Research Commision, 2011).

Based on the current outputs of the NFEPA project (Water Research Commision, 2011), there are no NFEPA features within the catchment of focus (Figure 3-2). An area marked as "River FEPA & associated sub-quarternary catchment" occurs within the X21H Ngodwana catchment approximately 2km to the north of the project site. River FEPAs achieve biodiversity targets for river ecosystems and threatened/near threatened fish species, and were identified in rivers that are currently in a good condition (A or B ecological category). Their FEPA status indicates that they should remain in a good condition in order to contribute to national biodiversity goals and support sustainable use of water resources.

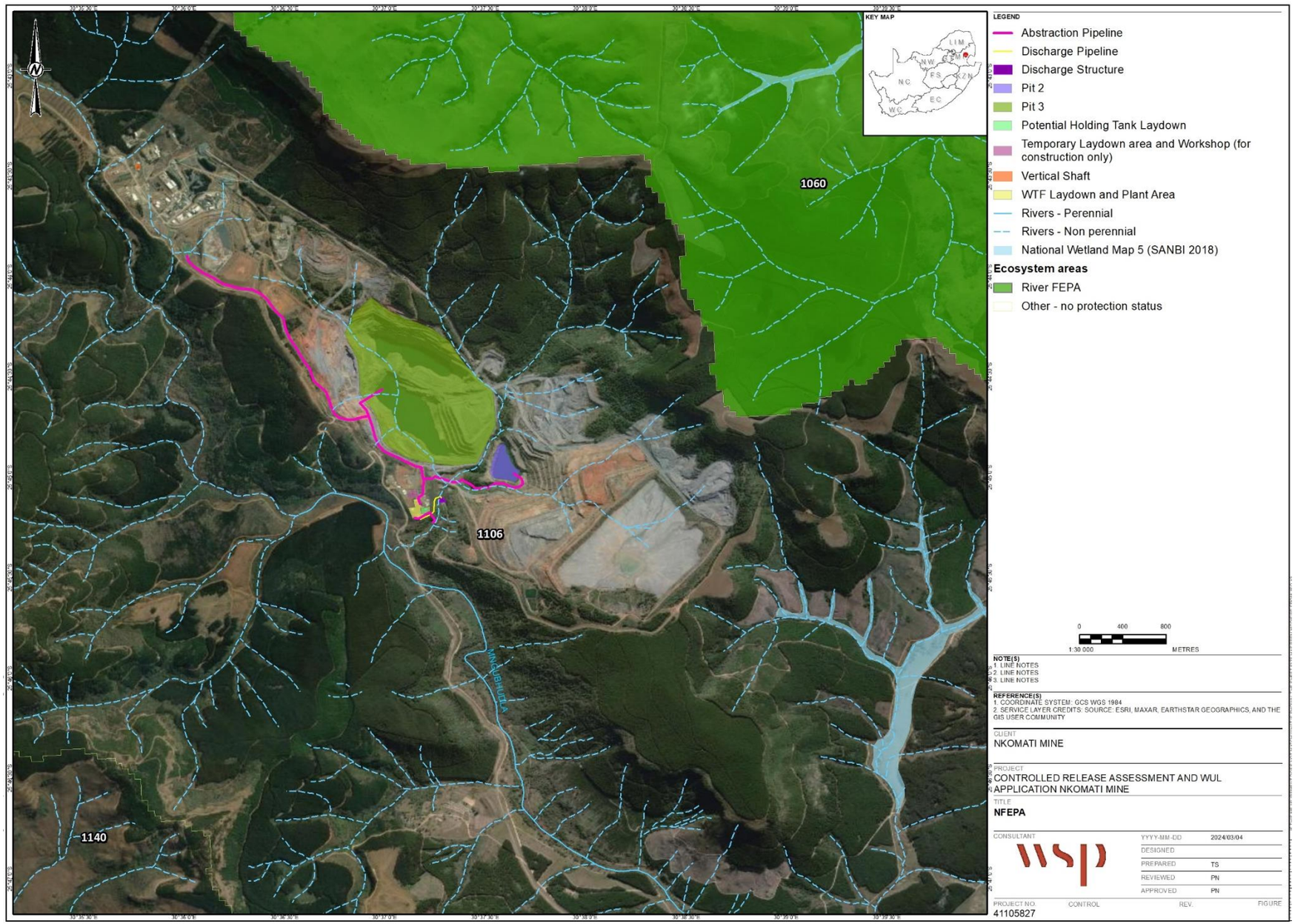


Figure 3-2 - Project Areas relative to the NFEPA features Map

3.2.3 MPUMALANGA BIODIVERSITY SECTOR PLAN

The Mpumalanga Biodiversity Sector Plan (MBSP) is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for national legislation and policy. The MBSP was published in 2014 by the Mpumalanga Tourism and Parks Agency (MTPA) and comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines for use in land-use and development planning, environmental assessment and regulation, and natural resource management. Strategically the MBSP enables the province to:

- Implement the NEM:BA, 2004 provincially, and comply with requirements of the National Biodiversity Framework, 2009 (NBF) and certain international conventions.
- Identify those areas of highest biodiversity that need to be considered in provincial planning initiatives; and
- Address threat of climate change (ecosystem-based adaptation).

The publication includes terrestrial and freshwater biodiversity areas that are mapped and classified in Protected Areas (PAs), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) or Other Natural Areas (ONAs) (MTPA, 2014).

The Project Area lie within an area mapped as *Heavily Modified* whilst the Mngubhudle River reach of focus has been mapped as *Other Natural Areas* (Figure 3-3). Definitions and management objectives of these categories are provided in Table 3-1.

Table 3-1: Mpumalanga Biodiversity Sector Plan Categories Associated with the proposed Project, as well as recommended Land Management Objectives

Category*	Description	Land Management Objective
Other Natural Areas	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been prioritized for biodiversity, they are still an important part of the natural ecosystem.	An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some authorisation may still be required for high-impact land-uses.
Heavily or Moderately Modified Areas	Areas that have been modified by human activity to the extent that they are no longer natural, and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructural functions, even if they are never prioritized for conservation action.	Such areas offer the most flexibility regarding potential land-uses, but these should be managed in a biodiversity-sensitive manner, aiming to maximize ecological functionality and authorization is still required for high-impact land-uses. Moderately modified areas (old lands) should be stabilized and restored where possible, especially for soil carbon and water-related functionality.

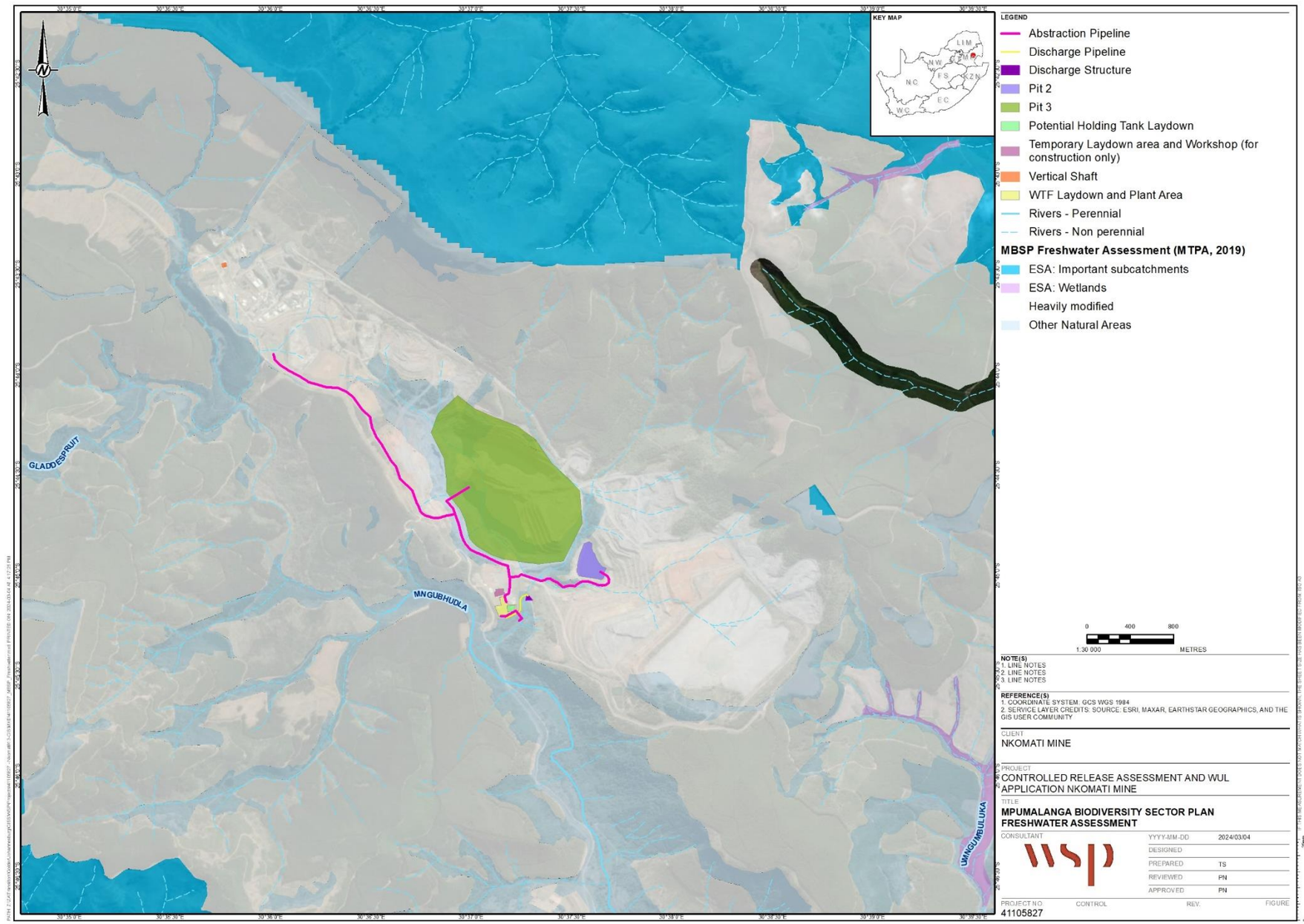


Figure 3-3 - Mpumalanga Biodiversity Sector Plan Map for freshwater resources

3.2.4 PRESENT ECOLOGICAL STATE, IMPORTANCE AND SENSITIVITY

The Present Ecological Status (PES) for the Mngubhudle River (SQR X11J-01106) is *Largely Modified* (Ecological Category D) with an Ecological Importance (EI) class of *High* and an Ecological Sensitivity (ES) class of *Very High.* This SQR is expected to host a total of 54 aquatic macroinvertebrates taxa and 9 fish species. The following are impacts and respective significance affecting the SQR (DWS, 2016):

- Serious/Abundant – Forestry;
- Large – Abstraction, runoff/effluent, Mining;
- Moderate – Algal growth, bed and channel disturbance, alien vegetation, roads, sedimentation, vegetation removal; and
- Small – Low water crossing, farm dams, erosion, inundation.

3.2.4.1 Expected Aquatic Macroinvertebrate Taxa and Fish Species

The expected macroinvertebrate community assemblage is comprised of taxa with a wide variety of tolerance/sensitivity to water quality and flow conditions (Table 3-2).

Table 3-2 – Expected aquatic macroinvertebrates and their tolerance ratings to water quality and velocity conditions

Family Names		
Turbellaria[1,c]	Crambidae (Pyralidae)[4,d]	Helodidae[4,a]
Oligochaeta[1,a]	Belostomatidae[1,b]	Hydraenidae[2,b]
Potamonautidae[1,c]	Corixidae[1,b]	Hydrophilidae[1,a]
Hydracarina[2,a]	Gerridae[1,b]	Psephenidae[3,d]
Baetidae > 2 sp[4,a]	Hydrometridae[2,b]	Athericidae[3,a]
Caenidae[2,b]	Naucoridae[2,c]	Ceratopogonidae[1,b]
Leptophlebiidae[3,b]	Nepidae[1,b]	Chironomidae[1,a]
Tricorythidae[3,e]	Notonectidae[1,b]	Culicidae[1,b]
Chlorocyphidae[3,b]	Pleidae[1,b]	Dixidae[3,b]
Synlestidae/Chlorolestidae[2,b]	Veliidae/mesoveliidae[1,b]	Muscidae[1,a]
Coenagrionidae[1,c]	Hydropsychidae 2 sp[2,d]	Simuliidae[1,c]
Lestidae[2,b]	Philopotamidae[3,d]	Tabanidae[1,b]
Platycnemidae[3,b]	Hydroptilidae[3,c]	Tipulidae[1,b]
Protoneuridae[2,b]	Lepidostomatidae[3,c]	Ancylidae[2,a]
Aeshnidae[2,a]	Leptoceridae[2,c]	Lymnaeidae[1,b]
Corduliidae[2,b]	Dytiscidae[1,b]	Physidae[1,b]
Gomphidae[2,c]	Elmidae/dryopidae[2,d]	Planorbinae[1,b]
Libellulidae[1,c]	Gyrinidae[1,c]	Sphaeriidae[1,b]
Superscript definitions: Sensitivity toward water quality modifications: 1=Tolerant; 2=Moderately Tolerant; 3=Moderately Intolerant; 4=Intolerant Sensitivity toward no-flow conditions: A=Tolerant; B=Moderately Tolerant; C=Moderately Intolerant; D=Intolerant		

The expected fish species for the Mngubhudle River (SQR X11J-01106) are presented in Table 3-3 (DWS, 2014).

The nine expected fish species are classified as Least Concern (LC) according to the IUCN Red List of Threatened Species. These species' tolerances to water quality modifications and no-flow conditions are as follows:

- Five are intolerant to water quality modifications and no-flow conditions;
- Two are moderately tolerant to water quality modifications and moderately intolerant to no-flow conditions;
- One species (*Enteromius anoplus*) is moderately tolerant to water quality modifications and to no-flow conditions; and
- One species is (*Clarias gariepinus*) tolerant to water quality modifications and to no-flow conditions.

Table 3-3 – Expected fish species, their conservation status and tolerance to water quality and flow conditions

Fish Species	Common Name	IUCN Status	Tolerance to modifications	
			Water Quality	No-Flow
Amphilius natalensis	Natal Mountain Catfish	Least Concern	Intolerant	Intolerant
Amphilius uranoscopus	Common Mountain Catfish	Least Concern	Intolerant	Intolerant
Chiloglanis pretoriae	Shortspine suckermouth	Least Concern	Intolerant	Intolerant
Clarias gariepinus	Sharptooth catfish	Least Concern	Tolerant	Tolerant
Enteromius anoplus	Chubbyhead Barb	Least Concern	Moderately Tolerant	Moderately Tolerant
Labeobarbus marequensis	Largescale yellowfish	Least Concern	Moderately Tolerant	Moderately Intolerant
Labeobarbus polylepis	Bushveld Smallscale Yellowfish	Least Concern	Moderately Tolerant	Moderately Intolerant
Pseudocrenilabrus philander	Southern Mouthbrooder	Least Concern	Intolerant	Intolerant
Tilapia sparrmanii	Banded Tilapia	Least Concern	Intolerant	Intolerant

4 RESULTS AND DISCUSSION

Results for the aquatic biomonitoring assessment undertaken on the 30th of November 2023 are discussed in the below sub-sections.

The results have been presented from upstream site to downstream site for ease of interpretation. Where possible, the collected data is compared against findings from the previously undertaken aquatic biomonitoring assessment (SAS, 2023).

4.1 FLOW CONDITIONS AND GENERAL HABITAT OBSERVATIONS

Flow conditions influence the processes that determine the size, shape, structure and dynamics of the aquatic ecosystems, and subsequently linked to habitats and biotic communities (Thoms & Thoms, 2006). Thus flow conditions and water levels aid in the interpretation of biological results.

The assessed upstream (site UP) section of the Mngubhudle River was wide (>2-5 meters), with a variable stream depth (<0.5 to 1.5 meters) and characterized by moderate flow above the culvert and fast flow below the culvert (Figure 4-1). The Adit Stream was predominantly narrow (<1 meter) and shallow (<0.5 meters) and characterized by fast flow above the culvert and moderate flow below the culvert (Figure 4-2). The Mngubhudle River downstream site G was characterized by variable stream width (<0.5 to 5 meters) and depth (<0.5 to 2 meters) with moderate flow above the culvert and fast flow below (Figure 4-3). It is worth noting that the project area had received significant rain the day before the field survey was conducted.

Habitat characteristics at the assessed Mngubhudle River sites were similar. Both upstream and downstream sites were dominated by cobbles and sand. There was a lack of instream aquatic vegetation, however the vegetation cover along the stream banks was high and composed of grasses and trees. The assessed Adit Stream was dominated by gravel and lacked instream aquatic vegetation however the vegetation cover along the stream banks was high and composed of grasses and trees.

There were no recent impacts observed at the time of the survey (other than the flood conditions). Existing impacts include forestry plantations, vegetation removal adjacent the roads and road crossings.

Figure 4-1 - Predominant flow conditions at the assessed Mngubhudle River upstream site UP. Moderate flows (left) and fast flows (right)

Figure 4-2 - Predominant flow conditions at the assessed Adit Stream site D. Fast flows (left) and moderate flows (right)

Figure 4-3 - Predominant flow conditions at the assessed Mngubhudle River downstream site G. Moderate flows (left) and fast flows (right)

4.2 *IN SITU* WATER QUALITY

The variables temperature, pH, electrical conductivity and dissolved oxygen were measured onsite by means of portable water meters. The obtained data were referenced against various water quality guidelines shown in Table 4-1 and the results are presented in Table 4-2.

These data are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms, and provide an indication of the physico-chemical status of the water at a sampling site at the time of the survey.

Table 4-1 - Sources for the recommended water quality guidelines for aquatic ecosystems

Variable	Source	Guideline limit
Temperature	South African Water Quality Guidelines: *Aquatic Ecosystems (Volume 7)* (Department Of Water Affairs And Forestry, 1996)	5 – 30 ˚C
pH		6 – 8
Dissolved Oxygen % Saturation		80 – 120 %
Dissolved Oxygen concentration	Minimum Dissolved Oxygen concentration for aquatic macroinvertebrates (Nebeker et al., 1996)	> 5 mg/ℓ
Electrical Conductivity	Conductivity guideline value of 500 µS/cm stipulated in U.S. U.S. Environmental Protection Agency (2010)	< 500

Each of the assessed parameters remained within the recommended target water quality range (TWQR) throughout the sites except the electrical conductivity (EC) at site D (Adit Stream site). The EC recorded at this site (1952 µS/cm) was considerably higher compared to the two sites along the Mngubhudle River (234 µS/cm at site UP and 328 µS/cm at site G). This elevated EC was likely linked to the upstream mine facilities which include the open pits (pit 2 and pit 3) and tailings dam. The TWQR of 500 µS/cm was significantly exceeded, thus expected to negatively impact aquatic biota within this system and the downstream reaches as can be seen by the slight increase in EC below the confluence with the Mngubhudle River (at site G). However the EC at site G remained within the TWQR which indicates that the low EC water coming from the upstream site UP aided in diluting the

elevated-EC water coming from the Adit Stream. It is however worth noting that the low EC along the Mngubhudle River may have been driven by rain water prior to the survey. Therefore, the elevated EC at the Adit Stream may potentially negatively impact the EC levels within the Mngubhudle River below the confluence during dry season periods.

The pH levels were neutral at the Mngubhudle River sites and marginally acidic at the Adit Stream, however all remained within the TWQR. The dissolved oxygen levels were similar throughout the sites and recorded within the TWQR. The abundance of cobbles and gravel within these systems results in white water riffles and rapids which facilitate the entrapment of dissolved oxygen from the atmosphere.

Therefore aquatic biota were not expected to be deterred due to water quality modifications at the Mngubhudle River. The elevated EC at the Adit Stream was expected to negatively impact aquatic biota.

Table 4-2 – *In situ* water quality data

Sites	Time	Temp. (ºC)	pH	EC (µS/m)	DO (mg/ℓ)	DO (%)
TWQR	**-**	**5 - 30º**	**6 – 8**	**<500**	**>5.0**	**80 - 120**
Site UP	14h00	21.6	7.00	234	7.52	94.0
Site D	12h30	21.8	6.34	**1952**	7.44	94.6
Site G	10h00	19.6	7.03	328	7.58	95.8
EC = Electrical Conductivity; DO = Dissolved Oxygen						

4.3 HABITAT ASSESSMENT

Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason, habitat evaluation is conducted simultaneously with biological evaluations in order to facilitate the interpretation of results (Ollis et al., 2006). The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore, assessment of the habitat is critical to any assessment of ecological integrity.

In the current study, the instream and riparian habitat assessment was based on the Index of Habitat Integrity (IHI) and the aquatic macroinvertebrate habitat integrity was based on the Integrated Habitat Assessment System (IHAS).

4.3.1 INDEX OF HABITAT INTEGRITY (IHI)

Results from the Index of Habitat Integrity (IHI) are presented in Table 4-3. The IHI is a tool developed to asses river habitat integrity and forms part of the River EcoStatus Monitoring Program (REMP) (Kleynhans, 2007a).

A desktop level and reach-based IHI was applied in the current study due to the small number of sampling sites per river reach. Observations made during the field survey were used to supplement the data used within the index.

Findings from the IHI indicate that the instream and riparian habitat integrity within the assessed Mngubhudle reach were *Largely Natural* (Ecological Category B) and *Largely Modified* (Ecological Category D) respectively. The major impacts within this system were indigenous vegetation removal,

exotic vegetation encroachment, channel modification and inundation due to the presence of culverts and the flood conditions at the time of the survey.

The instream and riparian habitat integrity within the assessed Adit Stream were *Largely Modified* (Ecological Category D) and *Seriously Modified* (Ecological Category E) respectively. Major impacts within this system were water quality modification (as indicated by elevated EC level of 1952 µS/cm), Flow and stream bed modification, indigenous vegetation removal and exotic vegetation encroachment.

Table 4-3 - Reach-based Index of Habitat Integrity scores obtained during the current survey

Watercourse	Habitat Component	IHI Score	Category	Major Impacts
Mngubhudle	In-stream	80.5	B	Channel modification and inundation
	Riparian	57.2	D	Indigenous vegetation removal and exotic vegetation encroachment
Adit	In-stream	47.3	D	Water quality modification and channel modification
	Riparian	38.2	E	Indigenous vegetation removal and exotic vegetation encroachment

4.4 AQUATIC MACROINVERTEBRATE ASSESSMENT

The following sections provide insight on the data collected as part of the aquatic macroinvertebrate assessment. The South African Scoring System (SASS, Version 5) and available habitat (Invertebrate Habitat Assessment System) that was sampled at each of the accessed sites, as well as the subsequent determination of the ecological condition of the observed assemblages in relation to reference conditions (Macroinvertebrate Response Assessment Index) are discussed.

4.4.1 INTEGRATED HABITAT ASSESSMENT SYSTEM

The Integrated Habitat Assessment System (IHAS) was developed by McMillan (1998) for use in conjunction with the South African Scoring System (SASS5) bioassessment. Results from the current study are provided in Table 4-4.

The assessed ecosystems lie within the upper foothills geomorphological zone (class D). Characteristic channel features within this geomorphological zone include moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present (Rowntree et al., 2000).

Based on the obtained IHAS scores, sites D and G presented *Good* macroinvertebrate habitat availability, whilst site UP presented *Adequate* habitat availability. Each of the sites exhibited a variety of habitat features within various flow and depth profiles, therefore expected to host macroinvertebrate assemblages comprising of high diversity of taxa especially at sites D and G.

Table 4-4 - Integrated Habitat Assessment System scores

Site	Sampling Habitat				IHAS	
	Stones-in-Current	Vegetation	Other Habitat / General	Physical Stream Condition	Score	Description
Site UP	11	7	16	25	59	Adequate
Site D	18	5	16	36	75	Good
Site G	20	10	14	31	75	Good
Maximum possible scores for Stones-in-Current = 20; Vegetation = 15; Other Habitat/General = 20; Physical Stream Condition = 45						

4.4.2 AQUATIC MACROINVERTEBRATES: ECOLOGICAL CONDITION

The SASS5 protocol was conducted to sample macroinvertebrates. This protocol provides a general indication of the current state of the macroinvertebrate community and subsequently the 'health' of the river ((Dickens & Graham, 2002). The collected SASS5 data is provided in Table 4-5 and discussed below.

A total of 20 (out of the expected 54 taxa) aquatic macroinvertebrate taxa were collected from the three assessed sites. The number of taxa collected ranged from nine at site D to eleven at site G. The collected macroinvertebrate assemblages were dominated by pollution-tolerant taxa (i.e., with a SASS5 sensitivity score of less than seven) with only two taxa that are moderately tolerant to pollution (Lestidae and Aeshnidae) recorded, both of which were collected at site G and only Aeshnidae as collected at site A.

Table 4-5 – SASS5 data for the current survey

Site	SASS5	# of Taxa	ASPT
Site UP	48	10	4.8
Site D	40	9	4.4
Site G	55	11	5

The SASS5 data obtained was used in the MIRAI (Thirion, 2008) to determine the Present Ecological State (PES, or Ecological Category) of the associated macroinvertebrate assemblage. The MIRAI provides a habitat-based cause-and-effect basis to interpret the deviation of the aquatic macroinvertebrate community from the reference condition. Results for the site-based MIRAI are shown in Table 4-6. These results should be interpreted with caution as the flood conditions may have altered the macroinvertebrate community distribution, with some being washed off into downstream reaches for example, and the collected sample

Based on the MIRAI, the ecological condition of the aquatic macroinvertebrate communities was *Critically Modified* (Ecological Category F) at each of the assessed sites. The modified states recorded were as a result of the change from reference conditions, especially within the water quality metric and the overall low diversity present within the assessed systems. Furthermore, the historic and on-going land use activities (mainly mining and forest plantations) within the study area have significantly impacted the receiving environment and subsequently the indigenous fauna and flora including aquatic biota.

Table 4-6 – MIRAI data for the current survey

Site	Metric Group	% change from Reference	MIRAI Value	EC	Description
Site UP	Flow Modification	88	11.7	**F**	Critically Modified
	Habitat	88			
	Water Quality	90			
Site D	Flow Modification	85	16.7	**F**	Critically Modified
	Habitat	83			
	Water Quality	82			
Site G	Flow Modification	81	16.2	**F**	Critically Modified
	Habitat	84			
	Water Quality	88			
EC = Ecological Category					

4.5 ICHTHYOFAUNA

The composition of fish communities is often altered by anthropogenic activities in the catchment. Changes in water quality, flows and habitat can result in the absence or addition of species, ultimately altering the biotic integrity of the system. Thus, fish can effectively give an indication into the degree of modification of the aquatic environment.

Fish sampling was undertaken by means of the electroshocking technique at each site however a single species (*Chiloglanis pretoriae* or Shortspine Suckermouth) was collected at site G only. This species is known to occur in shallow rocky reaches, riffles and rapids wherein it uses its large ventrally directed mouth to cling to stones, and feeds on aquatic macroinvertebrates such as mayfly, caddis fly and blackfly larvae (Le Roux & Steyn, 1968; Skelton, 2001). According to the IUCN Red List of Threatened Species (IUCN, 2023), this fish is categorized as Least Concern, however the population trend is unknown and identified threats include residential and commercial development, natural system modifications and pollution. Photographs of the collected specimen are provided in Figure 4-4.

Figure 4-4 - Photograph of *Chiloglanis pretoriae* taken during the current survey. Bottom photo showing the mouth parts

4.5.1 BIOTIC INTEGRITY BASED ON FISH COMMUNITIES

The Fish Response Assessment Index (FRAI) was applied to determine the ecological integrity of the fish community assemblages within the monitoring sites for the current study. The FRAI forms part of the River EcoStatus Monitoring Programme (REMP) which replaced the River Health Programme (RHP) in 2016 and is a component of the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) (Kleynhans, 2007b).

The FRAI is based on a combination of fish species habitat preferences, as well as intolerance to habitat changes, and the present frequency of occurrence (FROC) of species compared to the reference FROC (Kleynhans, 2007b), thus provides a cause-and-effect basis to interpret the deviation of the fish assemblage from the reference condition.

4.5.1.1 Fish habitat potential assessment

Fish habitat potential refers to the presence and abundance of suitable conditions for fish to inhabit, depending on the expected species' preferences for the particular river reach. The considered habitat metric groups are velocity-depth and cover – with five types of cover within each of the four velocity-depth classes (Table 4-7).

Table 4-7 - Fish habitat potential assessment metric groups

Slow-Deep	Slow-Shallow	Fast-Deep	Fast-Shallow
Overhanging veg.	Overhanging veg.	Overhanging veg.	Overhanging veg.
Undercut banks	Undercut banks	Undercut banks	Undercut banks
Substrate	Substrate	Substrate	Substrate
Aquatic veg.	Aquatic veg.	Aquatic veg.	Aquatic veg.
Water column	Water column	Water column	Water column

The sampled fish habitat potential was rated between 0 to 5 (1 = rare; 2 = sparse; 3 = common; 4 = abundant; 5 = very abundant) at each of the assessed sites (Figure 4-5) and these were considered in the determination of the expected frequency of occurrence (FROC) for each fish species.

The dominant fish habitat cover types were as follows:

- Substrate and water column within the fast shallow and fast deep velocity-depth classes at site UP;
- Overhanging vegetation and substrate within the slow shallow and fast shallow velocity-depth classes at site D;
- Overhanging vegetation, substrate and water column within the slow deep and fast deep velocity-depth classes at site G.

Thus, the expected fish species were largely those with a preference for the available habitat types within each of the river reaches.

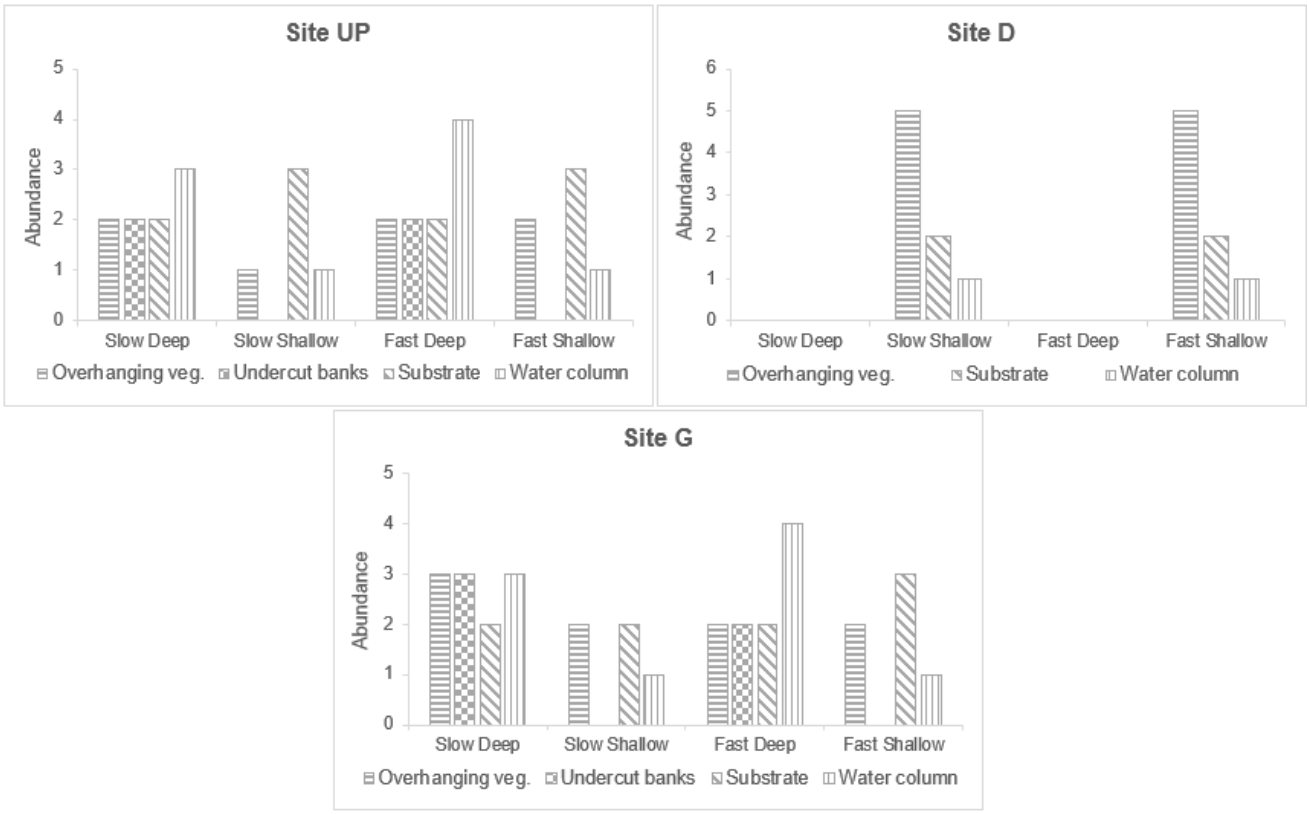


Figure 4-5 - Fish habitat metric group abundances at each site

4.5.1.2 Fish Response Assessment Index (FRAI)

The FRAI Index is based on a combination of fish species habitat preferences as well as intolerance to habitat changes, and the present/observed frequency of occurrence (FROC) of species compared to the reference FROC (Kleynhans et al., 2007).

The FRAI-based Present Ecological State (PES) for the assessed sites is provided in (Table 4-8). Ratings for the FROC were based on the species habitat preferences. Each site was characterised by suitable fish habitat and all nine species reported to occur within the catchment (Table 3-3) were expected at the time of the current survey. None of these species were collected at sites UP and D whilst a single species was collected at site G. The subsequent Ecological Categories were *Critically Modified* at sites UP and D and *Seriously Modified* at site G.

The absence of fish communities at the accessed sites was likely attributed to cumulative impacts associated with historical land use activities, mainly mining and forestry. The collected species are known to be congregatory however a single specimen was collected, thus it is suspected to have been displaced from upstream reaches to site G due to the flash flood which occurred several hours prior to the survey.

Table 4-8 - FRAI results for the assessed river reaches

Site	FRAI Score	Ecological Category	Description
Site UP	20.0	**E/F**	Critically Modified
Site D	20.0	**E/F**	Critically Modified
Site G	25.7	**E**	Seriously Modified

4.6 INTEGRATED ECOSTATUS DETERMINATION

The EcoStatus is defined as: "*The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services*" (Iversen *et al*., 2000). Thus the EcoStatus represents an integrated ecological state representing the drivers (hydro-morphology and physico-chemical) and responses (riparian vegetation, aquatic invertebrates and fish; Kleynhans & Louw, 2008). The integrated EcoStatus for the sampled sites are presented in Table 4-9.

Following integration of the defined ecological conditions obtained for the riparian component (i.e. IHI from riparian vegetation assessment) and the instream biological integrity (i.e. MIRAI from aquatic invertebrates and FRAI from fish), it was determined that sites UP and D represented an integrated EcoStatus of *Seriously Modified* conditions and site G *Largely to Seriously Modified* conditions.

In relation to the Recommended Ecological Category (REC) of *Largely Modified* (EC of D) – gazetted in April 2016 (*Classes of water resources and resource quality objectives for the catchments of the Inkomati in Terms of Section 13(1) and 63(1)(a) of the National Water Act, 1998 (Act No.36 of 1998)*, the assessed river reaches were observed to have deteriorated.

Table 4-9 – Integrated EcoStatus categories for the current study – EcoStatus version 1.02 (Kleynhans and Louw, 2007)

Site	Response Indices				EcoStatus	
	Riparian Vegetation EC (IHI)	MIRAI EC	FRAI EC	Instream EC	Score	Category
Site UP	57.2	11.7	20.0	14.9	37.5	**E**
Site D	38.2	16.7	20.0	18.0	28.8	**E**
Site G	57.2	16.2	25.7	19.8	39.8	**D/E**

5 SCREENING OF POTENTIAL IMPACTS

This section identifies and assesses the significance of the impacts likely to arise during the proposed activities and provide a short description of the mitigation required to limit the magnitude of the potential impact on the aquatic biodiversity receptors.

The proposed Project activities and placement of infrastructure to be considered as part of the impact assessment are listed below.

- Reverse osmosis WTP with a proposed maximum daily treatment volume flowrate of 13 000 m^3/day;
- Collection system (pipelines) to pump water from the Pit to the WTP; and
- Distribution system (pipelines) for discharge of treated mine water into the Adit Stream.

A map showing the location of the WTP and associated infrastructure is provided in Figure 5-1. The proposed activities which could potentially impact on the aquatic biodiversity receptors are indicated in Table 5-1.

Table 5-1 – Project activities per phase

Phase	Activity
Construction	▪ Bush clearing and soil disturbance ▪ Bulk earthworks ▪ Development of required service infrastructure on the site ▪ Site establishment ▪ Construction of project components (WTP and pipelines)
Operational	▪ Maintenance of infrastructure (e.g. access roads) ▪ Vegetation management around the WTP and pipelines ▪ Handling and disposal of general and hazardous waste ▪ Discharge of treated mine water into the Adit Stream (13 000 m^3/day)
Decommissioning	▪ Removal of infrastructure and rehabilitation activities

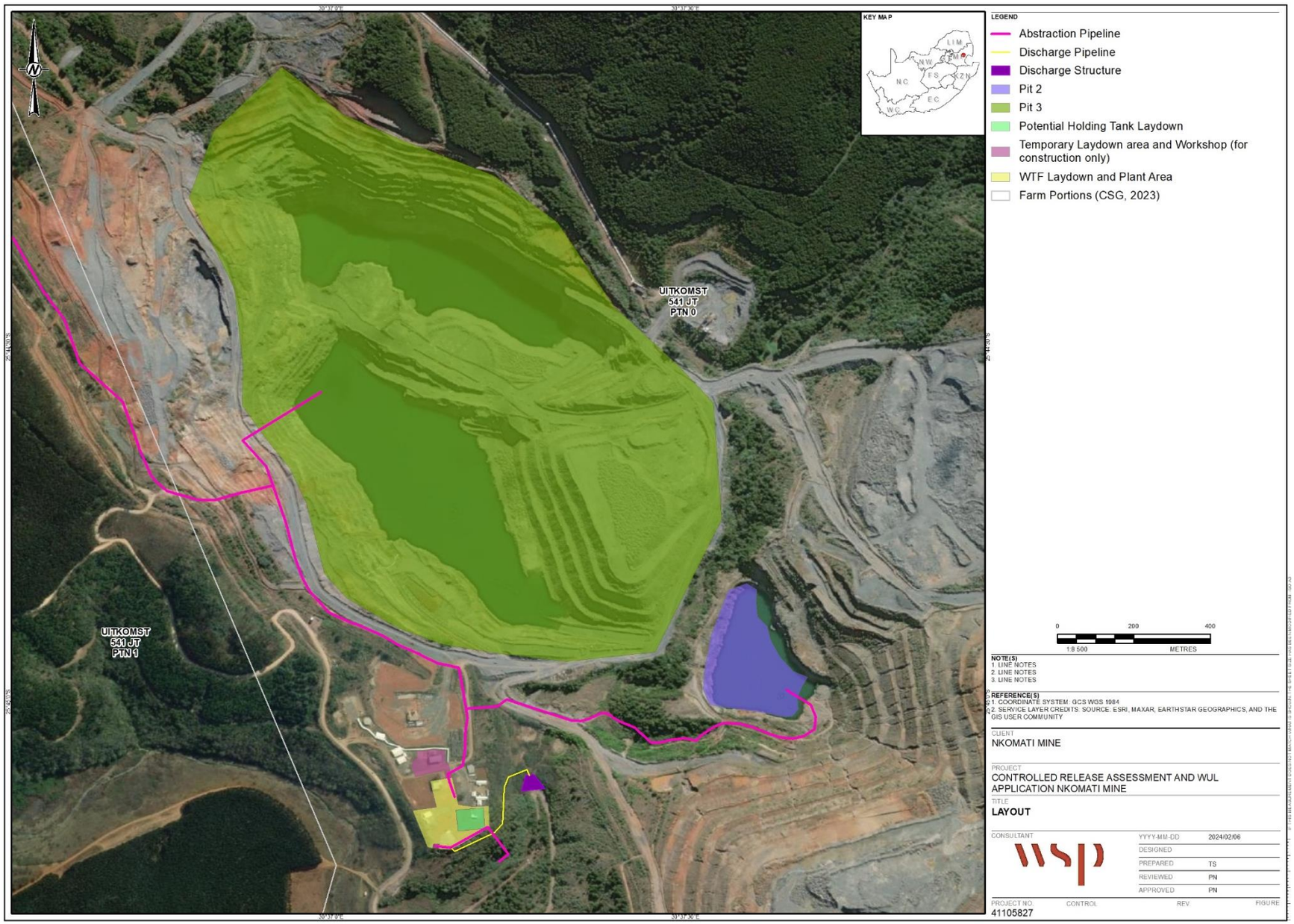


Figure 5-1 - Project Layout Map

5.1 RECEPTORS

The proposed location of the WTP is in close proximity to the Adit Stream with an approximate distance of 100m. Similarly, the proposed discharge structure will be placed to discharge into this stream. The Adit Stream flows for approximately 700 meters before draining into the Mngubhudle River. Therefore the main foreseeable receptors of impact are the Adit Stream and the Mngubhudle catchment.

5.2 CONSTRUCTION PHASE

The main foreseeable aquatic-related impacts associated with the construction phase are vegetation clearing, soil disturbance and the establishment of infrastructure. Vegetation clearing and soil disturbances result in bare land which increase surface runoff, erosion and subsequently the amount of suspended and dissolved solids and potentially pollutants from the construction site and or areas down gradient of the construction site (hazardous substances from unearthed soil, cement, and concrete composites) entering the associated watercourses. Similarly, the main impact associated with the establishment of infrastructure, is the mobilization of pollutants that reach associated watercourses.

5.2.1 IMPACT DESCRIPTION

Erosion and runoff into the associated aquatic ecosystems can result in increased sedimentation and degradation of habitat. This can directly alter aquatic habitats after deposition (Wood & Armitage, 1997), which in turn will negatively impact biotic community structures by displacing biota that favour the affected habitat. Suspended solids can also directly impact aquatic biota through the accumulation of silt on respiratory organs (i.e. gills) and by decreasing visibility (i.e. increasing turbidity), which will affect feeding habits of specific taxa. Erosion and runoff from cleared land can also alter water quality by increasing turbidity, as aforementioned, and by increasing the number of contaminants entering the watercourses. This is expected to alter the physio-chemistry of water and deter water quality sensitive biota.

Vegetation clearing near watercourses can result in the introduction of alien invasive species (both fauna and flora) which often negatively impact indigenous species. This can lead to the loss of invertebrates such as dragonflies, which in turn, has the potential to alter biological community structure. Most alien invasive trees are taller and characterised by a greater root depth and are responsible for the increased uptake of water thereby decreasing both surface water runoff and groundwater recharge. This can significantly affect hydrological conditions and river flows.

5.2.2 MITIGATION MEASURES

The following impact mitigation and management measures are recommended to avoid/minimise potential impacts on the watercourse arising from the construction activities:

- Limit vegetation removal to the infrastructure footprint area only. Where removed or damaged, vegetation areas (riparian or aquatic related) should be revegetated as soon as possible;

- Bare land surfaces downstream of construction activities must be vegetated to limit erosion from the expected increase in surface runoff from infrastructure;
- Environmentally friendly barrier systems, such as silt nets or, in severe cases, use trenches downstream from construction sites to limit erosion and possibly trap contaminated runoff from construction;
- Storm water must be diverted from the construction site and managed in such a manner to disperse runoff and prevent the concentration of storm water flow;
- Water used at construction sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses;
- Construction chemicals, such as cement and hydrocarbons should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions;
- All vehicles must be frequently inspected for leaks;
- No material may be dumped or stockpiled within any rivers or drainage lines in the vicinity of the proposed Project, and must be removed immediately without destroying habitat;
- All waste must be removed and transported to appropriate waste facilities; and
- High rainfall periods (usually November to March) should be avoided during the construction phase to possibly avoid increased surface runoff in attempt to limit erosion and the entering of external material (i.e. contaminants and/or dissolved solids) into associated aquatic systems.

5.2.3 IMPACT ASSESSMENT

Vegetation clearing along the proposed pipeline route and the construction of the WTP and pipeline installation were the identified activities associated with the construction phase of the Project. Impact assessment ratings for these activities are presented in Table 5-2.

The clearing of vegetation along the proposed pipeline route will pose risks including: contaminants (unearthed soil, oil spills etc.) reaching nearby watercourses and the introduction of alien invasive species. These impacts will lead to water quality and habitat modifications and subsequently the loss of biodiversity, i.e. through the increase in turbidity, sedimentation and loss of indigenous vegetation. Potential impacts upon the receptors (Adit Stream and Mngubhudle River) were determined to be *Moderate* pre-mitigation and *Very low* post-mitigation.

Similarly, construction of the WTP and installation of the pipeline will pose risks including: contaminants (oil spills, cement and other construction material) reaching the Adit Stream. These impacts will lead to water quality modifications, negatively affecting inhabiting biota within downstream reaches of the Mngubhudle catchment. Potential impacts upon the receptors were determined to be *Moderate* pre-mitigation and *Very low* post-mitigation.

These impacts can be reduced by avoiding the rainy season, and through effective implementation of the other recommended sediment and pollutant control mitigation measures.

Table 5-2 – Impact assessment ratings for the construction phase

Activity	Impact Description	Character	Ease of Mitigation	Pre-Mitigation						Post-Mitigation					
				Magnitude	Extent	Reversibility	Duration	Probability	Significance	Magnitude	Extent	Reversibility	Duration	Probability	Significance
Vegetation clearing for pipeline route	Risk of contaminants reaching watercourses (unearthed soil, oil spills etc.) leading to water quality and habitat modifications. Risk of erosion, an increase in flows due to bare surfaces and the introduction of alien invasive species.	Negative	Moderate	3	3	3	2	4	**44**	1	1	3	1	1	**6**
			Significance	**N3 - Moderate**						**N1 – Very low**					
Construction of WTP and pipeline installation	Risk of contaminants reaching the Adit Stream (e.g. unearthed soil, cement and other construction material, hydrocarbons from oil spills) resulting in water quality and habitat modifications.	Negative	Moderate	3	3	3	2	4	**44**	1	1	3	1	1	**6**
			Significance	**N3 - Moderate**						**N1 – Very low**					

5.3 OPERATIONAL PHASE

The main foreseeable aquatic-related impacts associated with the operational phase are: discharging water into the Adit Stream, altering the hydrological regime of the Mngubhudle river and downstream reaches. Discharging inadequately treated mine water and the management and maintenance activities such as the maintenance of infrastructure, vegetation clearing around the WTP and pipeline, handling and disposal of general and hazardous waste pose risks such as water quality deterioration and the spread of alien invasive species within areas down gradient of the Project site.

5.3.1 IMPACT DESCRIPTION

The disruption of flow in terms of natural flow levels and in-flow patterns is considered the most significant impact for aquatic biota. Other impacts include the alteration of water temperature, distribution of nutrients. Intermittent water releases will have impacts including: increase in erosion, sediment increase, and habitat destruction which will in turn will negatively affect the aquatic biota.

Furthermore, increased anthropogenic activities near watercourses increase the risk of introducing alien invasive species. Introduced fish species threaten local fish populations, through predation and habitat destruction for example. The continued spread of alien trees invading riparian zones will decrease river flows through uptake of water, thereby altering the hydrological regime of the watercourses.

5.3.2 MITIGATION MEASURES

The following mitigation measures are recommended to avoid/minimise potential impacts on the watercourse arising from the operational activities:

- It must be ensured that the flow regime defined in the Ecological Water Reserve (EWR) is maintained to support aquatic biota within the downstream watercourses;
- Runoff from the WTP site should not be allowed to flow into the nearby watercourses, unless authorised by the DWS (or the competent authority);
- Bare surfaces downstream from the developments, where silt traps are not an option, should be well vegetated in order to attempt to limit erosion and runoff that might be carrying contaminants;
- Biannual aquatic biomonitoring assessments of the associated water courses should be conducted by an aquatic specialist to determine impacts, whereafter new mitigation actions should be implemented as per the specialist's recommendations.

5.3.3 IMPACT ASSESSMENT

Impact assessment ratings for activities associated with the operational phase are presented in Table 5-3.

Potential impacts associated with the discharge of treated mine water were determined to be *Moderate* pre-mitigation and *Negligible* post-mitigation. These impact ratings were largely influenced by the long term effects of dams on the flow regime within the catchment. Associated impacts can, however, be significantly reduced by managed release of water from the dams into the downstream watercourses and effective implementation of the other recommended mitigation measures.

Potential impacts associated with the operational phase of the Plantation were determined to be *Minor* pre-mitigation and *Negligible* post-mitigation. These impact ratings were largely influenced by the anticipated impacts associated with Plantations such as increased water uptake and the increased sediment input into nearby watercourses. These impacts can be significantly reduced by placing silt traps and berms to prevent the build-up of sediment into nearby watercourses, and the effective implementation of the other recommended mitigation measures.

Vegetation clearing along the proposed pipeline route and the construction of the WTP and pipeline installation were the identified activities associated with the construction phase of the Project. Impact assessment ratings for these activities are presented in Table 5-2.

The clearing of vegetation along the proposed pipeline route will pose risks including: contaminants (unearthed soil, oil spills etc.) reaching nearby watercourses and the introduction of alien invasive species. These impacts will lead to water quality and habitat modifications and subsequently the loss of biodiversity, i.e. through the increase in turbidity, sedimentation and loss of indigenous vegetation. Potential impacts upon the receptors (Adit Stream and Mngubhudle River) were determined to be *Moderate* pre-mitigation and *Very low* post-mitigation.

Similarly, construction of the WTP and installation of the pipeline will pose risks including: contaminants (oil spills, cement and other construction material) reaching the Adit Stream. These impacts will lead to water quality modifications, negatively affecting inhabiting biota within downstream reaches of the Mngubhudle catchment. Potential impacts upon the receptors were determined to be *Moderate* pre-mitigation and *Very low* post-mitigation.

These impacts can be reduced by avoiding the rainy season, and through effective implementation of the other recommended sediment and pollutant control mitigation measures.

Table 5-3 – Impact assessment ratings for the operational phase

Activity	Impact Description	Character	Ease of Mitigation	Pre-Mitigation						Post-Mitigation					
				Magnitude	Extent	Reversibility	Duration	Probability	Significance	Magnitude	Extent	Reversibility	Duration	Probability	Significance
Discharge of treated mine water into the Adit Stream	Increase in river flows altering the natural flow regime. Risk of water quality modifications.	Negative	Moderate	4	4	3	4	4	**60**	2	3	3	4	2	**24**
Significance				**N3 - Moderate**						**N2 - Low**					
Maintenance of infrastructure; vegetation management; Handling and disposal of general and hazardous waste	Increase in surface runoff due to bare and paved surfaces. Risk of wastes reaching the Adit Stream and downstream reaches.	Negative	Moderate	2	3	3	4	3	**36**	1	1	3	2	1	**7**
Significance				**N3 - Moderate**						**N1 – Very low**					

6 CUMULATIVE IMPACTS

Presently, the primary land-use activities within the Project area are those associated with forestry plantations. Illegal mining activities have been observed to occur. Potential impacts associated with the above-mentioned land use activities include water quantity alterations (presence of farm dams, water abstraction for irrigation and uptake of water by the plantations); water quality deteriorations (contamination due to diffuse surface runoff), vegetation clearing and the introduction of exotic species, and solid waste disposal.

Consequently, major impacts within the assessed Mngubhudle River reaches were increased sedimentation and invasive species encroachment within the riparian zones. Illegal mining activities and decant of mine water from a non-operating mine have been identified as potential contributors of water quality deteriorations.

6.1 MONITORING PROGRAMME

An aquatic biomonitoring programme has been developed for the monitoring and preservation of the aquatic ecosystems assessed for the Project. The programme is aimed at better determining the ecological health of the ecosystems, provide long term trends in ecosystem integrity as well as aid in early detection of potential impacts that might severely affect the expected aquatic biota in the associated riverine systems.

Table 6-1 outlines the aquatic monitoring methods to be undertaken at the monitoring points set out above (see section 2.2) on a biannual basis by a suitably qualified aquatic ecologist. The annual programme comprises of a single survey in winter (or low flow season) for the Project Area and a single survey in summer (or high flow season) at the monitoring points indicated. This will determine the Present Ecological State (PES) for the assessed aquatic ecosystems which will further determine whether the proposed Project is impacting the associated aquatic ecology and to what extent.

Table 6-1 – Proposed aquatic biomonitoring programme. RQOs for EWRG1 Mngubhudle

Method and Aquatic Component of Focus	Details	Goal/Target	REC
Water Quality: *In situ* water testing focusing on temperature, pH, conductivity and oxygen content. *Ex situ* analysis of selected chemical parameters: ▪ Major cations; ▪ Physico-chemical parameters; and ▪ Trace elements. By means of the Inductively Coupled	Water quality should be tested on a biannual basis at each monitoring site to determine the extent of change from baseline results. Grab samples must be collected at the monitoring sites and transported to a *South African National Accreditation System* (SANAS) accredited laboratory for analysis.	No noticeable change from determined baseline (current report) water quality for each respective season.	Salt concentrations must be at levels that do not threaten the ecosystem and are suitable for users. The river water should not be toxic to aquatic organisms or be a threat to human health.

Method and Aquatic Component of Focus	Details	Goal/Target	REC
Plasma Optical Emission spectroscopy (ICP-OES) technique.			
Habitat Quality: Instream and riparian habitat integrity; and Availability/suitability of macroinvertebrate habitat at each monitoring site.	The application of the IHI should be done for the associated Kraalkopspruit and the Loopspruit reaches; The IHAS must be applied at each monitoring site prior to sampling.	The Ecological Category determined for each assessed site must be improved for the watercourses under study); and The baseline IHAS scores should improve.	Must be in a Moderately Modified or better condition ≥ D (≥ 42)
Aquatic Macroinvertebrates: Aquatic Macroinvertebrate assemblages must be assessed biannually.	This must be done through the application of the latest SASS protocol, incorporated with the application of the MIRAI as outlined in this Aquatic Study.	The baseline SASS5 scores should not noticeably deteriorate; and Baseline Ecological Categories should not be allowed to drop in category for each assessed site.	Must be in a Moderately Modified or better condition ≥ D (≥ 42)
Fish: Fish assemblages must be assessed biannually	Sampling of fish must be undertaken by utilising the electro-narcosis technique at sites presenting suitable fish habitat.	Baseline Ecological Categories should not be allowed to drop in category for each assessed site. The main goal for the Project must be to conserve the expected sensitive species.	Must be in a Moderately Modified or better condition ≥ D (≥ 42)
Whole Effluent Toxicity (WET): Also known as Direct Estimation of Ecological Effect Potential (DEEEP) tests are used as exposure indicators to give an estimation for the probability of an effect on the environment.	Water samples must be collected at designated monitoring sites and transported to a SANAS accredited laboratory for screening-level analysis.	No noticeable change from determined baseline findings from each respective season.	Not available.
Diatoms Assemblages: Samples must be collected biannually and sent to the laboratory for analysis	The diatom assessment will improve the understanding of the potential impacts from the surrounding activities on the water quality	The diatom based ecological water quality must not deteriorate from the baseline conditions.	Not available.
REC = Recommended Ecological Category			

7 CONCLUSION AND SPECIALIST OPINION

The following key findings are highlighted as part of the current aquatic biodiversity and impact assessment study:

A total of three monitoring sites were assessed, a single site downstream of the proposed discharge point along the Adit Stream and two sites along the Mngubhudle River, above and below the confluence with the Adit Stream. Findings from the *in situ* water quality assessment indicated a considerably high electrical conductivity level at the Adit Stream compared to the Mngubhudle River. This finding was suspected to be a result of mine water emanating from the one or more of the mine facilities (open pits 2 and 3 and tailings dam). The link between closed mines and increased electrical conductivity in receiving watercourses has been found to be a common occurrence (Price & Wright, 2016).

Findings from the aquatic macroinvertebrate community indicated *Critically Modified* ecological integrity at all sampled sites due to the low diversity of taxa. Based on the fish community assessment, the ecological integrity was determined to be *Critically Modified* at the Adit Stream and Mngubhudle upstream site (due to the absence of fish) whilst the Mngubhudle downstream site (where a single species was collected) was determined to be *Seriously Modified*. The integrated ecostatus were determined to be *Seriously Modified* at the two former sites and *Largely to Seriously Modified* at the latter site.

The low aquatic biodiversity within the assessed systems was likely attributed to cumulative impacts associated with historical and present land use activities, mainly mining and forestry plantations. Furthermore, the collected macroinvertebrate assemblages were dominated by pollution-tolerant taxa, thus indicating that water quality modifications have influenced instream aquatic biota over long periods.

It should be noted that the results in this report will be supplemented by the results of the upcoming low flow survey tentatively scheduled in May 2024.

7.1 REASONED OPINION WHETHER PROJECT SHOULD PROCEED

Based on the findings of the current aquatic biodiversity and impact assessment study, potential negative impacts due to activities of the proposed Project are likely to occur upon the main receiving receptor (the Mngubhudle catchment). The significance of impacts is predicted to be *Moderate* during the construction phase and reduced to *Very Low* upon implementation of mitigation measures; similarly, *Moderate* during the operational phase and reduced to *Low* and *Very Low* upon implementation of mitigation measures.

The development of the WTP is intended to treat mine impacted water which poses a risk or reaching nearby watercourses. This has a potential to decimate aquatic biota within the catchment, disrupting ecosystem functioning throughout the catchment and potentially within the interlinking catchments. Therefore, the predicted negative impacts of the WTP upon the receptors are out-weighed by the positive impacts. Thus no fatal flaws were identified during the current study and the proposed Project may proceed. Immediate implementation of the mitigation measures and the aquatic biomonitoring programme must be adhered to pre-construction, and throughout the operation phase to ensure that no deterioration of the associated watercourses occurs. The proposed Project should adopt a water

and habitat quality preservation mindset throughout the life of the Project to prevent the deterioration of the aquatic ecosystems.

8 REFERENCES

Abell, R., Thieme, M. L., Revenga, C., Bryer, M., Kottelat, M., Bogutskaya, N., Coad, B., Mandrak, N., Balderas, S. C., Bussing, W., Stiassny, M. L. J., Skelton, P., Allen, G. R., Unmack, P., Naseka, A., Ng, R., Sindorf, N., Robertson, J., Armijo, E., … Petry, P. (2008). Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. *BioScience*, *58*(5), 403–414. https://doi.org/10.1641/B580507

Barbour, M., Gerritsen, J., Snyder, B., & Stribling, J. (1999). *Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers : Periphyton, Benthic Macroinvertebrates, and Fish*.

Darwall, W. R. T., Smith, K. G., Tweddle, D., & Skelton, P. (2009). *The status and distribution of freshwater biodiversity in southern Africa*.

Department Of Water Affairs And Forestry. (1996). South African Water Quality Guidelines. Volume 7: Aquatic ecosystems. In *Aquatic Ecosystems* (Vol. 7).

Dickens, C. W. S., & Graham, P. M. (2002). The South African Scoring System (SASS) Version 5 Rapid Bioassessment Method for Rivers [supplemental]. *African Journal of Aquatic Science*, *27*(1), 1–10.

DWS. (2014). *A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Compiled by RQIS-RDM: https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx*. Compiled by RQIS-RDM:https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx accessed on. https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx

DWS. (2016). *Present Ecological State, Ecological Importance & Ecological Sensitivity*. https://www.dws.gov.za/iwqs/rhp/eco/peseismodel.aspx

Gerber, A., & Gabriel, M. (2002). *Aquatic Invertebrates of South African Rivers - Illustrations*.

Iversen, T. M., Madsen, B. L., & Bogestrand, J. (2000). River conservation in the European Community, including Scandinavia. In B. R. D. and G. E. P. P.J. Boon (Ed.), *Global Perspectives on River Conservation: Science Policy and Practice*. John Wiley & Sons Ltd.

Kleynhans. (2007a). Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). In *Joint Water Research Commission and Department of Water Affairs and Forestry report: Vol. Version 2*. https://www.dwa.gov.za/iwqs/rhp/eco/EcoStatus/ModuleA_EcoStatus/ModuleA_EcoClassification.pdf

Kleynhans, C. . (1996). A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo system, South Africa. *Journal of Aquatic Ecosystem Health*, *5*, 41–54.

Kleynhans, C. J. (2007b). Module D: Fish Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2) Joint Water Research Commission and Department of Water Affairs and Forestry report. *WRC Report No. TT 330*, *8*.

Kleynhans, C. J. (2008). *River Ecoclassification: Manual for Ecostatus Determination (Version 2). Module D: Volume 1 – Fish Response Assessment Index (FRAI)* (WRC Report No. TT 330/08.). Water Research Commission.

Kleynhans, C. J., & Louw, M. D. (2008). *River EcoClassification Manual for EcoStatus Determination (Version 2) - Module A: EcoClassification and EcoStatus Determination* (WRC Report No. TT 329/08.). Water Research Commission.

Kleynhans, C. J., Louw, M. D., & Moolman, J. (2007). Reference frequency of occurrence of fish species in South Africa. *Department of Water Affairs and Forestry and the Water Research Commission, South Africa*, *TT 331*, 102. http://www.dwa.gov.za/IWQS/rhp/projectdocuments/ReportFinalFROC.doc

Le Roux, P., & Steyn, L. (1968). *Fishes of the Transvaal* (1st ed.).

McMillan, P. (1998). An Invertebrate Habitat Assessment System (IHAS, version 2) for the Rapid Biological Assessment of Rivers and Streams. *A CSIR Research Project, Number ENV-P-I 98132 for the Water Resources Management Programme, CSIR*, *ii*, 44.

MTPA. (2014). *Mpumalanga Biodiversity Sector Plan Handbook. Compiled by Lötter M.C., Cadman, M.J. and Lechmere-Oertel R.G.*

Nebeker, A., Onjukka, S., Stevens, D., Chapman, G., & Özkaynak, H. (1996). Effect of low dissolved oxygen on aquatic life stages of the caddisfly Clistoronia magnifica (Limnephilidae). *Arch. Environ. Contam.*

Ollis, D. J., Boucher, C., Dallas, H. F., & Esler, K. J. (2006). Preliminary testing of the Integrated Habitat Assessment System (IHAS) for aquatic macroinvertebrates. *African Journal of Aquatic Science*, *31*(1), 1–14. https://doi.org/10.2989/16085910609503866

Price, P., & Wright, I. A. (2016). Water Quality Impact from the Discharge of Coal Mine Wastes to Receiving Streams: Comparison of Impacts from an Active Mine with a Closed Mine. *Water, Air, and Soil Pollution*, *227*(5). https://doi.org/10.1007/s11270-016-2854-7

Rowntree, K. M., Wadeson, R. A., & O'keeffe, J. (2000). ion of south african The development of a geomorphological classification system for the longitudinal zonation of south african rivers. In *South African Geographical Journal* (Vol. 82, Issue 3, pp. 163–172). https://doi.org/10.1080/03736245.2000.9713710

SAS. (2023). Aquatic Biomonitoring of the Gladdespruit and its Tributaries in the Vicinity of the Nkomati Mine. *Scientific Aquatic Services*, *SAS 22-114*(March).

Skelton, P. (2001). *A complete guide to the freshwater fishes of Southern* (2nd ed.). Africa-Struik.

Thirion, C. (2008). *River Ecoclassification: Manual for Ecostatus Determination (Version 2). Module E: Volume 1 – Macroinvertebrate Response Assessment Index (MIRAI).* (WRC Report No. TT 332/08.). Water Research Commission.

Thoms, M., & Thoms, M. C. (2006). *The ninth international symposium on regulated streams*. https://doi.org/10.1002/rra.900

U.S. Environmental Protection Agency. (2010). *A Field-Based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams (External Review Draft)*.

Water Research Commision. (2011). *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources* (No. TT 500).

Wood, P. J. (1997). *Biological Effects of Fine Sediment in the Lotic Environment*. *21*(2), 203–217.

Appendix A

METHODOLOGY

<table>
<tr><th>Methodology</th><th>Measurement description</th><th colspan="3">Guidelines/Description</th></tr>
<tr><td rowspan="5">In Situ Water Quality</td><td rowspan="5">Determined using portable field instruments:
pH: Eutech pHTester2;
Electrical Conductivity: Eutech ECTester11 Dual Range;
Dissolved oxygen: Eutech CyberScan DO300; and
Temperature: Eutech CyberScan DO300.</td><td>In situ water variable</td><td>Guideline</td><td>Guideline referenced</td></tr>
<tr><td>Temperature (ºC)</td><td>5 - 30</td><td rowspan="3">South African Water Quality Guidelines: Aquatic Ecosystems (Volume 7) (Department Of Water Affairs And Forestry, 1996)</td></tr>
<tr><td>pH</td><td>6 - 8</td></tr>
<tr><td>Dissolved Oxygen Saturation (%)</td><td>80 – 120</td></tr>
<tr><td>Dissolved Oxygen concentration (mg/ℓ)</td><td>>5</td><td>Minimum Dissolved Oxygen concentration for aquatic macroinvertebrates (Nebeker et al., 1996)</td></tr>
<tr><td>Electrical Conductivity (µS/m)</td><td>< 500</td><td>Conductivity guideline value of 500 µS/cm stipulated in U.S. U.S. Environmental Protection Agency (2010)</td></tr>
<tr><td>Habitat Assessment</td><td colspan="4">Habitat assessment can be defined as the evaluation of the structure, of the surrounding physical habitat, that influences the quality of the water resource, and the condition of the resident aquatic community (Barbour et al., 1999).
Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason, habitat evaluation is conducted simultaneously with biological evaluations in order to facilitate the interpretation of results.</td></tr>
</table>

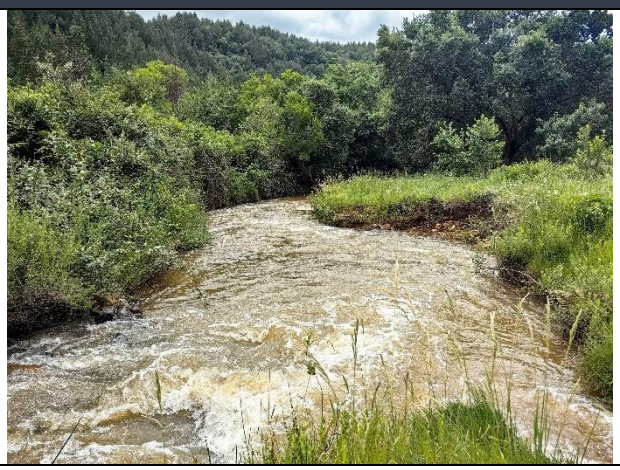
<table>
<tr><th>Methodology</th><th>Measurement description</th><th colspan="3">Guidelines/Description</th></tr>
<tr><td>Integrated Habitat Assessment System (IHAS)</td><td colspan="2">The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore, assessment of the habitat is critical to any assessment of ecological integrity. The IHAS, Version 2 was developed specifically for use with the SASS5 index and rapid biological assessment protocols in South Africa (McMillan, 1998).</td><td colspan="2"><table><tr><th>IHAS</th><th>Description</th></tr><tr><td>>65%</td><td>Good</td></tr><tr><td>55% – 65%</td><td>Adequate/Fair</td></tr><tr><td><55%</td><td>Poor</td></tr></table></td></tr>
<tr><td rowspan="3">Intermediate Habitat Integrity Assessment</td><td rowspan="2">Habitat integrity refers to the maintenance of a balanced, integrated composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996).</td><td colspan="3">Descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996).<table><tr><th>Score</th><th>Impact Category</th><th>Description</th></tr><tr><td>0</td><td>None</td><td>No discernible impact, or the factor is located in such a way that it has no impact on habitat quality diversity, size and variability.</td></tr><tr><td>1 – 5</td><td>Small</td><td>The modification is limited to a very few localities and the impact on habitat quality, diversity, size and variability is also very small.</td></tr><tr><td>6 – 10</td><td>Moderate</td><td>The modification is present at a small number of localities and the impact on habitat quality, diversity, size and variability is also limited.</td></tr><tr><td>11 – 15</td><td>Large</td><td>The modification is generally present with a clearly detrimental impact on quality habitat quality, diversity, size and variability. Large areas are, however, not influenced.</td></tr><tr><td>16 – 20</td><td>Serious</td><td>The modification is frequently present and the habitat quality, diversity, size and variability almost the whole of the defined section are affected. Only small areas are not influenced.</td></tr><tr><td>21 – 25</td><td>Critical</td><td>The modification is present overall with a high intensity; the habitat quality, diversity, size and variability in almost the whole of the defined section are detrimentally influenced.</td></tr></table></td></tr>
<tr><td colspan="3">Intermediate habitat integrity assessment classes/categories (Kleynhans, 1996)<table><tr><th>Score</th><th>Class (% of total)</th><th>Description</th></tr><tr><td>90 - 100</td><td>A</td><td>Unmodified, natural.</td></tr><tr><td>80 - 90</td><td>B</td><td>Largely natural with few modifications.</td></tr></table></td></tr>
</table>

Methodology	Measurement description		Guidelines/Description		
	60 - 79	C	Moderately modified.		
	40 - 59	D	Largely modified.		
	20 - 39	E	The loss of natural habitat, biota and basic ecosystem functions is extensive.		
	0 - 19	F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.		
Aquatic Macroinvertebrates	Aquatic macroinvertebrates were sampled using the qualitative kick sampling method called South African Scoring System (SASS, *version 5*) (Dickens & Graham, 2002)and identified using the hand guide from Gerber & Gabriel (2002). The SASS5 data obtained was used in the Macroinvertebrate Response Assessment Index (MIRAI) (Thirion, 2008) to determine the Present Ecological State (PES, or Ecological Category) of the associated macroinvertebrate assemblages.		**Biotic Integrity (Highveld (11) Upper Ecoregion)**		
			MIRAI Score	**Class**	**Description**
			90-100	A	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
			80-89	B	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
			60-79	C	Moderately modified. Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
			40-59	D	Largely modified. Fewer species present then expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
			20-39	E	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
			0-19	F	Critically modified. Few species present. Only tolerant species present, if any.
Ichthyofauna	Fish samples were collected using an electro-fishing device (Smith-Root LR24).		**FRAI Score (%)**		
			90 – 100	A	
			80 – 89	B	

Methodology	Measurement description	Guidelines/Description	
	Based on a survey of available literature and previous assessments, an expected species list was compiled, utilising the following sources: Skelton (2001), (Kleynhans et al., 2007) and IUCN. The PES or Ecological Category of the fish assemblage of the watercourses associated with the Project Area was conducted by means of the Fish Response Assessment Index (FRAI) (Kleynhans, 2008)	60 – 79	C
		40 – 59	D
		21 – 39	E
		0 – 20	F

Appendix B

SITE PHOTOGRAPHS

Site UP	
	
Upstream view	**Downstream view**
Site D	
	
Upstream view	**Downstream view**
Site G	
	
Upstream view	**Downstream view**

Appendix C

AQUATIC MACROINVETEBRATES DATA

Taxon	Sensitivity	Site UP	Site D	SIte G
ANNELIDA				
Hirudinea (Leeches)	3		A	
CRUSTACEA				
Potamonautidae* (Crabs)	3	A	A	
EPHEMEROPTERA (Mayflies)				
Baetidae 1sp	4		1	
Baetidae 2sp	6	B		B
ODONATA (Dragonflies & Damselflies)				
Coenagrionidae (Sprites and blues)	4	1		
Lestidae (Emerald Damselflies / Spreadwings)	8			A
Aeshnidae (Hawkers and Emperors)	8	1		A
Libellulidae (Darters/Skimmers)	4		1	A
HEMIPTERA (Bugs)				
Belostomatidae* (Giant water bugs)	3			1
Corixidae* (Water boatmen)	3			A
Gerridae* (Pond skaters/Water striders)	5	A	A	
Veliidae/M...veliidae* (Ripple bugs)	5		1	
TRICHOPTERA (Caddisflies)				
Hydropsychidae 1 sp	4	B		
Hydropsychidae 2 sp	6		A	B
Cased caddis:				
Leptoceridae	6	1		
COLEOPTERA (Beetles)				
Gyrinidae* (Whirligig beetles)	5	A	A	A
Hydrophilidae* (Water scavenger beetles)	5	1		A
DIPTERA (Flies)				
Ceratopogonidae (Biting midges)	5			A
Chironomidae (Midges)	2	1		A
Tipulidae (Crane flies)	5		A	
SASS Score		48	40	55
Number of Taxa		10	9	11
ASPT		4,8	4,4	5,0

Appendix D

DOCUMENT LIMITATIONS

DOCUMENT LIMITATIONS

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