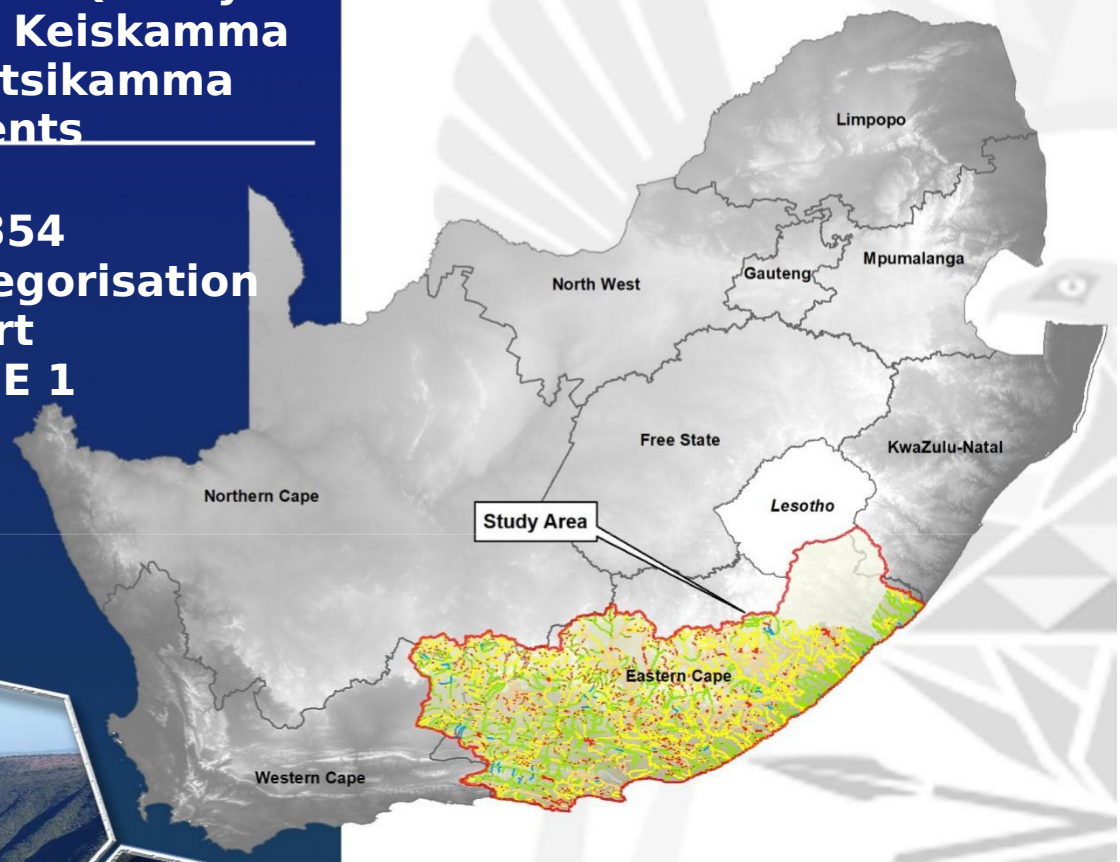
DEPARTMENT OF WATER AND SANITATION

Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments

WP11354
Rivers Eco-categorisation Report
VOLUME 1





REPORT NO.:
WEM/WMA7/00/CON/RDM/1723

December 2023

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Published by

Department of Water and Sanitation
Private Bag X313
Pretoria, 0001
Republic of South Africa

Tel: (012) 336 7500/ +27 12 336 7500
Fax: (012) 336 6731/ +27 12 336 6731

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This report is to be cited as:

Department of Water and Sanitation, South Africa. December 2023. Determination of Water Resource Classes, Reserve and RQOs in the Keiskamma and Fish to Tsitsikamma catchment: River's Eco-categorisation Report Volume 1. Report No: WEM/WMA7/00/CON/RDM/1723.

Prepared by:

GroundTruth: Water, Wetlands and Environmental Engineering



Title:	*River's Eco-categorisation Report - Volume 1*
Authors:	*M. Graham, K. Farrell, R. Stassen, B. van der Waal, B. Grant, J. MacKenzie, T. Pike, K, Mncwabe*
Project Name:	*Determination of Water Resource Classes, Reserve and RQOs in the Keiskamma and Fish to Tsitsikamma catchment: WP11354*
DWS Report No.:	WEM/WMA7/00/CON/RDM/1723
Status of Report	*Final*
First Issue:	*30 August 2023*
Final Issue:	*13 December 2023*

Approved for Groundtruth: Water, Wetlands and Environmental Engineering

P.M.G

13 December 2023

Dr Mark Graham *Date*

Director, GroundTruth

Supported by:

R Mathwedzha

Project Manager

Scientific Manager

Approved for the Department of Water and Sanitation by:

Director: Reserve Determination

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ACKNOWLEDGMENTS

The project team would like to acknowledge the following officials (in no particular order) for their contributions towards the overall project but especially during the two river survey programmes held in September 2022 and May 2023:

Department of Water and Sanitation (DWS)

- Tinyiko Mpete;
- Lawrence Mulangaphuma;
- Rendani Makhwedzha;
- Nobubele Boniwe;
- Lisakhanga Sichatane;
- Lungile Gaulana;
- Lorna Dlakana;
- Portrait Tshatshu;
- Lwando Dayimani;
- Anda Galoshe;
- Zanele Nyamende;
- Nqabisa Gwentshe;
- Thulani Matyeni;
- Ncamile Dweni;
- Zandile Naka;
- Siyabonga Ngcobos;
- Elliot Weni;
- Musa Nyambi;
- Nompilo Mahlobo;
- Phyllus Vaaltynp;
- Rehlokometsoe Miki Lebelo;
- Fundiswa Pakkies; and
- Sifiso Maseko.

Citizen Scientists

- Eric Qonya (Eastern Cape Economic Development, Environmental Affairs and Tourism;
- Yolokazi Galada (Department. of Forestry, Fisheries and the Environment); and
- Jacques Van Der Merwe (Gamtoos Irrigation Board).

LIST OF ACRONYMS

AEC	Alternative Ecological Category
AIP	Alien Invasive Plants
ASPT	Average Score Per Taxon
BHN	Basic Human Needs
CMA	Catchment management agencies
CVB	Channelled valley bottom
CD: WEM	Chief Directorate: Water Ecosystems Management
CR	Critically endangered
DO	Dissolved Oxygen
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EcoRegions	Ecological Regions
EIS	Ecological Importance and Sensitivity
EI	Ecological Importance
ES	Ecological Sensitivity
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Area
FMP	Flow Management Plan
FRAI	Fish Response Assessment Index
FROC	Frequency of Occurrence
FSA	Fish Support Area
GAI	Geomorphology Driver Assessment Index
GBIF	Global Biodiversity Information Facility
GRDM	Groundwater Resource Directed Measures
GSM	Gravel, Sand, Mud
HAI	Hydrological Assessment Index
HF	Hydraulic Fracturing
HGM	Hydrogeomorphic
IBA	Important Bird Areas
IBT	Interbasin Transfer
IEI	Integrated Ecological Index
IHI	Index of Habitat Integrity
IWUI	Integrated Water Use Index
JBS	Joint Basin Survey
LT	Least Threatened

MCA	Multi-criteria analysis
MIRAI	Macroinvertebrate Response Assessment Index
NFEPA	National Freshwater Ecosystem Priority Areas
NT	Near Threatened
NWM5	National Wetlands Map 5
NWA	National Water Act
PES	Present Ecological State
REC	Recommended Ecological Category
REMP	River Eco-status Monitoring Programme
RDM	Resource Directed Measures
RU	Resource Units
SASS5	South African Scoring System, Version 5
SCI	Social Cultural Importance
SIC	Stones-in-current
SOOC	Stones-out-of-current
SWSA	Strategic Water Source Area
TEC	Target Ecological Category
TDS	Total Dissolved Solids
UCVB	Unchanneled valley bottom
VEGRAI	Riparian Vegetation Response Assessment Index
VU	Vulnerable
WARMS	Water use Authorization & Registration Management System
WRC	Water Research Commission
WMA	Water Management Area
WR2012	Water Resources 2012
WRCS	Water Resources Classification System
WWTW	Wastewater Treatment Work

EXECUTIVE SUMMARY

Background and Purpose

This phase forms part of the following study: Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments. The purpose of this study is to determine appropriate Water Resource Classes, the Reserve and associated Resource Quality Objectives (RQOs) for all significant water resources in the study area to facilitate sustainable use of the water resources while maintaining ecological integrity. The aim is to implement the Water Resource Classification System (WRCS) (as per Regulation 810, 2010) to determine the Water Resource Classes, following the integrated framework (DWS, 2017), undertake the 7-step process to determine and set RQOs, and determine the Reserve for the water resources of the study area. This will ultimately assist the DWS in the management of the water resources in the study area and making informed decisions regarding the authorisation of future water use and the magnitude of the impacts of proposed developments.

The initial phase of this study included the identification of integrated Units of Analysis (IUAs), of which 19 were identified, followed by identifying “hotspots” which indicated the areas where EWR sites would be required to be quantified for the rivers. Consequently, the main rivers within these areas were selected and delineated in Management Resource Units (RU) (Report No. WEM/WMA7/00/CON/RDM/0422). It was these RU’s for where the required EWRs would be quantified. The primary focus of *this report* is the ecological categorisation (eco-categorisation) of all identified EWR sites within the RUs (Intermediate, Rapid 3 or field verification sites).

Scientific data was collected on both the driver components (geomorphology, hydraulics, water quality - in the form of diatoms) and the response components (fish, aquatic macroinvertebrates, riparian vegetation, instream-riparian habitat integrity). This data was collected during two (2) river surveys conducted in September 2022 and May 2023. The use of this present data, in relation to reference data was subsequently analysed, for the purpose to conduct the eco-categorisation process on all EWR sites, to determine the ecological categories at these sites. The next report will then be the EWR quantification, setting of flow regimes to maintain different ecological states.

Study Area and location of EWR sites

The locality of all EWR sites within the RU as identified during this study, is provided in **Table 1-1.**

Table 1-1: Location of all EWR sites

INTERMEDIATE EWR SITES						
IUA_T03	R_RU15_I	MTHA01_I	Mthatha (Lower)	T20G	-31.92622055	29.13647331
IUA_T02	R_RU14_I	MBAS01_I	Mbhashe (Middle)	T13C	-31.95809842	28.47223807
IUA_S02	R_RU24_I	BKEI01_R	Black Kei	S32K	-32.11819532	27.06884273
IUA_S03	R_RU13_I	GKEI01_I	Great Kei	S70A	-32.50811888	27.96629455
IUA_S01	R_RU11_I	TSOM01_I	Tsomo	S50G	-32.04397654	27.82105224
IUA_R02	R_RU10_I	BUFF01_I	Buffalo (Middle)	R20F	-32.99151874	27.64057286
IUA_R01	R_RU09_I	KEIS01_I	Keiskamma (Upper)	R10E	-32.80233328	27.02430956
IUA_Q03	R_RU08_I	KAT01_I	Kat (Upper)	Q94B	-32.56964523	26.72185233
IUA_Q02	R_RU06_I	FISH03_I	Great Fish (Lower)	Q91B	-33.08373323	26.22527359
IUA_M01	R_RU03_I	SWAR01_I	KwaZungu/ Swartkops	M10C	-33.72216489	25.30087336
IUA_KL01	R_RU02_I	GAMT01_I	Gamtoos	L90A	-33.76097595	24.69384012
RAPID 3 EWR SITES						
IUA_T04	R_RU31_R	MNGA01_R	Mngazi	T70B	-31.608958	29.405132
	R_RU33_R	NQAB01_R	Nqabarha	T90A	-32.091927	28.400234
	R_RU29_R	MTEN01_R	Mtentu	T60C	-31.130483	29.757179
IUA_T01	R_RU27_R	MBHA02_R	Mbhashe (Upper)	T11H	-31.807857	28.346994
IUA_S03	R_RU26_R	GCUW01_R	Gcuwa	S70D	-32.319770°	28.136094°
	R_RU0_12	KUBU03_R	Kubusi (Lower)	S60B	-32.50722	27.731348
IUA_S01	R_RU21_R	INDW01_R	Indwe	S20D	-31.897077	27.409825
IUA_S01	R_RU20_R	WKEI01_R	White Kei	S10J	-32.003057	27.351052
IUA_R01	R_RU18_R	KEIS02_R	Keiskamma (Lower)	R10L	-33.075316	27.218534
	TYUM01_R	TYUM01_R	Tyume	R10H	-32.910291	26.932242
IUA_Q03	R_RU16_R	KOON01_R	Koonap	Q92G	-33.042856	26.658506

	R_RU15_R	KAT02_R	Kat (Lower)	Q94F	-32.890965	26.68407
IUA_N01	R_RU04_R	SUND02_R	Sundays (Lower)	N40C	-33.404384	25.407919
IUA_L01	R_RU05_R	KOUG01_R	Kouga	L82D	-33.788449	24.025821
IUA_K01	R_RU01_R	KROM01_R	Kromme	K90A	-33.9370951	24.2690587
FIELD VERIFICATION SITES						
IUA_T04	R_RU34_R	MTAK01_FV	Mtakatye	T70E	-31.61528	29.05771
IUA_SO2	R_RU23_R	KLIP01_FV	Klipplaats	S32G	-32.259687	26.856693
	R_RU22_R	KSMI01_FV	Klaas Smits	S31G	-31.99845	26.89427
IUA_R02	R_RU35_R	BUFF03_FV	Buffalo (Upper)	R20B	-32.80347	27.37056
	R_RU20_R	BUFF02_R	Buffalo (Lower)	R20F	-32.991768	27.775910
IUA_S03	R_RU25_R	KUBU01_FV	Kubusi (Upper)	S60A	-32.595016	27.423866
	R_RU012_I	KUBU02_FV	Kubusi (Middle)	S60B	-32.595016	27.423866
	R_RU26_R	GCUW02_FV	Gcuwa (downstream of Butterworth)	S70D	-32.319770°	28.136094°
IUA_Q01	R_RU36_R	GFIS04_FV	Great Fish (u/s Craddock)	Q30E	-32.16074	25.61178
	R_RU12_R	FISH01_FV	Great Fish (Upper)	Q21B	-31.919527	25.390974
	R_RU37_R	GBRA01_FV	Great Brak	Q13B	-31.89216	25.43476
	R_RU13_R	LFIS01_FV	Little Fish (Upper)	Q80B	-32.50617	25.42683
	R_RU38_R	LFIS02_FV	Little Fish (Lower)	Q80G	-33.09345	25.82152
IUA_Q02	R_RU07_R	FISH02_R	Great Fish (Middle)	Q50C	-32.604885	25.751772
	R_RU14_R	TARK01_FV	Tarka	Q44C	-32.283315	25.759280
IUA_P01	R_RU10_R	BOES01_FV	Boesmans	P10G	-33.543899°	26.391105°
IUA_LN01	R_RU09_R	SUND01_FV	Sundays (Upper)	N22C	-33.07812	25.01548
IUA_K01	R_RU23_R	KABE01_FV	Kabeljous (Lower)	K90G	-33.970394	24.906996
	R_RU01_R	GROO01_FV	Groot (Upper)	K80D	-34.032134	24.195684
IUA_KL01	R_RU39_R	TWEE01_FV	Twee Riviere	L82D	-33.83039	23.89823

	R_RU40_R	GAMT02_FV	Gamtoos (Lower)	L90B	-33.84453	24.86604

Approach and Methodology

The eco-categorisation process was followed according to the methods of Kleynhans and Louw (2007). Eco-categorisation refers to the determination and categorisation of the Present Ecological Sate (PES) (health and integrity) of various biophysical attributes of rivers compared to the natural (or close to natural) reference conditions. The state of the river is expressed in terms of the following biophysical components:

- **Drivers:** *In situ* water quality and diatoms (inferred information relating to the physical-chemical conditions [water quality]); Geomorphology; Hydraulics; and Hydrology; and
- **Biological responses:** fish, aquatic macroinvertebrates and riparian vegetation, as well as instream-riparian habitat integrity.

Various processes and models were followed to assign an ecological category (A-F with A=Natural and F=Critically modified) for each component. Ecological evaluation in terms of expected reference conditions, followed by the integration of these components, represents the Ecological State (EcoStatus) of a river. The Recommended Ecological Category (REC) was further discussed amongst the specialist team, taking cognisance of the driver component, as well as the Ecological Importance and Sensitivity (EI-ES). Furthermore, although not included within this report, the Target Ecological Category (TEC) has been identified for those systems where the PES and REC cannot be achieved (for Intermediate EWR sites only). It is this TEC that will be taken forward when the study moves into the socio-economic and trade-off phase whereby system constraints may need to be considered (i.e. systems where anthropogenic impacts have changed the ecological infrastructure to such an extent that the probability of removing that anthropogenic impact is not likely (i.e bridges, dam walls, road crossings etc).

Eco-categorisation results summary

The results for the Intermediate and Rapid 3 EWR sites are summarised in **Table 1-2** and the field verification sites in **Table 1-3** below. All the EWR sites are illustrated in **Figure 3-1**. Important to note that various recommendations/interventions have been summarised below, with the aim to improve the EcoStatus (PES) and aim to achieve the REC. These have been split between:

1. Flow (F) interventions: whereby to what extend can the impacts/influences be mitigated i.e implementing operating rules for instream dams to release the EWR, or at least a baseflow to aid in improved flows; and
2. Non-Flow (NF) interventions, being those that could potentially be rehabilitated and/or restored (i.e. Waste Water Treatment Works (WWTW)).

Table 1-2: Summary of the eco-categorisation results for the Intermediate and Rapid 3 EWR sites

INTERMEDIATE EWR SITES

River	**Lower Mthatha**
EWR Site Code	**MTHA01_I**
Driver component	**PES**
HAI	C
Diatoms	
GAI	C
Response component	**PES**
FRAI	C
MIRAI	C
VEGRAI	D
Ecostatus	**C**
EI	High
ES	High
REC	B/C

EcoStatus (PES)

- Widespread erosion in the catchment, especially in the upper catchment;
- Several dams in the upper to middle catchment along the Mthatha River;
- Deterioration of the PES is mostly driven by the riparian vegetation, due to the extremely high presence of alien invasive plant (AIP) species throughout the riparian zone (non-flow related); and
- Diatoms used to infer the present physical-chemical state of the system. The diatom community indicating moderate to good water quality overall.

EI-ES

- Both remained High.

REC

- F: The current hydropower releases taking place during the dry season, which is unnatural for the system and providing artificial ques for the fish, followed by limited releases during the wet seasons. Therefore, consider more freshets for this system to ensure this REC of a B/C is achieved;
- NF: Removal of the high AIP within the riparian zone and management thereof, thus if the above can be achieved, this will improve the overall EcoStatus health; and
- NF: Improvement of water quality – the river is under stress and hence requires the upgrade and proper maintenance of the associated upstream WWTW, in order to reduce the volume and load of nutrients entering the system.

River	**Middle Mbhashe**
EWR Site Code	**MBAS01_I**
Driver component	**PES**
HAI	
Diatoms	
GAI	C
Response component	**PES**
FRAI	D
MIRAI	C
VEGRAI	C/D
Ecostatus	C/D
EI	Moderate
ES	Moderate
REC	C/D

EcoStatus (PES)

- Flow modifications owing to flows in the Mbhashe supported through releases from the Ncora Dam;
- Although the Colly Wobbles Hydropower Scheme is located downstream of this EWR site, the associated transfer from this operation is having an influence on this site owing to increased flows pushing up (higher impact during the low flow period). This is illustrated from the HAI whereby the natural flows are lower than the present day flows;
- Water quality changes/flow modifications owing to the Colly Wobbles Hydropower Scheme.;
- Increased erosion across the catchment with increased connectivity between sediment sources and the channel;
- Primarily driven by the fish component due to high recordings of non-native fish species (*Labeobarbus aeneus* (Small mouth Yellowfish) - BAEN)
- Simuliidae larvae recorded to be in their outbreak densities in September 2022, although the floods which occurred in February 2023, managed to re-set the system, and the Simuliidae population drastically reduced to their natural abundance state; and
- Diatoms used to infer the present physical-chemical state of the system. The diatom community indicating moderate to good water quality overall.

EI-ES

- Both remained Moderate.

REC

- Most components were NF related, thus maintain the EcoStatus as a C/D.

River	**Black Kei**
EWR Site Code	**BKEI01_I**
Driver component	**PES**
HAI	C
Diatoms	D
GAI	C
Response component	**PES**
FRAI	E
MIRAI	D/E
VEGRAI	D
Ecostatus	D/E
EI	Moderate
ES	Moderate
REC	**D**

EcoStatus (PES)

- Frequent erosion throughout catchment with localised increases in connectivity to the channel;
- Several dams in the upper to middle catchment reducing bedload, as well as several weirs along the lower catchment;
- Extensive erosion due to cattle trampling/grazing along the flood features and banks;
- Degradation primarily driven by the fish due to non-native fish species);
- Macroinvertebrates (limited biotopes i.e no marginal vegetation and the community being further driven by constant low flows;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022, although the floods which occurred in February 2023, manged to re-set the system, and the Simuliidae population drastically reduced to their natural abundance state;
- Degradation of the eco category is primarily driven by the fish component due to the presence of non-native fish species (translocated and alien), as well as flow modification and water quality impairments;
- High AIP within the riparian zone; and
- Diatoms used to infer the present physical-chemical state of the system. The diatom community indicated poor water quality overall, the leading drivers of physical-chemical include the WWTW in Queenstown and the agricultural activities downstream.

EI-ES

- Both remained Moderate.

REC

- F: Increase event hydrology (high-flows floods) particularly to ensure those floods take place on the floodplain to reset the riparian zone;
- F: Ensure moderate events (freshets) – this may potentially improve the macroinvertebrate component and controlling the Simuliidae densities;
- F: Priority wetlands identified within the same primary catchment area was W_RU13 (S32D) and W_RU12 (S32E) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this primary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas;
- NF: Clearing of the AIP within the riparian zone; and
- NF: Land management of the catchment (cattle trampling and grazing) to avoid further bank erosion.

River	Great Kei
EWR Site Code	GKEI01_I
Driver component	PES
HAI	C/D
Diatoms	
GAI	C
Response component	PES
FRAI	D
MIRAI	C
Ecostatus	C/D
EI	High
ES	Moderate
REC	C

EcoStatus (PES)

- Widespread erosion in the catchment, especially in the upper catchment;
- Several instream dams in the upper catchment;
- Negative impact state is primarily driven by the riparian vegetation component. Extensive territorialisation on flood features;
- The fish component also contributes to the negative impact on the PES category , owing to a deviation from natural conditions. High non-native fish species (LUMB -large predators than naturally expected in this system, as well as *Clarias gariepinus* - Sharptooth Catfish - CGAR);
- Creation of a movement/migratory barrier owing to the downstream weir – thus an impact on the fish community along this reach was recorded;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022, although the floods which occurred in February 2023, which re-set the system, and the Simuliidae population drastically reduced to their natural abundances; and
- Diatoms were used to infer the present physical-chemical state of the system and which indicated nutrient and salinity increases (causing eutrophication).

EI-ES

- The EI improved from Moderate to High, primarily owing to **riparian-wetland natural vegetation importance** based on expert rating; and
- The ES remained Moderate.

REC

- F: Increased event hydrology (high flows-floods) needs to be more frequent – this may potentially improve the riparian vegetation component;
- F: Moderate events (freshets) – – this may potentially improve the macroinvertebrate component and controlling the Simuliidae densities. Chapter 10 of this report provides a dedicated chapter regarding the potential management of Simuliidae populations in these catchment areas in relation to setting floods/freshets;
- NF: Land management (cattle trampling and grazing); and
- NF: Unauthorised and illegal sand mining operations should be investigated which are taking place upstream from this EWR site.

River	Tsomo
EWR Site Code	**TSOM01_I**
Driver component	**PES**
HAI	D
Diatoms	
GAI	D
Response component	**PES**
FRAI	E
MIRAI	C
VEGRAI	C/D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	C/D

EcoStatus (PES)

- Widespread erosion in the catchment;
- The transfer from the Ncora Dam to Mbashe and the offtake is having an impact on the sediments and floods further downstream, thus impacting both the hydrology and geomorphology. Also there is a weir located just upstream of this site;
- Several instream dams in the upper to middle catchment with several weirs along the lower catchment;
- The unsustainable impacted state of the fish ecological category is primarily driven by the dominance of translocation (i.e. *Labeobarbus aeneus* – Smallmouth Yellowfish - LAEN), with translocated CGAR and alien *Cyprinus carpio* – Carp – CCAR) also present;
- Movement barrier impacting on the migration of fish species due to the downstream weir – thus an impact on the fish community along this reach
- The riparian vegetation component is on a negative trajectory, due to high trampling pressure resulting in degradation and thus bank scouring and undercut banks. Natural vegetation removal and high AIP. Due to the disturbance of the natural riparian vegetation, pathways are created for AIP to invade; and
- Diatoms were used to infer the present physical-chemical state of the system. Although the diatom community indicated moderate to good water quality – the leading drivers of the physical-chemical changes were mainly due to non-functioning WWTW located in Queenstown and the agricultural activities downstream.

EI-ES

- Both remained Moderate.

REC

- F: Improvement of those moderate to low flows could benefit the riparian vegetation and instream components, and ultimately improve the HAI score;
- F: Priority wetlands identified within the same primary catchment area was W_RU18 (S50E) and W_RU21 (S50C) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this primary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas;
- NF: Clearing of the AIP within the riparian zone;
- NF: Land management of the catchment (cattle trampling and grazing) to avoid further bank erosion; and
- NF: Unauthorised and illegal sand mining operations to be investigated.

River	Middle Buffalo
EWR Site Code	**BUFF01_I**
Driver component	**PES**
HAI	C
Diatoms	D
GAI	C
Response component	**PES**
FRAI	E
MIRAI	DD
VEGRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

EcoStatus (PES)

- Localise erosion in the catchment producing fine sediment;
- Dam and weirs in close proximity reducing bedload input;
- Primarily the degradation in the PES category is driven by the fish and riparian vegetation component, due to high non-native fish species (LUMB -large predators than naturally expected in this system);
- Downstream dam creating an impact on the natural migration of fish species due to the barrier created by the dam;
- High encroachment of AIP plant species within the riparian zone;
- Macroinvertebrate community predominantly comprised of tolerant taxon to impaired water quality conditions;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022, although the floods which occurred in February 2023, which re-set the system, and the Simuliidae population drastically reduced to their natural abundances; and
- Diatoms were used to infer the present physical-chemical state of the system. Water quality highly compromised with nutrient and salinity increase (eutrophication). Altered Physical-chemical state of the system, due to the discharge of non-compliant waste by Schornville and Zwelitsha WWTWs upstream.

EI-ES

- The EI decreased from High to Moderate primarily owing to a reduction in **riparian-wetland natural vegetation importance** based on expert rating and **instream habitat integrity class criteria**; and
- The ES remained Moderate.

REC

- F: Priority wetlands identified within the same primary catchment area was W_RU15 (R20E) and W_RU26 (R20D) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this primary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas;
- F: Improvement of water quality (urgent), which will ultimately improve the instream biotic communities. The river is under stress and hence requires the upgrade and proper maintenance of the associated upstream WWTW, in order to reduce the volume and load of nutrients entering the system;
- NF: Clearing of AIP within the riparian zone and the banks; and
- Overall, maintain the EcoStatus as a D category.

River	**Upper Keiskamma**
EWR Site Code	**KEIS01_I**
Driver component	**PES**
HAI	D
Diatoms	
GAI	D
Response component	**PES**
FRAI	E
MIRAI	C
VEGRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

EcoStatus (PES)

- Sandile Dam upstream mostly used for irrigation (flow modification) and creating a movement barrier upstream for the fish;
- There are limited releases from Sandile dam, thus impacting on the hydrology. The purpose of this dam is primarily for irrigation and some domestic use;
- Widespread continuous grazing and frequent erosional features in the catchment increasing surface erosion;
- The negative trajectory of the EcoStauts (PES) is not just focussed on the flow modification, it is also driven by the fish component, due to high non-native fish species (LUMB -large predators than naturally expected in this system);
- Significant increase in terrestrial and/or alien woody abundances within the riparian zone, with the marginal zone becoming shaded out; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality and having tolerances towards nutrient and salinity increase.

EI-ES

- Both remained Moderate.

REC

- Overall, maintain EcoStatus as a D category;
- F: The present baseflows are considerably lower than the natural flows and highly concerning. Thus if the flows can be improved, the REC can be reassessed for improvement, as the aquatic health of the system will also be improved;
- F: Increase event hydrology (high-flows floods) particularly to ensure those floods take place on the floodplain to reset the riparian zone (terrestrial woody composition). Furthermore, will improve the fish ques and will overall improve the water quality along the reach;
- F: Ensure moderate events (freshets) – this may potentially improve the macroinvertebrate component and reset the biotopes;
- NF: Removal of the high AIP within the riparian zone and management thereof; and
- NF: Land management of the catchment (cattle trampling and grazing) to avoid further bank erosion

River | **Upper Kat** **EWR Site Code** | **KAT01_I** **Driver component** | **PES** HAI | D Diatoms | GAI | C **Response component** | **PES** FRAI | C MIRAI | C VEGRAI | C **Ecostatus** | **C** **EI** | Moderate **ES** | High	***EcoStatus (PES)*** • Riparian vegetation – terrestrialisation prominent at this site, suggesting smaller and less frequency flood events, pulses are not coming through or the duration is too short. Hence scouring is prohibited, flushing out of sediments and debris are thus reduced, wetting the riparian banks is not taking place, riparian vegetation is dying out and terrestrials' pioneers and AIP are encroaching; • Trampling and widespread grazing by livestock along the banks destabilises the geomorphic features at the site (namely, inset benches, level of embeddness, level of sedimentation and armouring) and increases erosion across the catchment; • Simuliidae (Blackfly) larvae recorded to be in their outbreak densities in September 2022, although the floods which occurred in February 2023, managed to re-set the system, resulting in the Simuliidae population to drastically reduced to their natural abundance state; and • Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good to moderate water quality and having tolerances towards nutrient and salinity increase. ***EI-ES*** • Both remained Moderate and High respectively. ***REC*** • F: Ensure moderate events (freshets) – to be longer and more often for the purpose of the riparian vegetation and colonise the system with those expected sensitive macroinvertebrates to water quality and flow***.***
River | **Lower Great Fish** **EWR Site Code** | **FISH03_I** **Driver component** | **PES** HAI | C Diatoms | D GAI | C **Response component** | **PES** FRAI | E MIRAI | C VEGRAI | C **Ecostatus** | **C** **EI** | Moderate **ES** | Moderate **REC** | **C**	***EcoStatus (PES)*** • Sustained high flows and high baseflows due to the major upstream Interbasin Transfer (IBT) scheme contributing to the altered flows along this reach (flow modification); • Fish community primarily comprising non-native fish species; • The artificial flows further impacting migration cues for fish that need to move upstream for spawning purposes; • Macroinvertebrates ecological category mostly driven by water quality due to irrigation and return flows; and • Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicative of poor water quality with species tolerant of electrolyte-rich, strongly polluted rivers and flowing waters and high conductivity. ***EI-ES*** • Both remained Moderate.

	REC • F: Maintain the EcoStatus as a C, being impacted due to the upstream IBT - which cannot be altered due to the importance of the IBT for socio-economic development; and • NF: Need to continually ensure water quality is managed to not decrease the current category, as a result of the upstream towns and return flows (nutrients).
River Swartkops **EWR Site Code** SWAR01_I **Driver component** PES HAI D Diatoms GAI C **Response component** PES FRAI D/E MIRAI C VEGRAI B **Ecostatus** C **EI** Moderate **ES** High REC B/C	***EcoStatus (PES)*** • Reductions in freshets and flood flows driving geomorphological processes; • The unsustainable state of the fish response is based on the downstream activities of the EWR site, namely major sand mining, resulting in considerable channel modification and the formation of migration barriers for the eels needing to move upstream the Swartkops; • Mostly non-native fish species dominating the fish community due to movement throughout the catchment, translocation and these alien fish species predating on the indigenous species; and • Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated moderate to good water quality. Species tolerant of mild pollution. This was the only site with endemic species, *Achanthes subaffinis Cholnok*. Its preference is slow flowing water and oligotrophic streams. ***EI-ES*** • The EI remained Moderate; and • The ES improved from Moderate to high, due to **stream size sensitivity to modified flow/water level changes** and **riparian-wetland zone habitat integrity class criteria**. ***REC*** • Albany Alluvial Vegetation is located downstream of the site near to the sand mining activities taking place. This vegetation type is a threatened ecosystem and is categorised as Endangered. It is further narrowly distributed, placing the ecosystem type at risk of collapse. Protection of this reach is vital for the upkeep of this vegetation type; and • F and NF: **A directive should be issued from DWS as a matter of urgency to the polluters responsible for the illegal sand mining within the Swartkops channel just outside of the Groendal Nature Reserve**. Major rehabilitation effort will be required along this reach in order to improve the hydrology (flow), water quality, and overall improving the ecosystem functioning and associated instream biotic health and integrity, to ultimately meet the REC.

River	**Gamtoos**
EWR Site Code	**GAMT01_I**
Driver component	**PES**
HAI	D
Diatoms	C
GAI	C
Response component	**PES**
FRAI	D
MIRAI	D
VEGRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

EcoStatus (PES)

- Kouga Dam ~15 km upstream, trapping significant volumes of bedload, nutrients and high flows;
- Livestock grazing and trampling along the banks of the Gamtoos River results in the destabilisation of the geomorphic features at the site, driven by all the components (fish, macroinvertebrates and riparian vegetation);
- Habitat cover features and velocity depth classes have all decreased for the fish;
- Mostly non-native fish species dominating the fish community due to movement throughout the catchment, translocation and these alien fish species predating on the indigenous species;
- Highly disturbed site, high agricultural encroachment (citrus farming) into the riparian zone;
- Disturbance of the riparian zone creates unrequired pathways for AIP and hence there is a high AIP presence and continued infestation throughout the riparian zone;
- Macroinvertebrate community primarily driven by a combination of flow modification and water quality impairment; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated moderate water quality. The Kouga Dam upstream is acting as a contaminant sink and trapping most of the pollutants which would otherwise end up along this stretch of the river. The Groot, Doringkraal and Hol rivers joining the river upstream also appear to be draining largely undeveloped areas, mountainous areas, limiting the impacts on the Gamtoos from these rivers.

EI-ES

- Both remained Moderate.

REC

- Maintain the EcoStatus as a D owing to this system being a hard-working river system (socio-economic, irrigation for extensive citrus farming);
- F: Possible release for irrigation into the river for abstraction lower downstream.
- NF: Need to continually ensure water quality is managed to not decrease the current category, as a result of the return flows (nutrients) – ensure river buffer zones are adhered to; and
- NF: Clearing of the AIP within the riparian zone.

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River	Mngazi
EWR Site Code	**MNGA01_R**
Driver component	**PES**
Diatoms	
IHI (instream)	C/D
IHI (riparian)	C
Response component	**PES**
FRAI	C
MIRAI	
Ecostatus	**C**
EI	High
ES	High
REC	

EcoStatus (PES)
- Primarily driven by fish due to the community dominated by non-native fish species;
- Mhlangu Dam in upper reaches (flow modification);
- Cattle trampling and grazing (erosion) within the riparian zone;
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality; and
- Macroinvertebrate community responded mostly to moderate to high water quality and adequate flow conditions.

EI-ES
- EI remained High; and
- ES improved from Moderate to High mainly due to **stream size sensitivity to modified flow/water level changes**.

REC
- F: Better management of alien invasive vegetation within the riparian zone;
- NF: Ensure rehabilitation measures are implemented following gravel mining activities; and
- NF: Ecological Sensitivity reassessed to High.

River	Nqabarha
EWR Site Code	**NQAB01_R**
Driver component	**PES**
Diatoms	C
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	**F**
MIRAI	C
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**C**

EcoStatus (PES)
- Primarily driven by fish due to the community dominated by non-native fish species;
- Compromised water quality owing to upstream WWTW;
- Reduced baseflows owing to degradation of wetlands in upper catchment; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated moderate water quality. The Idutywa WWTW discharges into the tributary of the Nqabarha River and is likely the cause of elevated dissolved solids and conductivity due to its poor maintenance.

EI-ES
- Both remained Moderate.

REC
- F: Alien invasive vegetation management and eradication;
- NF: Management of upstream WWTW, will ultimately improve the state of the water quality, coupled with an improvement to the overall instream biotic communities thereafter, leading to a more a functional ecosystem; and
- NF: Catchment management and improvement.

River	Mtentu
EWR Site Code	**MTEN01_R**
Driver component Diatoms IHI (instream)	**PES**
IHI (riparian)	C
Response component	**PES**
FRAI	C
MIRAI	
Ecostatus	**C**
EI	High
ES	High
REC	

EcoStatus (PES)

- Loss of seasonal flows;
- Primarily driven by fish due to the community dominated by non-native fish species;
- Exotic vegetation encroachment within the riparian zone;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022, although no upstream dams and flow modification, may be owing to constant high flows; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality. Limited anthropogenic impacts, mostly rural areas upstream of this site.

EI-ES

- EI remained High; and
- ES improved from Moderate to High primarily owing to **stream size sensitivity to modified flow/water level changes**.

REC

- Ecological Sensitivity reassessed to be High;
- F: Flagship river;
- F/NF: The presence of flow sensitive macroinvertebrates (as well as water quality sensitive macroinvertebrates);
- F/NF: SW-SWSA;
- NF: Downstream Provincial Nature Reserve; and
- NF: Maputaland-Pondoland Region of plant endemism (including the Dwarf Palm (Endangered) - which only occurs along this reach of the Mtentu thus system requires protection).

River	Upper Mbhashe
EWR Site Code	MBHA02_R
Driver component	PES
Diatoms	
IHI (instream)	
IHI (riparian)	
Response component	PES
FRAI	C
MIRAI	
Ecostatus	
EI	High
ES	Moderate
REC	

EcoStatus (PES)

- Water transfer from Tsomo River (flow modifications);
- Primarily driven by fish due to the community dominated by non-native fish species;
- Upstream migration impedance due to hydropower weir below lower Mbhashe River intermediate site (Collywobbles weir);
- Good macroinvertebrate biotope availability;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022;
- Riparian zone intact; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality.

EI-ES

- EI improved from Moderate to High primarily due to **habitat diversity class, riparian-wetland zone habitat integrity class and instream habitat integrity class**; and
- ES remained Moderate.

REC

- Ecological Importance reassessed to High;
- F/NF: Flow and water quality sensitive aquatic macroinvertebrates should remain within the system;
- F: Hydropower station upstream;
- F: Higher flows owing to the upstream transfer;
- F: Priority wetland identified within the same primary catchment area was W_RU22 (T11A) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this primary catchment area, affected by the aforementioned influences. The restoration of this wetland (and others) ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas; and
- NF: Maputaland-Pondoland Region of plant endemism.

River	Gcuwa
EWR Site Code	**GCUW01_R**
Driver component	**PES**
Diatoms	
Response component	**PES**
FRAI	D
MIRAI	D
Riparian vegetation	D
Ecostatus	D
EI	Moderate
ES	Moderate
REC	D

EcoStatus (PES)

- Diatoms were used to infer the present physical-chemical state of the system and which indicated good water quality. Although further downstream of this site, water quality is highly compromised with nutrient enrichment due to the town of Butterworth and dysfunctional WWTW, with raw sewage flowing directly into the Gcuwa River;
- The downstream water quality impairments is preventing upstream migration of catadromous eels;
- Macroinvertebrates responded to both water quality and flow modifications (to be expected - as the site is directly located downstream of the Gcuwa dam wall); and
- Habitat dominated by bedrock and limited marginal vegetation.

EI-ES

- Both remained Moderate.

REC

- F: Operational rules of the dam should be developed and implemented (this will be undertaken during the scenarios and consequences phase of the study); and
- F: Gcuwa dam wall proposed to be extended primarily for human consumption.

River	Indwe
EWR Site Code	**INDW01_R**
Driver component	**PES**
Diatoms	
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	**F**
MIRAI	C/D
Ecostatus	C/D
EI	Moderate
ES	Moderate
REC	C/D

EcoStatus (PES)

- Primarily driven by the fish component as the community is dominated by non-native fish species;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022;
- No bed armouring/high embeddedness – indication of a lack of floods/freshets coming through, supplementing the potential occurrence of the Simuliidae outbreak;
- Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality.

EI-ES

- Both remained Moderate.

REC

- Maintain as per the PES; and
- Indwe reach is a stressed area – high water use for domestic purposes.

River	White Kei
EWR Site Code	**WKEI01_R**
Driver component	**PES**
Diatoms	
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	E
MIRAI	C
Ecostatus	C/D
EI	Moderate
ES	Moderate
REC	**C**

EcoStatus (PES)

- Loss of baseflows, freshets and annual floods;
- Primarily driven by the fish component as the community is dominated by non-native fish species;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality.

EI-ES

- Both remained Moderate.

REC

- F: Irrigation schemes aid in social economic upliftment; and
- F: Some flow sensitive aquatic macroinvertebrate taxa present within the system, which should remain.

River	Lower Kubusi
EWR Site Code	**KUBU03_R**
Driver component	**PES**
Diatoms	
Response component	**PES**
FRAI	E
MIRAI	
Riparian vegetation	C
Ecostatus	C
EI	**High**
ES	High
REC	B/C

EcoStatus (PES)

- Primarily driven by the fish component, as it comprises mostly non-native fish species dominating the fish community due to movement throughout the catchment, translocation and these alien fish species predating on the indigenous species;
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality

EI-ES

- Both remained High.

REC

- F: Wriggleswade – if they can release, and will release the required operational rules, this will ultimately improve flows and buffer the impaired water quality with the aim to reach this REC;
- F/NF: Part of a Strategic Water Source Area (SWSA) that requires priority protection measures and a formal hydrological flow gauge preferably in the form of real flow measurements; and
- NF: Improvement of water quality (high sedimentation) entering the Kubusi from the small upstream tributary Tois River.

River	Lower Keiskamma
EWR Site Code	**KEIS02_R**
Driver component	**PES**
Diatoms	D
IHI (instream)	C
IHI (riparian)	
Response component	**PES**
FRAI	E
MIRAI	C
Ecostatus	**C**
EI	High
ES	High
REC	

EcoStatus (PES)

- Primarily driven by the fish component, as it comprises mostly non-native fish species dominating the fish community due to movement throughout the catchment, translocation and these alien fish species predating on the indigenous specie;
- Simuliidae (Blackfly) larvae recorded to be in their outbreak densities in September 2022;
- Aquatic biotopes availability remains good for aquatic macroinvertebrates, although smothered in filamentous algae due to nutrient inputs from the agricultural activities on the eastern bank of the river;
- Upstream dams (Sandile, Tyume) resulting in a loss of floods; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated poor water quality.

EI-ES

- Both remained High.

REC

- F/NF: Presence of both flow and water quality sensitive aquatic macroinvertebrates present and should remain within the system;
- NF: Water quality improvement required, although more prominent further upstream near the upper Keiskamma (rural areas); and
- F: Linkage to Keiskamma Estuary.

River	Tyume
EWR Site Code	**TYUM01_R**
Driver component	**PES**
Diatoms	C
IHI (instream)	C
IHI (riparian)	
Response component	**PES**
FRAI	D/E
MIRAI	
Ecostatus	**C**
EI	High
ES	High
REC	

EcoStatus (PES)

- Primarily driven by the fish component as the community is dominated by non-native fish species;
- Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope;
- Reduced floods due to dam upstream; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated moderate water quality.

EI-ES

- EI improved from Moderate to High due to **habitat diversity class**; and
- ES remained High.

REC

- F: Flow sensitive aquatic macroinvertebrates present and which should remain within the system;
- F: This reach is a fish support area (FSA) (*Amatolacypris trevelyani*, - Border Barb - IUCN Status Endangered), *Sandelia bainsii*, - Eastern Province Rock - IUCN Status Endangered);
- Ecological Importance reassessed to a High; and
- NF: Aim for water quality improvements.

River	**Koonap**
EWR Site Code	**KOON01_R**
Driver component	**PES**
Diatoms	D
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	E
MIRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

EcoStatus (PES)
- Primarily driven by the fish component as the community is dominated by non-native fish species;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022;
- Highly turbid system;
- Cattle trampling and grazing (causing bank collapse);
- Algae smothering instream biotopes;
- Macroinvertebrate community primarily responded to poor water quality conditions; and
- Diatoms used to infer the present physical-chemical state of the system. The diatom community indicated poor water quality.

EI-ES
- Both remained Moderate.

REC
- Maintain the PES.

River	**Lower Kat**
EWR Site Code	**KAT02_R**
Driver component	**PES**
Diatoms	
IHI (instream)	D
IHI (riparian)	C
Response component	**PES**
FRAI	E
MIRAI	C
Ecostatus	C/D
EI	**Moderate**
ES	Moderate
REC	C/D

EcoStatus (PES)
- Primarily driven by the fish component as the community is dominated by non-native fish species;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022;
- Extensive irrigation;
- Loss of floods owing to reduced release pattern from various upstream dams, including the main Katrivier Dam
- Bed and channel modification owing to large number of weirs along reach (resulting in changes in instream habitat availability); and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality, although species driven by nutrients due to irrigation.

EI-ES
- Both remained Moderate.

REC
- Maintain the PES.

River	Lower Sundays
EWR Site Code	**SUND02_R**
Driver component	**PES**
Diatoms	D
IHI (instream)	D
IHI (riparian)	D
Response component	**PES**
FRAI	D
MIRAI	C/D
Ecostatus	**D**
EI	Low
ES	Moderate
REC	**D**

EcoStatus (PES)

- Darlington Dam and Korhaansdrift weir are resulting in limited flows and alterations to natural flow patterns downstream of the dams;
- Extensive irrigation from abstraction from upstream Korhaansdrift weir (for citrus farming);
- The PES is driven by a combination of the driver and response components, due to the knock-on effect from the extensive flow modification taking place;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022 (flow modification); and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated poor water quality, and species driven by nutrients due to irrigation, as well as upstream Kirkwood WWTW, suggested to be failing

EI-ES

- EI re-assed from moderate to low due to **riparian-wetland zone habitat integrity class, instream migration link class criteria, instream habitat integrity class criteria** and final **ecological importance** for the site; and
- ES remained Moderate.

REC

- F: Major upstream weir (Korhaansdrift) and dam (Darlington Dam);
- F: Concern owing to linkage to the Sundays Estuary owing to possible negative impact on the estuary, owing to possible reduced floods and reduced flows (to be addressed by the estuarine team);
- F: Irrigation schemes aid in social economic upliftment; and
- Ecological Importance reduced from Moderate

River	**Kouga**
EWR Site Code	**KOUG01_R**
Driver component	**PES**
Diatoms IHI (instream)	B/C
IHI (riparian)	C
Response component	**PES**
FRAI	**F**
MIRAI	B/C
Ecostatus	C
EI	**High**
ES	High
REC	B/C

EcoStatus (PES)

- Due to the complete dominance of non-native predatory fish species within the mainstem Kouga River (including translocated CGAR and several others, there are no collection records for *Pseudobarbus swartzi* (Gamtoos redfin) and *Sandelia capensis* (Cape Kurper) within main Kouga stem. They appear to be confined to tributaries where non-nature species are less frequent;
- Simuliidae larvae recorded to be in their outbreak densities in September 2022. The rest of the macroinvertebrate assemblage appeared to have a preference for both moderately fast to fast flowing water and standing water, cobbles and moderate to low requirement for unmodified Physical-chemical conditions;
- Loss of baseflows due to groundwater abstractions for irrigation in the upper reaches and tributaries of the Kouga River;
- Extensive exotic vegetation encroachment, although limited other riparian impacts; and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality.

EI-ES

- EI improved from Moderate to High due to **habitat diversity class criteria**; and
- ES improved from Moderate to High due to **stream size sensitivity to modified flow/water level changes**.

REC

- Both EI-ES improved to High;
- F/NF: Presence of aquatic macroinvertebrates with a preference for very fast flow flowing waters (excluding the Simuliidae larvae) and moderately unmodified water quantity conditions;
- F: Potential improvement to baseflows owing to reduced groundwater use;
- F: Priority wetland identified within the same quaternary catchment area was W_RU03 (L82D) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of this wetland within the same quaternary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas;
- NF: As a result of the above, aim to potentially introduce working for water programs to manage the AIPs along this reach and implement programs to stabilised banks and prevent erosion once the aliens have been removed; and
- NF: Ensure that water quality does not deteriorate with the continued maintenance of the upstream WWTW (Twee-Riviere, Nabooms etc).

River	Kromme
EWR Site Code	**KROM01_R**
Driver component Diatoms	**PES**
Response component FRAI	**PES** E/F
MIRAI Riparian vegetation	C D
Ecostatus	**D**
EI	High
ES	High
REC	**C**

EcoStatus (PES)

- Complete dominance of non-native fish species, including alien *Lepomis macrochirus* – Bluegill – LMAC and *Micropterus salmoides* – Largemouth Bass – MSAL. Furthermore, downstream Krom River Dam limiting upstream migration of catadromous eels;
- Riparian vegetation clearing due to trampling, grazing and increased erosion;
- Abstraction, irrigation and return flows (flow modification and water quality impairments); and
- Diatoms were used to infer the present physical-chemical state of the system. The diatom community indicated good water quality.

EI-ES

- Both remained High;
- This system forms part of the very important Kromme wetland system and provides much ecological goods and services; and
- The river further feeds into the Krom Estuary downstream.

REC

- EI-ES both remained High, which is imperative for the protection of the Geelhout tributary which supports the main Kromme River;
- F: System forms part of the very important Kromme wetland system and provides ecological goods and services and hence requires specific management and protection ecological specifications to support the high importance status; and
- F: Priority wetland identified within the same quaternary catchment area was W_RU02 (K90A) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of this wetland within the same quaternary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas.

Table 1-3: Summary of the eco-categorisation results for the field verification sites

					EcoStatus	
IUA_T04	R_RU34_R	MTAK01_FV	Mtakatye	T70E	B/C	B/C
IUA_SO2	R_RU23_R	KLIP01_FV	Klipplaats	S32G	C	C
IUA_S02	R_RU22_R	KSMI01_FV	Klaas Smits	S31G	C/D	C/D
IUA_R02	R_RU35_R	BUFF03_FV	Buffalo (Upper)	R20B	B/C	B/C
IUA_R02	R_RU20_R	BUFF02_FV	Buffalo (Lower)	R20F	D/E	D
IUA_S03	R_RU25_R	KUBU01_FV	Kubusi (Upper)	S60A	C	C
IUA_S03	R_RU12_I	KUBU02_FV	Kubusi (Middle)	S60B	C	C
IUA_SO3	R_RU26_R	GCUW02_FV	Gcuwa (downstream of Butterworth)	S70D	E	D
IUA_Q01	R_RU36_R	GFIS04_FV	Great Fish (u/s Craddock)	Q30E	C/D	C/D
IUA_Q02	R_RU07_R	FISH02_FV	Great Fish (Middle)*	Q50C	*Could not be assessed due to high flows*	
IUA_Q01	R_RU37_R	GBRA01_FV	Great Brak	Q13B	C/D	C/D
IUA_Q01	R_RU13_R	LFIS01_FV	Little Fish (Upper)	Q80B	C	B/C
IUA_Q01	R_RU38_R	LFIS02_FV	Little Fish (Lower)	Q80G	C	C
IUA_P01	R_RU10_R	BOES01_FV	Boesmans	P10G	*Dry*	
IUA_LN01	R_RU09_R	SUND01_FV	Sundays (Upper)	N22C	C	C
IUA_K01	R_RU39_R	KABE01_FV	Kabeljous (Lower)	K90G	C	B/C
IUA_K01	R_RU01_R	GROO01_FV	Groot (Upper)	K80D	B/C	B/C
IUA_KL01	R_RU40_R	TWEE01_FV	Twee Riviere	L82D	D	C/D
IUA_KL01	R_RU41_R	GAMT02_FV	Gamtoos (Lower)	L90B	C/D	C

**Access constrained due to Interbasin transfer. Data could not be collected.*

Overall, this study revealed that the Keiskamma, Fish to Tsitsikamma catchment areas predominantly display moderately to largely modified conditions, falling into ecological categories C and D for the most part. Several Rapid 3 EWR sites, primarily located within the Pondoland area (primary catchment T), remain largely natural with minimal modifications, preserving their ecosystem functions. The primary factors influencing the entire study area catchment are compromised water quality, stemming from the negligence and dysfunctionality of WWTW, and water quantity driven by extensive agricultural practices like sheep farming and citrus cultivation, leading to water extraction for irrigation. Notably, flow modifications occur along the Mbhashe River (hydropower) and the Great Fish River (IBT scheme). While playing a crucial and positive role in enabling water storage for agricultural irrigation, domestic use, and hydropower generation, these modifications contribute to heightened agricultural productivity and electricity generation, supporting economic development in the Eastern Cape Province. However, the large instream dams, weirs, and IBT scheme exert pressure on river systems and associated wetlands, altering the natural flow and impacting sediment transport, nutrient cycling, and habitat availability for instream aquatic biota. These changes are negatively affecting biodiversity and disrupting wetland health (Report No. WEM/WMA7/00/CON/RDM/1223), posing challenges to strike a balance between water management benefits and natural ecosystem preservation in this study area.

If the anthropogenic impacts are addressed precisely and timeously, the overall aquatic health of the rivers can be improved. Longer term flow related Integrated Management Systems need to be put in place to address unlawful use, abstraction, operational rules for environmental releases from dams and the restoration and rehabilitation of wetlands.

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1. INTRODUCTION

1.1 Background

The National Water Act, 1998 (No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for and authority over water resource management for the benefit of the public without affecting the functioning of water resource systems. To achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of Resource Directed Measures (RDM). These measures are protection-based and include Water Resource Classification, determination of the Reserve and setting the associated Resource Quality Objectives (RQOs). These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources, while allowing socio-economic development.

The provision of water required for the maintenance of the natural functionality of the ecosystem and provision of Basic Human Needs (BHN) is the only right to water in the National Water Act (No. 36 of 1998) (NWA). The other water users from a strategic use who are second in line to other water users are subject to formal gazetted General Authorization and water use authorization as per Section 21 of the NWA.

The Department of Water and Sanitation, through the Chief Directorate: Water Ecosystems Management (CD: WEM), has initiated a study for the determination of Water Resource Classes, Reserve and associated Resource Quality Objectives for the identified significant water resources in the Keiskamma and Fish to Tsitsikamma catchments. The water resource components included for this study are rivers, wetlands, groundwater and estuaries. The Reserve determination include both the water quantity and quality of the Ecological Water Requirements (EWR) and Basic Human Needs (BHN). This will ensure the availability of water required to protect aquatic systems (i.e. the EWR) and that the essential needs of individuals that are directly dependent on these water resources (i.e. BHN) are met.

1.2 Purpose of this study

The Keiskamma and Fish to Tsitsikamma catchments within the Mzimvubu to Tsitsikamma Water Management Area (WMA 7) are amongst many waters stressed catchments in South Africa. These areas are important for conservation and have recognisable protected areas, natural heritage, cultural and historical sites that require protection. However, water use from surface as well as groundwater for agricultural and domestic purposes are high, especially in the more arid catchments, impacting on the availability of water resources for the protection of the aquatic ecosystems. Industrial practices and domestic water use are on the rise in some of these catchments, especially around the major towns and cities. Water transfers into the study area from adjacent WMAs and within the study area and numerous storage dams changes the natural flow patterns, impacting on the aquatic biota.

Thus, the main purpose of the study is to determine, appropriate Water Resource Classes, the Reserve and set associated RQOs for all significant water resources in the study area to facilitate sustainable use of the water resources while maintaining ecological integrity.

The aim is to:

- implement the Water Resource Classification System (WRCS) (Regulation 810, 2010) to determine the Water Resource Classes (classes ranging from 1 – 3);
- follow the integrated framework (DWS, 2017);
- undertake the 7-step process to determine and set RQOs; and
- determine the Reserve for the significant water resources in the study area.

This will ultimately assist the DWS in the management of the water resources in the study area and aid in the making of informed decisions regarding the authorisation of future water use and the magnitude of the impacts of proposed developments. It must be noted that the protection and management of water resources should be done in an integrated manner, hence from source to sea. This illustrates the importance of realising that IWRM requires the co-operation and buy in of stakeholders in the catchment and hence the forming of partnerships is essential i.e water forums, catchment management agencies (CMA), Integrated Development Management Plans, Estuarine Management plans etc. The IWRM also relies heavily on co-operative governance. Representative participation on the platforms that the Department creates through studies such as this, is in the form of Project Steering Committees, but the latter is but one example, of inviting integrated participation.

1.3 Purpose of this report

The purpose of this report is to document the results of the Ecological Categorisation (determination of the overall PES Eco-Categorisation) of all identified EWR sites within the Keiskamma and Fish to Tsitsikamma catchment areas, based on the information and data that is currently available through various previous studies undertaken and the observed data that is to be obtained during the scheduled river surveys. Where information has been obtained from available information, or from other surveys conducted from adjacent other natural water resources such as wetlands, estuaries and/or groundwater, that integration is considered (although this will be addressed further on in the study). This will be relevant to the gazetting of the Reserve. The following information has been documented in this report per EWR site:

- Site name, river and co-ordinates;
- Site photos;
- Quaternary catchments and sub-quaternary reach;
- Ecoregion;
- Geomorphic zone;
- Gauging weirs at or near the site;
- Total catchment area;
- Natural Mean Annual Runoff (MAR) at the EWR site;
- Altitude;
- Prioritised Resource Units (RU);

- Present Ecological State (PES) for the EWR site and for each component and the EcoStatus;
- Trends per component;
- Ecological Importance and Sensitivity (EIS);
- The overall EcoStatus (PES), and
- The Recommended Ecological Category (REC).

The specialist components consist of the drivers (geomorphology, Physical-chemical variables and hydrology) and the response (instream vegetation, riparian vegetation, fish and macroinvertebrates).

1.4 Approach for the Eco-Categorisation Phase

The full project approach and methodology will be in accordance with the process as outlined in Regulation 810 (Government Gazette 33541) dated 17 September 2010, **as well as the methodologies as prescribed by the DWS for Reserve determinations of rivers, wetlands, groundwater and estuaries and the determination of Resource Quality Objectives (RQO).** The integrated steps as developed through the 'Development of Procedures to operationalise Resource Directed Measures (DWS, 2017)' will be used to guide the various activities (see **Figure 1-1**).

The Eco-Categorisation forms part of Step 3 of Figure 1-1 and Step 3 of the integrated steps for the determination of the Reserve (**Figure 1-2**).

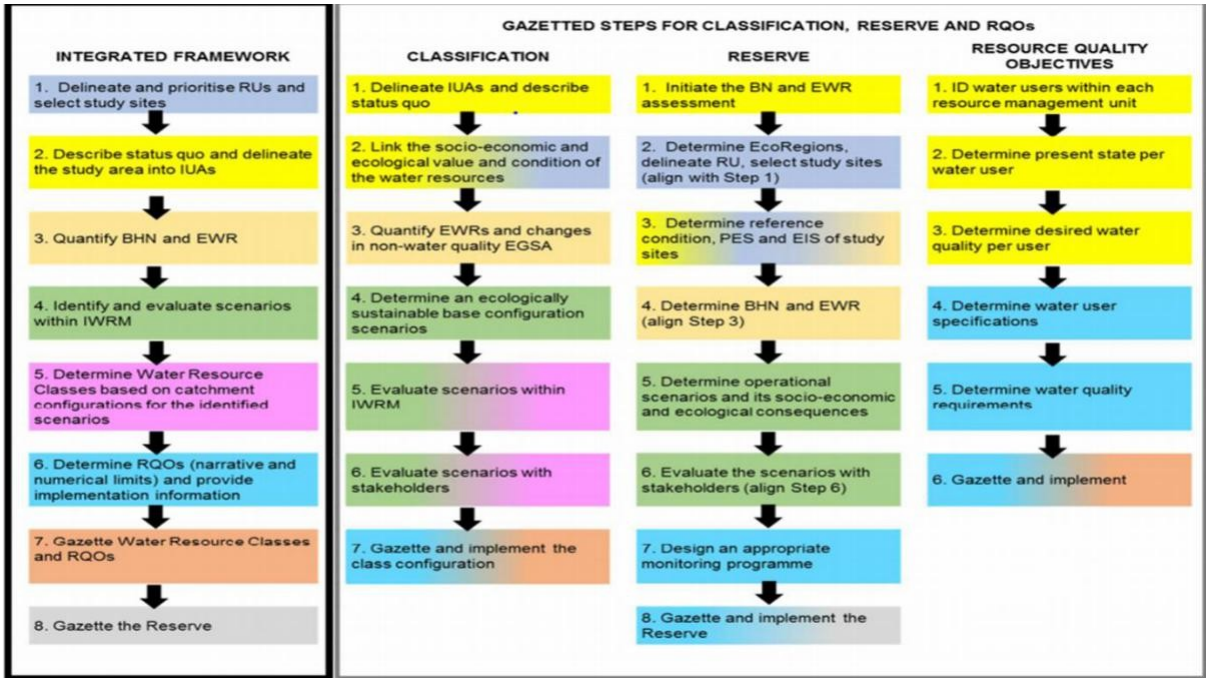


Figure 1-1: Integrated framework for determination of Water Resource Classes, Reserve and RQOs

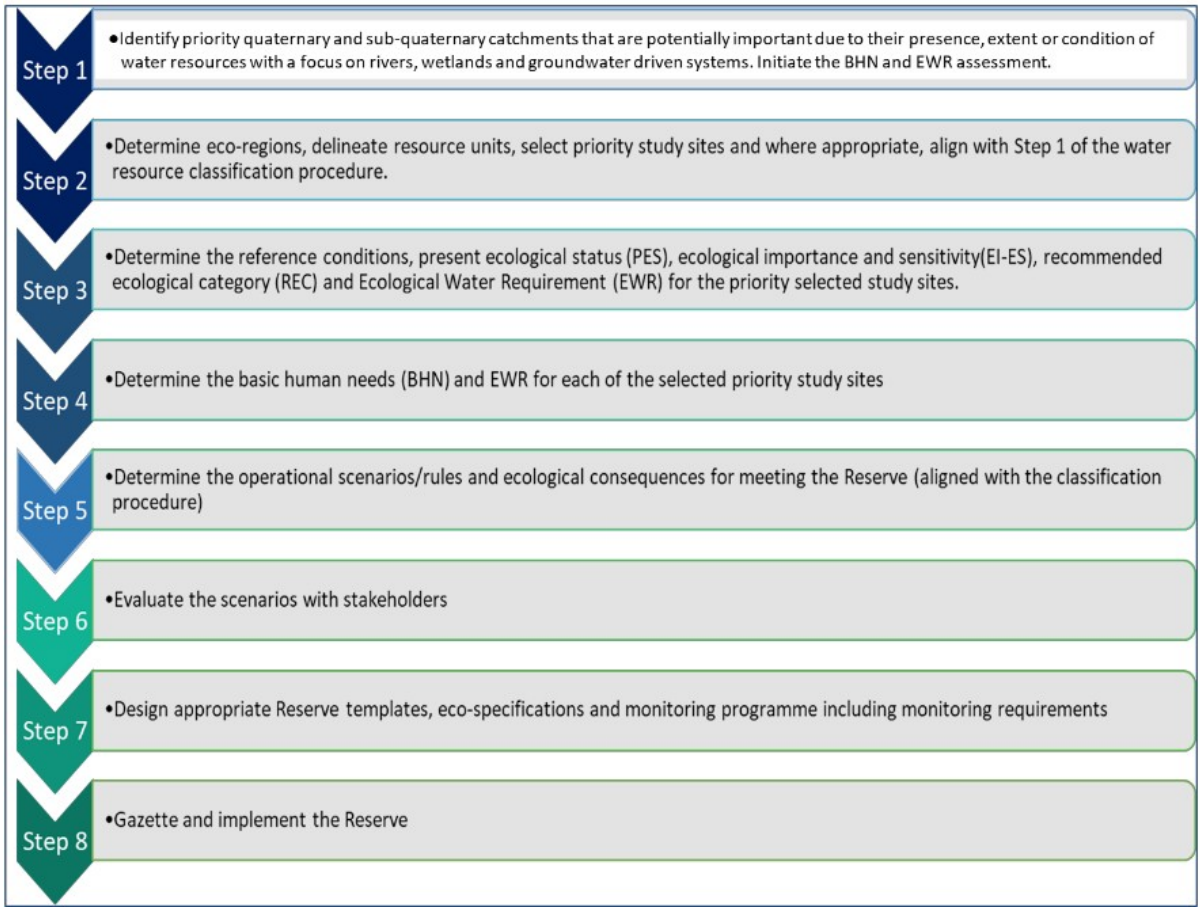


Figure 1-2: Integrated steps for the determination of the Reserve (DWS, 2017)

2. OVERVIEW OF STUDY AREA

2.1 Rivers, wetlands, groundwater and estuaries

The study area forms part of the Mzimvubu to Tsitsikamma WMA7 as indicated in Table 2-1. The water resources of the Mzimvubu River (T31 – T36) are not included as part of the study. Secondary catchments T40 (Mtamvuna) and T50 (Mzimkhulu) form part of WMA 4. A detailed overview and status quo of the study area in terms of the rivers, wetlands, estuaries and groundwater, water resource infrastructure and socio-economics has been presented in the delineation of IUAs Report (Report Number: WEM/WMA7/00/CON/RDM/0322).

A brief overview of each of the water resources components, namely rivers, wetlands, groundwater and estuaries, are provided below.

The rivers in the study area ranges from large perennial to semi-ephemeral as well as small coastal systems that all drains towards the Indian Ocean (**Figure 2-1**). It consists of five large drainage basins with a number of smaller rivers in-between. The larger drainage basins are the:

(i) **Great Kei River** (drainage region S), with its main tributaries of the **Black Kei River** (S31, S32), White Kei River (S10A to S10J), with its tributary, the **Indwe River** (S20A to S20D), the Tsomo River (S50A to S50H), and the **Thomas River** (S40A to S40E), **Kubusi River** (S60A to S60E) and **Xilinxa River** (S70C to S70E);
(ii) **Mbashe River** (part of drainage region T and includes T11, T12 and T13);
(iii) **Great Fish** (drainage region Q) with its main tributaries of the **Tarka** (Q41A-Q41B, Q41D, Q44A-Q44C)**, Little Fish** (Q80B – Q80E, Q80G), **Koonap** (Q92A – Q92C, Q92E, Q92G and **Kat rivers** (Q94A - Q94B, Q94D, Q94F);
(iv) **Sundays** (drainage region N) which falls mainly in the Great Karoo; and
(v) **Gamtoos River** (drainage region L) situated in the Karoo, with its major tributaries, namely **Groot** (L30C – L30D, L50B, L70B – L70D, L70F – L70G)**, Baviaanskloof** (L81A – L81D) and **Kouga Rivers** (L82B – L82E, L82G – L82H).

Furthermore, **Figure 2-2** illustrates the above along with the studies delineated Integrated Units of Analysis.

A summary of the catchment areas and their main rivers is illustrated in **Figure 2-3** and **Table 2-1.**

Table 2-1: Main catchments and rivers in the study area

K80	Tsitsikamma and small coastal rivers
K90	Krom, Seekoei rivers and small coastal rivers, also part of Algoa System
L10 - L90	Gamtoos with main tributaries Groot, Baviaanskloof and Kouga
M10 - M30	Koega, Swartkops and small coastal rivers, part of the Algoa System
N10 - N40	Sundays
P10 - P40	Kowie, Kariega, Boesmans and small coastal rivers (or Albany Coast)
Q10 - Q90	Fish River with main tributaries of Little Fish, Koonap and Kat
R10 - R50	Keiskamma, Buffalo, Nahoon and Gqunube Rivers (also known as the Amatole System)
S10 - S70	Great Kei River with main tributaries of Klipplaats, Indwe, White Kei, Black Kei
T10	Mbhashe
T20	Mthatha
T60	Small coastal rivers (Mtentu, Msikaba, Mzintlava), including estuaries of high conservation value
T70	Small coastal rivers (Mtakatye, Mngazi), including estuaries of high conservation value

	Major Rivers
T80 & T90	Small coastal rivers, including estuaries of high conservation value

The topography of the study area is hilly to mountainous with plains and hills of the Groot Karoo, with the Drakensberg Mountains along the north-eastern boundary of the study area. The rivers are deeply incised in the coastal strip.

The study area consists of 345 quaternary catchments (**Figure 3-1**), covering a total catchment area of more than 143 000 km^2. The sub-catchments, associated rivers and catchment areas are listed in **Table 2-2** for futher detail.

Table 2-2: The sub-catchments within the study area

catchment		Main River		Catchment
K	K80A-F	Tsitsikamma	Elandsbos, Kleinbos, Storms, Elands, Groot, Klasies, Klipdrift	1 206
	K90A-G	Krom	Seekoei, Kabeljous	1 558
L	L11, L12, L21, L22, L23, L30, L40, L50, L60, L70, L81, L82, L90	Gamtoos	Sout, Buffels, Kariga, Plessis, Heuningklip, Groot, Baviaanskloof, Kouga	34 816
M	M10, M20, M30	Swartkops	Van Stadens, Maitland, Bakens, Papkuils, Coega	2 630
N	N11, N12, N13, N14, N21, N22, N23, N24, N30, N40	Sundays	Kamdeboo, Gats, Melk, Bul, Voel, Kariega	21 248
P	P10, P20, P30, P40	Boesmans	Diepkloof, Boknes, Kariega, Kowie, Kasouga, Riet, Wes-Kleinemonde, Oos-Kleinemonde	5 322
Q	Q11, Q12, Q13, Q14, Q21, Q22, Q30, Q41, Q42, Q43, Q44, Q50, Q60, Q70, Q80, Q91, Q92, Q93, Q94	Great Fish	Groot-Brak, Pauls, Tarka, Baviaans, Koonap, Little Fish, Kat	30 243
R	R10, R20, R30, R40, R50	Keiskamma	Tyume, Buffalo, Nahoon, Qinira, Gqunube, Kwelera, Kwenxura, Quko, Tyolomnqa, Gxulu, Bhirha, Mgwalana	7 936
S	S10, S20, S31, S32, S40, S50, S60, S70	Great Kei	White-Kei, Indwe, Klipplaat, Klaas Smit, Black-Kei, Tsomo, Kubusi, Gcuwa	20 485
T	T11, T12, T13, T20, T60, T70, T80, T90	Mbashe	Xuka, Mgwali, Mthatha, Mzamba, Mtentu, Msikaba, Mzintlava, Mntafufu, Mngazi, Mngazana, Mtakatye, Mdumbi, Nenga,	17 938

catchment		Main River		Catchment
			Mncwasa, Xora, Nqabarha, Shixini, Qhorha, Kobonqaba	
			Total catchment area	**143 382**

[1] *WR2012 Data*

In terms of the wetlands, the study area has been divided into 11 sub-catchments to provide broad management units within which wetland prioritisation and assessments have been undertaken. The sub-catchments are as follows:

- Gamtoos (L catchment, channelled/ unchannelled valley bottom, depression, seepage-slope wetlands rare)
- Sundays (N catchment, depression and combination of channelled valley bottom and depression, seepage-slope wetlands rare)
- Fish (Q catchment, depression or channelled valley bottom)
- Tsitsikamma and Krom (K8 and K9 catchments, depression and channelled valley bottom)
- Algoa (M catchment, depression and channelled valley bottom)
- Bushmans (P catchment, depression)
- Kei (S catchment, seepage-slope, channelled valley bottom)
- Amatola (R catchment, channelled valley bottom and seepage)
- Mbhashe (T11, T12, T13 catchment, seepage and channelled valley bottom)
- Mthatha (T2 catchment, channelled valley bottom)
- Wild Coast (T6, T7, T8, T9 catchments, channelled valley bottom and unchannelled valley bottom)

Refer to Report No. WEM/WMA7/00/CON/RDM/1623 for further information on the wetlands.

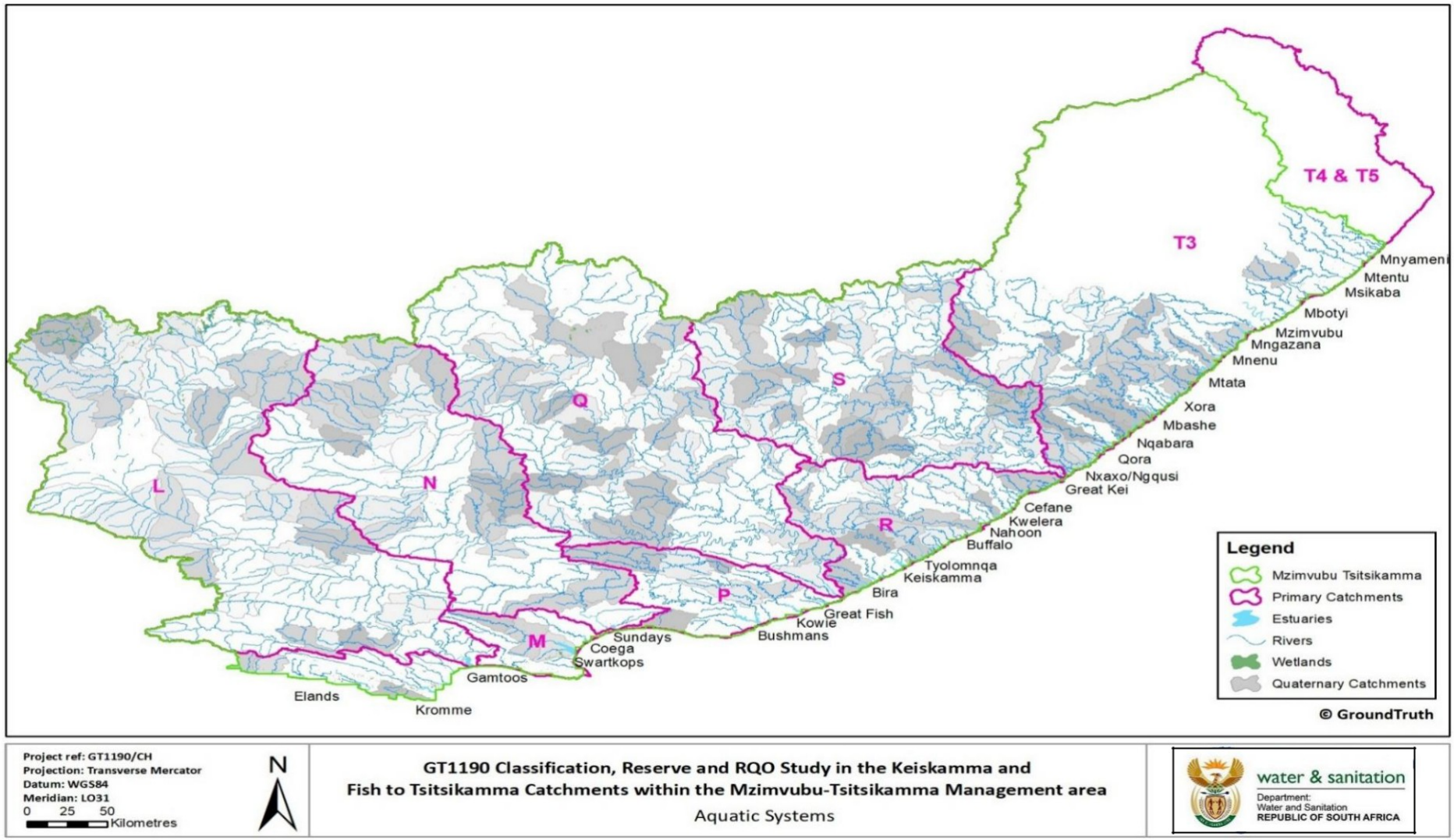


Figure 2-1: Study area of the Keiskamma, Fish to Tsitsikamma

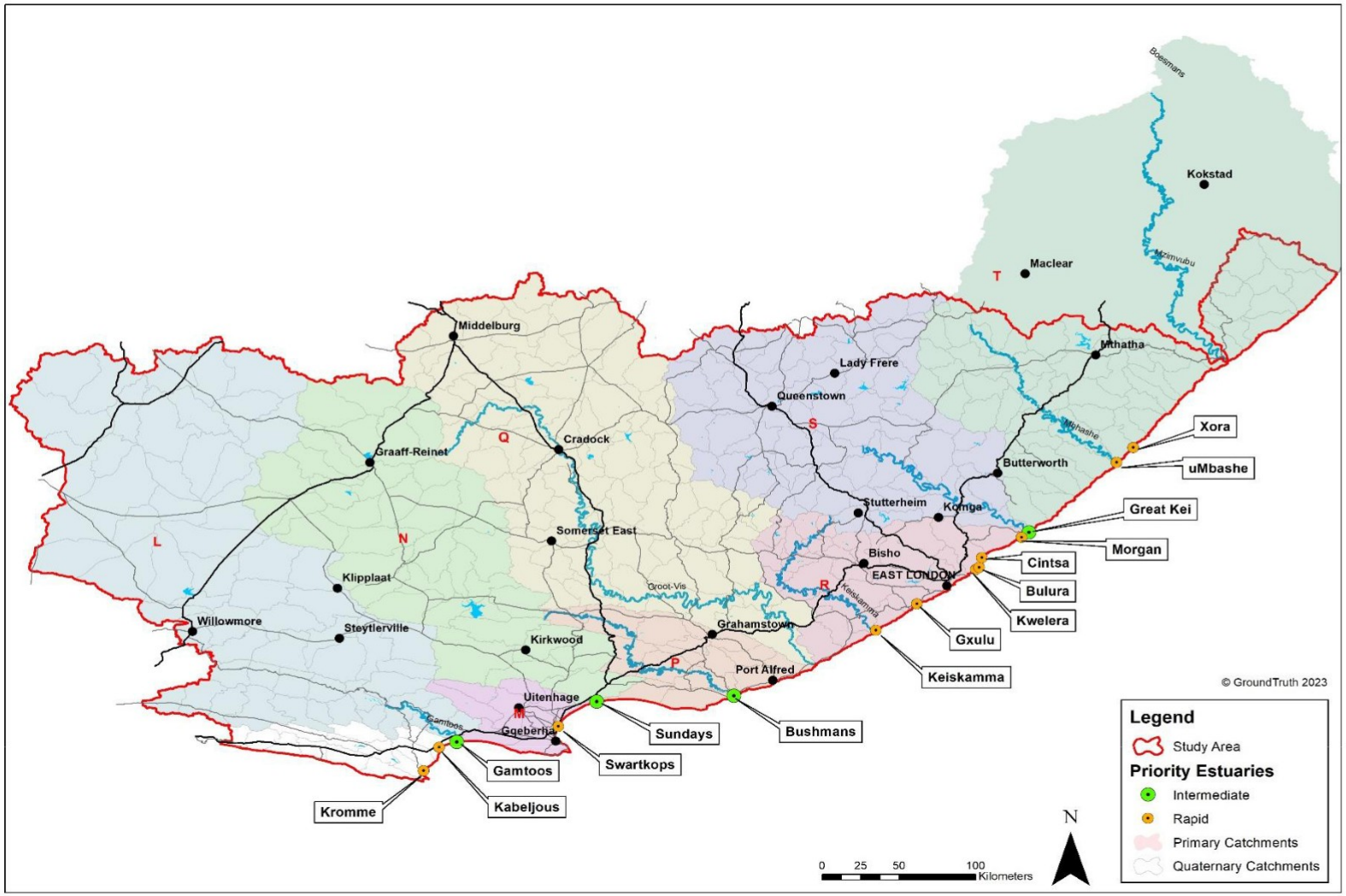


Figure 2-2: Overview of the greater study area (primary catchments)

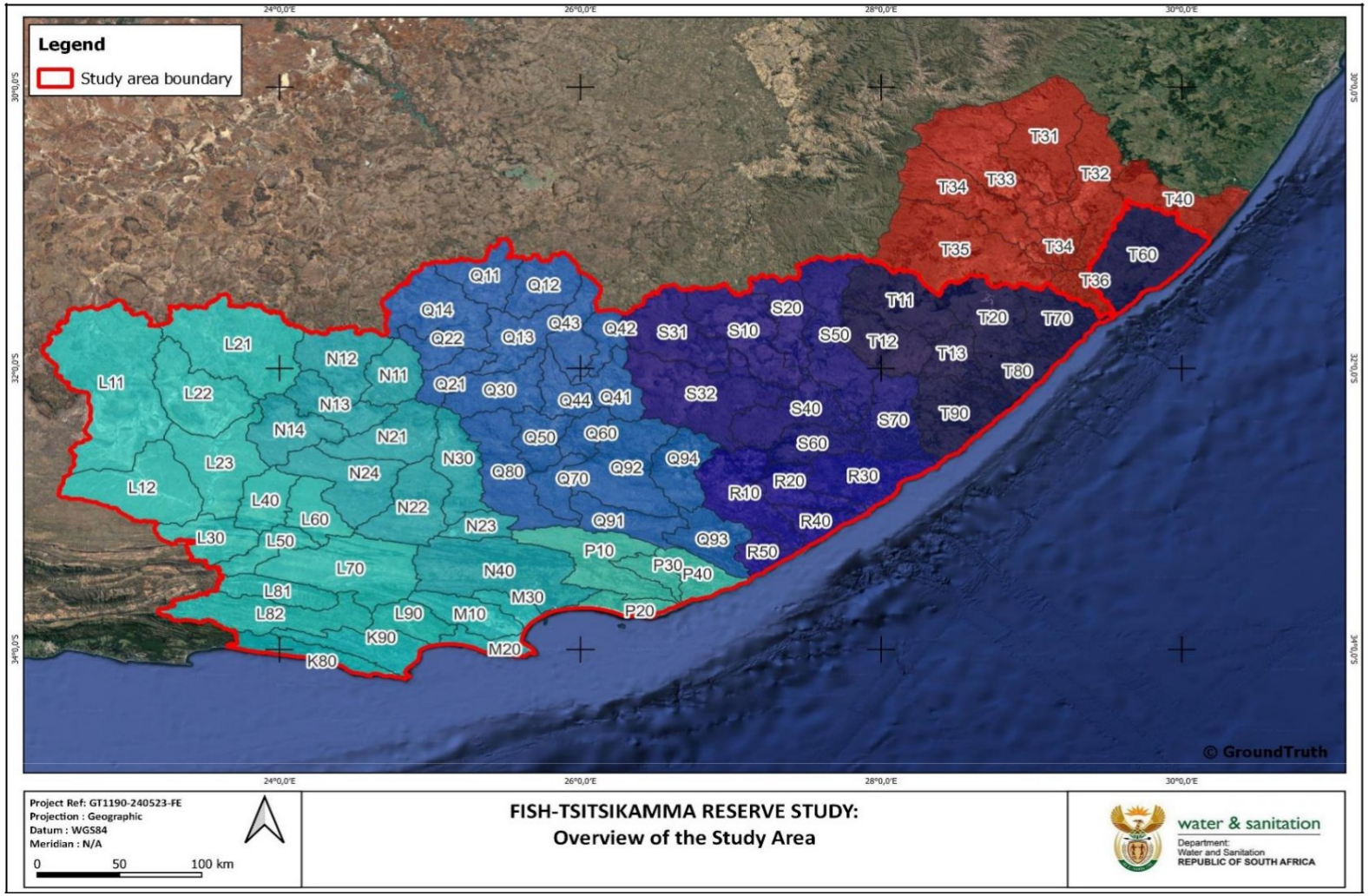


Figure 2-3: Overview of the greater study area (tertiary catchments)

From a groundwater perspective, the major aquifer systems associated with the Cape and Karoo Supergroups are mainly of a fractured type, where groundwater occurrence, is due to secondary deformation relating to faults, fissures, fractures, bedding planes and joints. The Karoo Supergroup also constitutes a fractured and intergranular aquifer over widespread areas associated with intrusive and extrusive igneous rocks, i.e., dolerite sills and dykes as well as basalt. The quaternary sand and alluvium constitute limited intergranular aquifers in the project area where groundwater occurrence is because of pore spaces between sand particles. Borehole yields in the fractured aquifers vary greatly depending on the lithological unit intersected during drilling and the arenacous: argillaceous ratio within the respective lithological units. Refer to Report No. WEM/WMA7/00/CON/RDM/1323 for further information on the groundwater.

There are 251 coastal drainage systems within the study area, comprising 154 estuaries and a further 97 microsystems. Most of the estuaries in the study area are within the warm temperate marine bioregion (>60%) with the rest within the subtropical bioregion. Many estuaries are adjacent to Marine Protected Areas (MPA), including 25 systems in the warm temperature bioregion, such as the Tsitsikamma, the Great Kei and the Pondoland MPAs (Van Niekerk, *et al.,* 2020). Five of the nine different types of estuaries are present in the study area. These include:

i. Small temporarily closed systems,
ii. Large temporarily closed systems,
iii. Small fluvially dominated systems,
iv. Large fluvially dominated systems, and
v. Predominantly open estuaries.

Figure 2-1 illustrates some of the larger estuaries for context to the study area.

2.2 Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) in accordance with Le Maitre *et al.,* 2018 are described as areas of land that either:

a. Supply relatively large quantity of mean annual surface water runoff, being cognisant of their size and thus considered nationally important;
b. Have high groundwater recharge and where the groundwater forms a nationally important resource/ hotspot; or
c. Areas where surface and groundwater importance are integrated and whereby, they include transboundary Water Source Areas that extend into Lesotho and Swaziland (Eswatini).

An update of the 2018 SWSAs have been undertaken in 2021 (Lötter & Maitre, 2021, **Figure 2-4**). This updated information has been used and the SWSAs within the study area were identified. The SWSAs are provided for surface water, groundwater, and surface water-groundwater interaction. Most of the surface water SWSAs are present along the coast, especially in the Tsitsikamma (K80), Kromme (K90), Upper reaches of R10 (Keiskamma) and R20 (Buffalo), S60 (Kubusi) and the rivers in the T catchments (Mbhashe, Mthatha, Pondoland Coastal Rivers). The groundwater SWSAs are scattered throughout the study area, with some

inland in the drier Karoo area (upper reaches of Groot, Sundays and Fish Rivers) and along the coast (**Figure 2-4**).

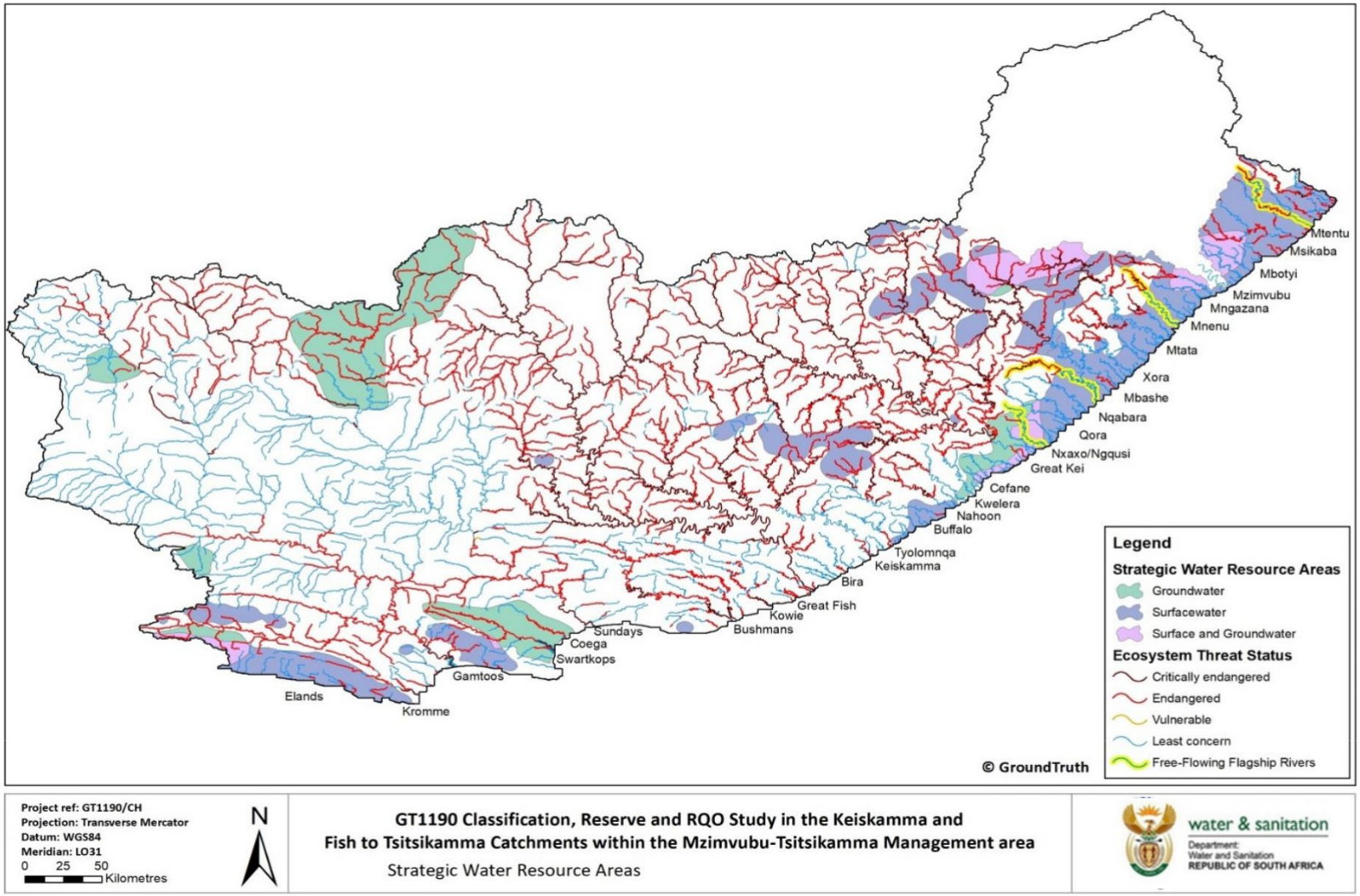


Figure 2-4: Strategic Water Source Areas in the study area

3. SUMMARY OF PRIORITY RIVER RESOURCE UNITS

An assessment of the system was undertaken during the inception, gap analysis and resource units (RU) phases of the study to identify and confirm the priority water resources, quaternary and sub-quaternary catchments, Ecological Water Requirement (EWR) sites, estuary, wetlands and groundwater driven systems where ecological gaps exist that needed to be addressed. These have been supported by the determination of hotspot areas based on an Integrated Ecological Index and Water Resource Use Index. The hotspot assessment identified the level of Reserve determination that was required (see Gap Analysis and Resource Units Reports (Report Numbers: WEM/WMA7/00/CON/RDM/0222 and WEM/WMA7/00/CON/RDM/0422 respectively) for further information).

Based on (i) the assessment of information and data available, (ii) the status quo or current developments and impacts per IUA and (iii) any proposed new developments that will impact on the water resources, three levels of priority were identified for rivers, namely:

- **Priority 1**, where rivers were assessed on an **Intermediate Level.** This was an assessment of the biological responses namely the fish, aquatic macroinvertebrates and the riparian vegetation, following by running their associated models namely the Fish Response Assessment Index (FRAI); the Macroinvertebrate Response Assessment Index (MIRAI) and the Riparian Vegetation Response Assessment Index (VEGRAI). Furthermore, the drivers were also assessed namely the geomorphology, hydrology and water quality Their associated models namely the Geomorphology Driver Assessment Index (GAI), Hydrological Assessment Index (HAI) and assessing the water quality, by inferring information from the diatom community, to ultimately determine the Present Ecological State (PES) using the EcoStatus Level 4 model. The Ecological Importance and Ecological Sensitivity (EI-ES), Recommended Ecological Category (REC) and possible Alternative Ecological Categories (AEC) were also assessed. Furthermore, this Reserve level including the hydraulics and discharge survey data (high and low flows). The Habitat-Flow-Stressor Response approach will be followed to determine the EWRs where applicable. The Fish, Invertebrate Flow Habitat Assessment Model (FIFHA) will be used to assess fish and macroinvertebrate responses (ecological consequences) to the operational scenarios during low flow conditions.

- **Priority 2**, where rivers were assessed on a **Rapid Level 3**. An assessment of the biological responses and interpreting the data thereof through running the MIRAI, FRAI, and Index of Habitat Integrity (IHI) (used as a surrogate to the VEGRAI when running the EcoStatus model), will be used to determine the PES/ EcoStatus, EI-ES and REC. This includes the hydraulics survey data (low flows) used to verify the DRM/RDRM results and determine the EWR. Rapid 3 Reserves are conducted specifically where there are ecological concerns due to Wastewater Treatment Works (WWTWs), smaller scale water use activities (e.g. irrigation, small farm dams, to mention a few); and

- **Priority 3**, whereby **Field Verifiations** were undertaken and additional desktop assessments will be conducted. The objective of verification in identified reaches is to assess and compare the results of the desktop PES, EI and/ or ES and to provide specific recommendations for future management of these smaller tributaries.

Approached for each of the components and models mentioned above are detailed in Chapter 4 below.

Refer to Table 3-1 and Figure 3-1 for the selected intermediate, Rapid 3 EWR sites and field verification sites identified for the study and within each delineated Integrated Unit of Analysis (IUA). In addition, refer to Table 3-2 for those supplementary desktop sites identified. This included measuring the *in situ* water quality, obtaining a diatom sample and running the IHI for additional information regarding the catchments.

Table 3-1: Intermediate and Rapid 3 survey sites per priority RU

			EWR site code				
INTERMEDIATE EWR SITES							
IUA_T03	Lower Mthatha	R_RU15_I	MTHA01_I	Mthatha (Lower)	T20G	-31.92622055	29.13647331
IUA_T02	Lower Mbhashe	R_RU14_I	MBAS01_I	Mbhashe (Middle)	T13C	-31.95809842	28.47223807
IUA_S02	Black Kei	R_RU24_I	BKEI01_R	Black Kei	S32K	-32.11819532	27.06884273
IUA_S03	Lower Great Kei	R_RU13_I	GKEI01_I	Great Kei	S70A	-32.50811888	27.96629455
IUA_S01	Upper Great Kei	R_RU11_I	TSOM01_I	Tsomo	S50G	-32.04397654	27.82105224
IUA_R02	Buffalo/ Nahoon	R_RU10_I	BUFF01_I	Buffalo (Middle)	R20F	-32.99151874	27.64057286
IUA_R01	Keiskamma	R_RU09_I	KEIS01_I	Keiskamma (Upper)	R10E	-32.80233328	27.02430956
IUA_Q03	Koonap and Kat	R_RU08_I	KAT01_I	Kat (Upper)	Q94B	-32.56964523	26.72185233
IUA_Q02	Great Fish	R_RU06_I	FISH03_I	Great Fish (Lower)	Q91B	-33.08373323	26.22527359
IUA_M01	M primary catchment	R_RU03_I	SWAR01_I	KwaZungu/ Swartkops	M10C	-33.72216489	25.30087336
IUA_KL01	Kromme from Kromme Dam to estuary and Gamtoos	R_RU02_I	GAMT01_I	Gamtoos	L90A	-33.76097595	24.69384012
RAPID 3 EWR SITES							
IUA_T04	Pondoland coastal	R_RU31_R	MNGA01_R	Mngazi	T70B	-31.608958	29.405132
		R_RU33_R	NQAB01_R	Nqabarha	T90A	-32.091927	28.400234
		R_RU29_R	MTEN01_R	Mtentu	T60C	-31.130483	29.757179
IUA_T01	Upper Mbhashe, Upper Mthatha	R_RU27_R	MBHA02_R	Mbhashe (Upper)	T11H	-31.807857	28.346994
IUA_S03	Lower Great Kei	R_RU26_R	GCUW01_R	Gcuwa	S70D	-32.319770	28.136094°
		R_RU0_12	KUBU03_R	Kubusi (Lower)	S60B	-32.507220	27.731348
IUA_S01	Upper Great Kei	R_RU21_R	INDW01_R	Indwe	S20D	-31.897077	27.409825

			EWR site code				
IUA_S01		R_RU20_R	WKEI01_R	White Kei	S10J	-32.003057	27.351052
IUA_R01	Keiskamma	R_RU18_R	KEIS02_R	Keiskamma (Lower)	R10L	-33.075316	27.218534
		TYUM01_R	TYUM01_R	Tyume	R10H	-32.910291	26.932242
IUA_Q03	Koonap and Kat	R_RU16_R	KOON01_R	Koonap	Q92G	-33.042856	26.658506
		R_RU15_R	KAT02_R	Kat (Lower)	Q94F	-32.890965	26.684070
IUA_N01	Sundays downstream Darlington Dam	R_RU04_R	SUND02_R	Sundays (Lower)	N40C	-33.404384	25.407919
IUA_L01	Kouga to Kouga Dam, Baviaanskloof	R_RU05_R	KOUG01_R	Kouga	L82D	-33.788449	24.025821
IUA_K01	Tsitsikamma and headwaters of Kromme to Kromme Dam	R_RU01_R	KROM01_R	Kromme	K90A	-33.9370951	24.2690587
FIELD VERIFICATION							
IUA_T04	Pondoland coastal	R_RU34_R	MTAK01_FV	Mtakatye	T70E	-31.615280	29.057710
IUA_SO2	Black Kei	R_RU23_R	KLIP01_FV	Klipplaats	S32G	-32.259687	26.856693
		R_RU22_R	KSMI01_FV	Klaas Smits	S31G	-31.998450	26.894270
IUA_R02	Buffalo/ Nahoon	R_RU35_R	BUFF03_FV	Buffalo (Upper)	R20B	-32.803470	27.370560
		R_RU20_R	BUFF02_R	Buffalo (Lower)	R20F	-32.991768	27.775910
IUA_S03	Lower Great Kei	R_RU25_R	KUBU01_FV	Kubusi (Upper)	S60A	-32.595016	27.423866
		R_RU012_I	KUBU02_FV	Kubusi (Middle)	S60B	-32.595016	27.423866
		R_RU26_R	GCUW02_FV	Gcuwa (downstream of Butterworth)	S70D	-32.319770°	28.136094°
IUA_Q01	Upper Fish	R_RU36_R	GFIS04_FV	Great Fish (u/s Craddock)	Q30E	-32.160740	25.611780
		R_RU12_R	FISH01_FV	Great Fish (Upper)	Q21B	-31.919527	25.390974
		R_RU37_R	GBRA01_FV	Great Brak	Q13B	-31.892160	25.434760
		R_RU13_R	LFIS01_FV	Little Fish (Upper)	Q80B	-32.506170	25.426830
		R_RU38_R	LFIS02_FV	Little Fish (Lower)	Q80G	-33.093450	25.821520

			EWR site code				
IUA_Q02	Great Fish	R_RU07_R	FISH02_R	Great Fish (Middle)	Q50C	-32.604885	25.751772
		R_RU14_R	TARK01_FV	Tarka	Q44C	-32.283315	25.759280
IUA_P01	P primary catchment	R_RU10_R	BOES01_FV	Boesmans	P10G	-33.543899°	26.391105°
IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	R_RU09_R	SUND01_FV	Sundays (Upper)	N22C	-33.078120	25.015480
IUA_K01	Tsitsikamma and headwaters of Kromme to Kromme Dam	R_RU23_R	KABE01_FV	Kabeljous (Lower)	K90G	-33.970394	24.906996
		R_RU01_R	GROO01_FV	Groot (Upper)	K80D	-34.032134	24.195684
IUA_KL01	Kromme from Kromme Dam to estuary and Gamtoos	R_RU39_R	TWEE01_FV	Twee Riviere	L82D	-33.830390	23.898230
		R_RU40_R	GAMT02_FV	Gamtoos (Lower)	L90B	-33.844530	24.866040

Table 3-2: Desktop sites

IUA_KO1	Tsitsikamma and headwaters of Kromme to Kromme Dam	Elandsbos	K80A
IUA_KO1	Tsitsikamma and headwaters of Kromme to Kromme Dam	Tsitsikamma	K80E
IUA_KLO1	Kromme from Kromriver Dam to Estuary and Gamtoos	Kromme (Middle)	K90D
IUA_KLO1	Kromme from Kromriver Dam to Estuary and Gamtoos	Kromme (Lower)	K90E
IUA_KLO1	Kromme from Kromriver Dam to Estuary and Gamtoos	Geelhoutboom	K90E
IUA_KLO1	Kromme from Kromriver Dam to Estuary and Gamtoos	Seekoei	K90F
IUA_KLO1	Kromme from Kromriver Dam to Estuary and Gamtoos	Swart	K90F
IUA_KLO1	Kromme from Kromriver Dam to Estuary and Gamtoos	Diep	K90D
IUA_L01	Kouga to Kouga Dam, Baviaanskloof	Baviaanskloof	L81D
IUA_L01	Kouga to Kouga Dam, Baviaanskloof	Nabooms	L82D
IUA_L01	Kouga to Kouga Dam, Baviaanskloof	Louterwater	L82C
IUA_M01	M primary catchment	Elands	M10C
IUA_M01	M primary catchment	Sand	M10B
IUA_M01	M primary catchment	Chatty	M10D
IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	Kariega	L23D
IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	Groot	L70G
IUA_LN01	Groot to Kouga confluence, Upper Sundays to Darlington Dam	Buffels	L22A
IUA_N01	Sundays downstream Darlington Dam	Coerney	N40D
IUA_P01	P primary catchment	Bloukrans	P40A
IUA_Q01	Upper Fish	Pauls	Q30B
IUA_Q02	Great Fish	Great Fish	Q70C

IUA_Q03	Koonap and Kat	Middle Kat	Q94D
IUA_R01	Keiskamma	Cata	R10B
IUA_R02	Buffalo/ Nahoon	Yellowoods	R20E
IUA_S02	Black Kei	Komani	S31F
IUA_S03	Lower Great Kei	Kubusi	S60E
IUA_T01	Upper Mbhashe , Upper Mthatha	Xuka	T11C
IUA_T01	Upper Mbhashe , Upper Mthatha	Mthatha (Upper)	T20A
IUA_T04	Pondaland Coastal	Xura	T60F
IUA_T04	Pondaland Coastal	Msikaba	T60G
IUA_T04	Pondaland Coastal	Mntafufu	T60K
IUA_T04	Pondaland Coastal	Mzintlava	T60J
IUA_T04	Pondaland Coastal	Bululo	T70B
IUA_T04	Pondaland Coastal	Xora	T80D

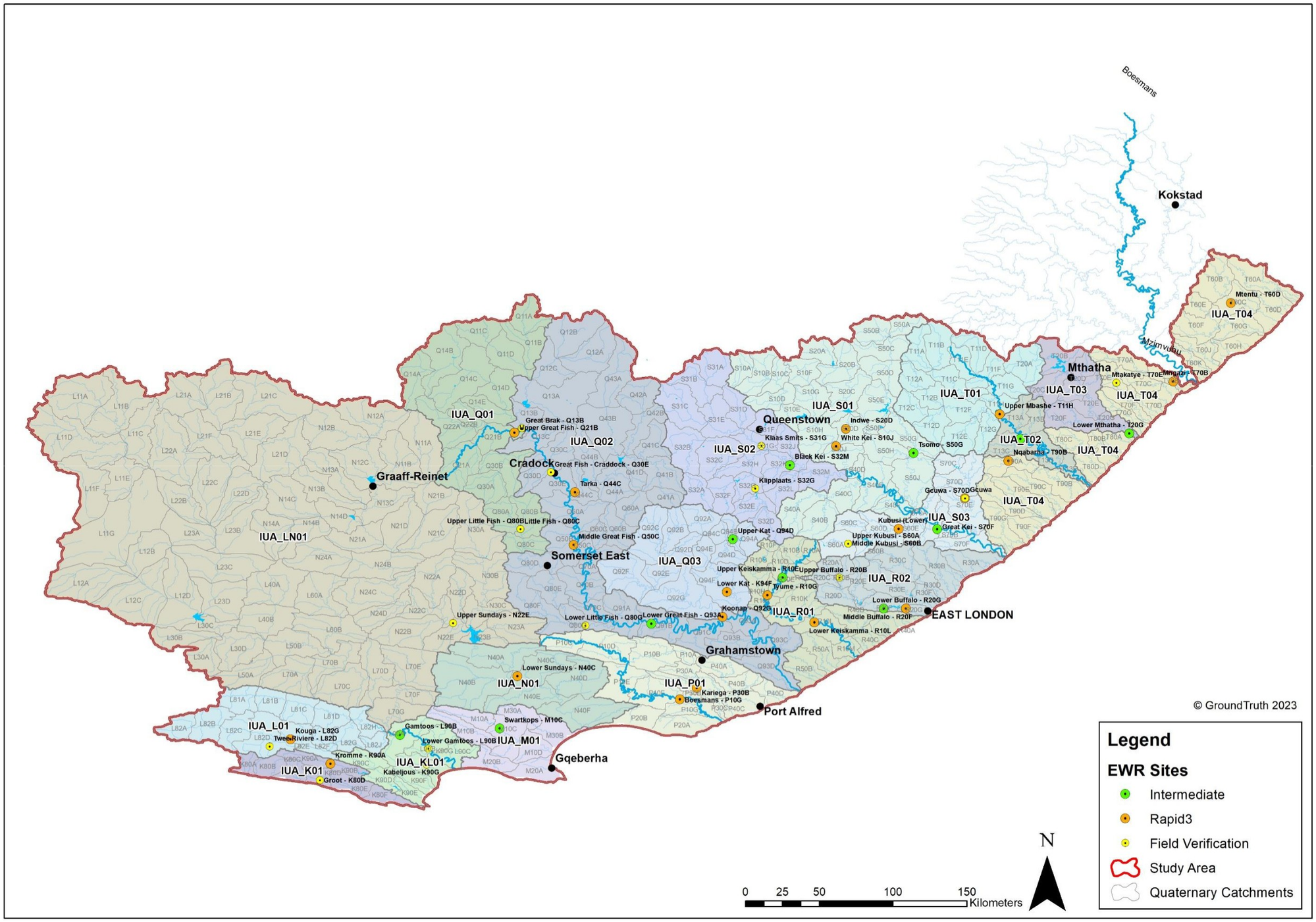


Figure 3-1: Map illustrating the various EWR sites assessed during September 2022 (Intermeidate, Rapid Level 3 and Field Verification) and May 2023 (Intermediate sites only) within each IUA

4. ECO-CATEGORISATION APPROACH

The post low flows and post high-flows river surveys were conducted from 6 – 27 September 2022 and 3 – 15 May 2023 respectively. The post low-flow river survey assessed all identified priority RUs throughout the Keiskamma, Fish to Tsitsikamma catchment areas (Intermediate, Rapid Level 3 and Field Verifications). The post high-flow survey did a re-assessment at the Intermediate sites only.

For further information regarding the two river surveys, please refer to Report number WEM/WMA7/00/CON/RDM/0722 and WEM/WMA7/00/CON/RDM/1423 respectively for the survey reports. Below is a summary of the methods adopted for the various components for the purpose of the eco-categorisation of the rivers.

The Ecological Categorisation[1] (Eco-Categorisation) approach is used to determine and categorise the PES and REC based on the health and integrity of the biophysical attributes of a river ecosystem, relative to the natural reference condition of that system (Kleynhans & Louw 2007). It forms an integral part of the Ecological Reserve determination methods. Flows and water quality conditions cannot be recommended without information on the predicted resulting state, the Ecological Category (EC) (Kleynhans & Louw 2007). The primary objective of the eco-categorisation process is to recognise the causes and sources of the deviation of the derived PES through the various models, in relation to the reference condition of that river's biophysical attributes. The result is to ultimately gain information to derive future desirable and attainable ecological objectives for the river (Kleynhans & Louw 2007).

The various components required for the Eco-Categorisation process to determine the integrated state or PES, the EcoStatus Level 4 model (Kleynhans & Louw 2007) include the following:

- Drivers:
  - Physical-chemical variables/diatoms;
  - Geomorphology; and
  - Hydrology

- Biological Responses:
  - Fish;
  - Riparian vegetation; and
  - Aquatic macroinvertebrates

Below a detailed outline of the various components conducted during the surveys for the eco-categorisation of the various EWR sites.

1 The new terminology of eco-categorisation instead of ecoclassification is being used to differentiate between the process that is followed to categorise the ecological categories as part of the Reserve determination and the approach to determine the water resource classes as part of the Water Resource Classification System.

4.1 Drivers

4.1.1 *Water quality: In situ water quality*

A suite of ancillary *in-situ* water quality was measured in-field at all EWR sites during both surveys. The variables measured included pH, Electrical Conductivity (EC) / Total Dissolved Solids (TDS), Dissolved Oxygen (DO), oxygen saturation (DO%), temperature, salinity, and clarity. Equipment was calibrated before the site surveys to ensure accurate and reliable measurements. All *in situ* water quality were referenced against the South African Guidelines for Freshwater Ecosystems, Volume 7 (DWAF, 1996).

4.1.2 *Water quality: Benthic diatoms*

Sampling of diatoms was done according to the prescribed protocols in Taylor *et al.* (2005). Typically, this entailed collecting five smallish rocks at each sample site from random positions across the river where there was flow of water. The top surface of all the rocks that were exposed to the water column were then scraped using a toothbrush, which removed diatoms attached to the rock surface into a container with a small volume (<100 ml) of river water. Once the rocks had been adequately scraped, the water in the container that has the five subsamples was then transferred to a small sample bottle. A small amount of 95% ethanol (~10% of the sample bottle volume) was then added to the bottle to preserve the diatom sample. Sample bottles were then labelled and submitted to the Northwest University for preparation and analysis. The results from the laboratory were then interpreted according to the Specific Pollution sensitivity Index (SPI) to determine river "health status" (CEMAGREF, 1982). Other useful diatom indices used to further infer water quality conditions were the Percentage of pollution Tolerant Valves (% PTV), which was the proportion of diatoms in the sample that are tolerant to pollution, and the percentage of deformed cells, which was the proportion of diatoms in the sample which were deformed because of toxicants in the water.

For this study, diatoms were used as a surrogate to the Physical-chemical Driver Assessment Index (PAI). The desktop assessment revealed gaps in data available for reference and recent conditions at the EWR sites or the Sub-Quaternary (SQ) reach within which the sites are located. Several data sources were used to collate information of the current and historical Physical-chemical state of the assessed river systems and associate catchments. The DWS Resource Quality Information Services (RQIS) website was the obvious first choice used to obtain data from the country wide DWS monitoring network. Most of data obtained from the RQIS did not show reference/baseline conditions as most of it was collected after major impacts had been introduced in the catchments. Additionally, the lack of consistent monitoring left years' worth of gaps in data. Further, there was no recent data, which posed a challenge when attempts were made to assess the current Physical-chemical state (see Table 4-1 for DWS site information and RQIS data obtained during desktop assessment). Other data sources were also sought for information including local conservation bodies. literature and experts who have done work in the area.

The porosity in data limited the ability to assess site reference conditions confidently and accurately. Additionally, the PAI could not be used for the Physical-chemical class category as it is data dependent. The diatom results obtained from the 2022 and 2023 river surveys

were used to infer the reference condition and the current status of the river systems in question. The use of diatoms in the monitoring of water quality is well documented. In the study, the diatoms were used to infer the reference and current Physical-chemical status of the system for the following reasons:

- **Long environmental memory** – analyses of diatom fossil records allow for the reconstruction of the history of water quality in an area. This is useful in assessing the changes in water over time and possibly infer the reference/natural state of the system in question;
- **Diverse species composition** – diatom communities exhibit extensive species diversity. Each species has unique preferences and tolerances to specific Physical-chemical property changes. By quantifying diatom communities, it is possible to identify which Physical-chemical properties have deviated from natural and are driving the Physical-chemical status currently observed in the system in question;
- **Indicators of nutrient enrichment** – nutrient enrichment is one of the leading contributors to impaired water quality in the catchment. This is largely due to the mismanaged wastewater treatment works, which discharge poorly and, in some cases, untreated wastewater into watercourses. Certain diatom species are known to be good indicators of eutrophic water bodies and identifying river systems with elevated nutrient concentration and prone to algal blooms;
- **Sensitivity to pollutants** – diatoms are also good indicators of inorganic pollution. This is especially an important in identifying heavy metal pollution in river system; and
- **Rapid assessment and monitoring** – diatom sampling and analyses are relatively easy quick and cost effective. This allows for an and effective and holistic assessment of water quality.

In the absence of an adequate dataset to assess reference and current Physical-chemical state, **diatoms** proved to be an adequate surrogate from which information on the Physical-chemical status of the systems can be drawn. Satellite imagery, geographic information system (GIS) and Green Drop data were used to assess the change and identify the catchment drivers of the Physical-chemical state of the systems in question. Combined these sets of data provided a picture of the natural state of each EWR site and how the current state has deviated from reference conditions.

Table 4-1: DWS site information and RQIS data obtained during desktop assessment

Intermediate	Groot River	L7H006Q01	-33.7311	24.6183	Different River within same catchment	1968 - 2016	2486
Intermediate	Kouga River	L8R001Q01	-33.7400	24.5881	Different SQ Reach, immediately downstream of Kouga Dam. Groot, Doringkraal and Hol confluence DOWNSTREAM of DWS site and U/S of the EWR site.	1968 - 2016	1047
Intermediate	Swartkops River	M1R001Q01	-33.6900	25.2667	Dam in different SQ reach	2012	659
Intermediate	Sundays River	N4H001Q01	-33.3778	25.3547	Different SQ	1971 -2023	853
Intermediate	Sundays River	N4H002Q01	-33.4225	-33.4225	Different SQ	1986 - 2012	158
Intermediate	Kariega River	P3H001Q01	-33.5544	26.6036	Site 30 km downstream, with two rivers confluencing before, bush lodges and dams along length of one (Kariega). EWR Site is actually on the Assegaai River, not Kariega	1971 - 2022	1416

Intermediate	Great Fish	Q5R001Q01	-32.5298	25.7568	Site at dam wall U/S of EWR site in different SQ reach. Non-perennial stream draining a relatively little impacted area (sparse farm houses) confluencing before EWR site	1977 - 2008	1630
Intermediate	Great Fish	Q9H012Q01	-33.0981	26.4447	Site 55km downstream of EWR site (different SQ reach), three stream confluencing before. Stream appears to be draining unimpacted areas.	1972 - 2022	1957
Intermediate	Kat River	Q9H026Q01	-32.5767	26.7556	Different SQ Reach, 4.8km downstream of EWR site. Stream confluencing U/S before DWS site and downstream of EWR site	1973 - 2022	862
Intermediate	Keiskamma River	R1H017Q01	-32.7181	27.1064	Dam in different SQ reach 27km upstream of EWR site, stream confulencing upstream of EWR. Seems to be draining rural built-up area.	1989 - 2022	1283
Intermediate	Keiskamma River	R1R001Q01	-32.7181	27.1064	Dam in different SQ reach 27km upstream of EWR site,	2001 - 2021	45

					stream confluencing upstream of EWR. Seems to be draining rural built-up area.		
Intermediate	Buffalo River	R2H027	-32.9916	27.6400	Different SQ	1994 - 2022	919
Intermediate	Black Kei River	S3H013	-32.1739	27.3725	Different SQ Reach 64km downstream of EWR site. Waqu, unknown and Intsikizi rivers confluencing before DWS site	2003 - 2022	418
Intermediate	Tsomo River	S5H002Q01	-32.0433	27.8228	Different SQ	1971 - 2022	535
Intermediate	Great Kei	S7H004Q01	-32.5153	28.0156	Different SQ Reach downstream of EWR site, Toleni River confluencing before DWS site	1990 - 2022	956
Intermediate	Mbhashe River	T1H004Q01	-31.9203	28.4478	DWS site 17 km U/S of EWR site. Qunu River confluencing upstream of EWR. Qunu drains largely built up semi-rural area	1972 - 2017	294

Rapid	Groot River	K8H006Q01	-34.0325	24.1964	Different SQ	1999 - 2023	473
Rapid	Kouga River	L8H005Q01	-33.7906	24.0306	Different SQ	1990 - 2022	1177
Rapid	Sundays River	N2H007Q01	-33.0944	25.0128	Different SQ	1974 - 2022	632
Rapid	Boesmans River	P1H003Q01	-33.3292	26.0775	DWS Site, some 100km upstream of EWR site with three streams coming in U/S and before the EWR site	1971 - 2022	1596
Rapid	Great Fish River	Q2H002Q01	-31.9050	25.4300	Different SQ	1973 - 2023	3121
Rapid	Little Fish	Q8H010Q01	-32.5608	25.4456	Different SQ Reach 7.5km downstream of DWS site, which confluences upstream before DWS site	1986 - 2008	845
Rapid	Great Fish River	Q9H001Q01	-33.1278	26.6139	Different SQ Reach, DWS in Great Fish River 15km before confluence with Koonap	1987 - 2020	1165

Rapid	Buffalo River	R2R003Q01	-32.9892	27.7311	Site immediately downstream of Bridle Drift Dam	1972 – 2022	1985
Rapid	White Kei River	S1H004	-31.8474	27.1852	Different SQ Reach, DWS site 42km upstream of EWR site. 4 streams/rivers confluencing downstream of DWS site and before the EWR site	2003 – 2022	510
Rapid	Indwe River	S2H005Q01	-31.7958	27.4311	Different SQ Reach, DWS site 15km upstream of EWR site. Immediately downstream of dam and weir	1996 – 2022	560
Rapid	Indwe River	S2R001Q01	-31.7958	27.4311	Different SQ Reach, DWS site 15km upstream of EWR site. Immediately downstream of dam and weir	1980 – 2022	1480
Rapid	Klaas Smits River	S3H006Q01	-31.9233	26.7864	Different SQ Reach, DWS site 18km upstream of EWR site. Komani River which drains Queenstown area confluencing downstream of DWS site and before the EWR site.	1977 - 2022	1354

Rapid	Kubusi River	S6H002Q01	-32.5756	27.6231	Different SQ	1971 – 1995	759
Rapid	Gcuwa River	S7H001Q01	-32.3275	28.1447	Different SQ Reach, DWS site 10km upstream of EWR site. iCegcuwana River confluencing downstream of DWS site and before the EWR site	1971 – 2022	730
Rapid	Mngazi River	T7H001Q01	-31.5547	29.2456	Different SQ Reach, DWS site 28 km upstream of EWR site. Mgwenyana River confluencing downstream of DWS site and before the EWR site	1971 - 2022	564
Rapid	Xuka River	XUKA RIVER (1) AT THE BRIDGE ON R61	-31.6719	28.1108	Different SQ Reach, DWS site 62km upstream in the Xuka River.		
Rapid	Tarka River	Q4H013Q01	-32.3139	25.7414		1993 - 2022	1298

4.1.3 *Geomorphology*

The geomorphology was assessed at all Intermediate EWR sites, using the GAI method that was developed by Rowntree. (2013), with Level 4 assessments carried out for each site. This included the following general steps for undertaking a Level 4 GAI field assessment:

- Classify and describe the site using river planform, valley confinement, reach type; slope, morphological features and sediment composition;
- Define the reference state to describe the natural/pristine condition of the geomorphology at each site to benchmark changes in geomorphology at the time of Intermediate surveys (i.e., the present ecological state). This was largely based on historical aerial photos and the geomorphic zone classification;
- Assess the changes to connectivity (hillslope-channel, longitudinal, lateral and vertical);
- Describe and assess the changes to the sediment balance for the reach (catchment erosional process, channel erosion and channel mining);
- Describe and assess the impacts on the stability of the bed, banks, and flood zones (changes to vegetation cover, trampling, excavation); and
- Describe and assess the impacts on the morphological condition and habitat (changes to channel dimensions, sediment composition, extent of habitat).

These data were used in the GAI level 4 model to derive a PES score with flow relation and confidence scores.

4.1.4 *Hydrology*

The Hydrological Assessment Index (HAI) has been developed as part of the methodologies for the determination of the Ecological Water Requirements. The approach provides an indication of the changes in hydrology from reference/ natural to present day at each selected intermediate EWR site and is based on monthly long term natural and present-day flow time series. The result of HAI is used by ecologists to interpret changes in habitats using the hydraulics (depths, velocities, wetted perimeter, etc.) and to explain some changes in the response components (fish, macroinvertebrates, vegetation).

The assessment is based on the long-term changes from natural to present with 0, no change to 5, extreme change from natural in five metrics, namely:

- Low flows – changes to baseflows and can either be less or more flows than natural or the introduction of constant flows due to dam releases;
- Introduction of zero flows/ duration – Changing a perennial system (no zero flows) to a more seasonal or even ephemeral system due to no flows or the duration of the zero flow months increase in a seasonal stream;
- Seasonality – changes due to reduced flows during wet months (storing of excess runoff in dams) and releases from these dams during dry months for water use downstream. The so called "swopping of seasons";

- Moderate events – changes to moderate floods/ freshets due to delayed spilling of dams after dry season (dam need to fill with first rains), thus delaying the early season cleaning of the rivers from algae and sediment build-up (flushing event); and
- Even hydrology (floods) – reduction in the peaks of flood events or less frequent spilling due to large dams capturing most of the catchment runoff, resulting in the loss of important ecosystems.

Ecologists rank these metrics according to the impact that changes will have on the available habitats, thus affecting the overall habitats.

4.2 Responses

4.2.1 *Ichthyofauna*

Fish samples were collected using different techniques, including electrofishing, cast netting as well as from visual observations at all Rapid 3 and Intermediate EWR sites. Fish sampling techniques were deployed in a variety of depth and flow classes to sample each habitat to show fish species preferences for each. Electrofishing is regarded as the most effective single method for sampling fish communities in wade-able streams (Plafkin *et al.*, 1989). Fish were identified in the field, photographed and released at the point of capture. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001).

The FRAI method developed by Kleynhans (2007) for application in South Africa was used to assess the response of the reference fish assemblage to changing environmental conditions based on the observations made during the two river surveys. Fish species are categorised in the FRAI model according to an intolerance rating that take trophic preferences and specialisation into account, as well as all the flow, habitat, and water quality requirements. The ratings are then formulated into a relative FRAI index value, which is grouped into one of six descriptive fish assemblage integrity index classes.

The expected and observed Frequency of Occurrence (FROC) of fish species were compiled using the reference frequency of occurrence for fish species in South Africa (Kleynhans *et al.,* 2007). Data from the 2014 Present Ecological State (PES) - Ecological Importance and Ecological Sensitivity (EIS) dataset (DWS, 2014) was also consulted with the derivation of FROC. Additional fish data was also gathered from Mr Elliot Weni from DWS, who conducts the fish sampling at some of the REMP sites through the Keiskamma, Fish to Tsitsikamma study area. These sites were aligned to some of this studies EWR sites. This enabled the specialist to supplement the fish database, and which was added to the FRAI model, supporting both reference conditions and/or fish data recorded for the last hydrological year. These FROC values were used to interrogate the FRAI model to evaluate changes from reference conditions. FRAI is a rule-based model developed by DWA (Kleynhans, 2007) that assesses environmental intolerances and preferences of the reference fish assemblage, as well as the response of the constituent species of the assemblage to particular groups of environmental determinants or drivers. These intolerance and preference attributes are categorised into metric groups with constituent metrics that relates to the environmental requirements and preferences of individual species.

Assessment of the response of the species metrics to changing environmental conditions occur either through direct measurement (surveys) or are inferred from changing environmental conditions (habitat). Evaluation of the derived response of species metrics to habitat changes are based on knowledge of species ecological requirements. Usually, the FRAI is based on a combination of fish sample data and available habitat for fish. Changes in environmental conditions are related to fish stress and form the basis of ecological response interpretation and to determine the Present Ecological Category of the fish assemblage.

4.2.2 *Riparian Vegetation*

Riparian vegetation was assessed at all Intermediate EWR sites only, using the VEGRAI method that was developed by Kleynhans et al. (2007), with Level 4 assessments carried out for each site. This included the following general steps for undertaking a Level 4 VEGRAI:

- Define the reference state to describe the natural/pristine condition of riparian vegetation at each site to benchmark changes in riparian vegetation at the time of Intermediate surveys (i.e., the present ecological state);
- Establish the extent of the riparian zone and divide into two zones (i.e., marginal and non-marginal zones) based on signs of zone interfaces (i.e., topographical/elevation changes, plant composition/community changes, terrestrial vegetation, etc.);
- Assess the condition of marginal and non-marginal zones taking note of key drivers and pressures;
- Describe the native woody (i.e., trees and shrubs) and non-woody vegetation (i.e., grasses, sedges, reeds, forbs, etc.) within each zone, taking note of key/indicator/dominant species;
- Obtain estimates of the cover, abundance, and composition of woody and non-woody vegetation; and
- Evaluate and interpret any impacts observed at each site that are affecting riparian vegetation in terms of vegetation removal, alien vegetation invasion, and water quantity and water quality, and assess the intensity and extent of each impact.

4.2.3 *Index of Habitat Integrity*

This index was conducted at all Rapid 3 EWR sites and field verification sites, as prescribed in Kleynhans et al. (2008). The Index of Habitat Integrity (IHI) assessed indicators of instream and riparian habitat modification. Furthermore, it essentially considered the deviations/changes of habitat from natural conditions with reference to intensity and extent of human-induced impacts that have affected habitat integrity within river catchments. The assessments were achieved through determining the condition of each site by incorporating biological responses to driver changes (e.g. hydrological, geomorphological, physic-chemical, etc.) as well as through an integration of driver state or condition. The instream criteria assessed included water abstraction, flow modification, bed and channel modification, physical-chemical, inundation, alien macrophytes, introduced aquatic fauna and rubbish dumping. The riparian integrity took cognisance in vegetation removal, alien vegetation, bank erosion, channel modification, water abstraction, inundation, flow modification and physical-chemical conditions. The riparian score from this index was consequently used as a surrogate to the VEGRAI score for Rapid 3 sites when running the EcoStatus Level 4 model.

4.2.4 *Aquatic Macroinvertebrates*

Aquatic macroinvertebrate sampling was done using the Soth African Scoring System (SASS) version 5 protocol, as developed and refined by Dickens & Graham (2002). This index measures aquatic macroinvertebrate presence data at a family taxon level. Each taxon is allocated a sensitivity value between 1 and 15 according to its perceived sensitivity to water quality changes (with 1 being the least sensitive and 15 the most sensitive). Results are expressed as index scores: the SASS Score and the Average Score per Taxon (ASPT). This SASS5 technique has been accredited to ISO 17025 standards and forms part of one of the DWS river eco-categorisation models for EcoStatus determination. The SASS5 sampling was undertaken by an accredited SASS5 practitioners at all Rapid 3 and Intermediate EWR sites during both river surveys. The prescribed DWS MIRAI (Thirion, 2008) uses SASS5 and pre-determined reference condition data to determine the macroinvertebrate Ecological Condition of a site. The model considers three main drivers influencing macroinvertebrate community composition, namely: i) flow, ii) habitat and iii) water quality. These drivers create the instream habitats that affect instream biotic communities. Therefore, the Ecological Category generated by the MIRAI reflects the influence of each driver on the site and the macroinvertebrate community.

Additional aquatic macroinvertebrate data was gathered from Dr Christa Thirion, Ms Nqabisa Gwentshe, Ms Portrait Tshatshu and Ms Lorna Dlakana from DWS, who conducts the SASS5 biomonitoring at all REMP sites through the Keiskamma, Fish to Tsitsikamma study area. These sites were aligned to some of this studies EWR sites. This enabled the specialist to supplement the macroinvertebrate database, and which was added to the MIRAI model, supporting both reference conditions and/or macroinvertebrate data recorded for the last hydrological year.

4.3 Ecological Categories

Varying procedures are followed for each component to assign an Ecological Category (EC) ranging from A to F (where A represents a natural state and F a critically modified state) (**Figure 4-1**). It must be noted that the ecological category scale represents a continuum whereby the boundaries between categories, along the continuum, are descriptive, notional and arbitrarily defined points. Subsequently, there may be circumstances where there could be ambiguity as to which category a particular entity belongs to. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson *et al*., 2004). This is therefore referred to as boundary categories and assigned a B/C, C/D category etc (Figure 4-1)**.**



Figure 4-1: Illustration of the distribution of ecological categories on a continuum

4.4 EcoStatus and Recommended Ecological Categories

Ecological evaluation against the expected reference conditions, followed by integration of the categories of each component, provides a description of the Ecological Status or *EcoStatus* of a river. Consequently, the EcoStatus is defined as the integration of the river's features (instream and riparian zones) which influences its ability to support appropriate biota (Kleynhans & Louw 2007). This ability relates directly to the capacity of the system to provide a variety of ecosystem services.

The trends in the PES are then evaluated. A trend is viewed as a directional change in the attributes of the drivers and biota (as a response to drivers) at the time of the PES assessment. A trend can be absent (close to natural or in a hanged state but stable), negative (moving away from reference conditions) or positive (moving back towards natural - when alien vegetation is cleared, for instance). The ultimate objective is to determine if the biota have adapted to the current habitat template or are still in a state of flux. Generally, such an assessment can be approached from a driver perspective. This means that there can be a positive or negative trend response from the biota if the drivers (specifically geomorphology and water quality) are still in a directional state of change (+ or -).

It must be noted that cognisance was taken when comparing the PES, 2014 and the EcoStatus 2023. The PES, 2014 was based on various components, while the EcoStatus 2023 was only based on fish, macroinvertebrates and riparian vegetation, or for Rapid 3 sites, the riparian habitat integrity was used as a surrogate. The reason for deviation is thus provided.

Furthermore, the evaluation/comparison of the following 9 ecological importance and 8 ecological sensitivity (EIS) were evaluated for each EWR site using the PES/EIS (2014) study (although the EIS was done per sub-quaternary reach), along with in-field results from the surveys:

(i) Ecological Importance
- Fish representivity and rarity
- Macroinvertebrate representivity and rarity
- Riparian-wetland-instream: vertebrates
- Riparian-wetland-instream: natural vegetation
- Habitat diversity
- Habitat size
- Habitat integrity
- Riparian-wetland habitat integrity
- Instream and riparian migration

(ii) Ecological Sensitivity
- Physical-chemical sensitivity:
- Fish and macroinvertebrates
- Fish: no flow
- Macroinvertebrates: velocity
- Riparian-wetland-instream – vertebrates: flow or water level changes
- Riparian-wetland – vegetation:
- water level changes

- Stream size (flow/water level changes)

This updated information was then used when assessing the Recommended Ecological Category (REC) for the EWR site. The *modus operandi* followed by DWS's Directorate: Resource Directed Measures (RDM) is that, if the EIS is high or very high, the ecological aim should be to improve the condition of the river. However, the causes related to a particular PES should also be considered to determine if improvement is realistic and attainable. This relates to whether the problems in the catchment can be addressed and mitigated. If the EIS evaluated as moderate or low, the ecological aim should be to maintain the river in its PES. Within the Ecological Reserve context, Ecological Categories A to D can be recommended as future states (the REC) depending on the EIS and PES. Ecological Categories E and F - the PES is regarded as ecologically unacceptable, and remediation is required.

4.5 Eco-categorisation Workshop

Following both seasonal surveys undertaken in September 2022 and May 2023, an Eco-Categorisation specialist workshop was held on 18 and 19 October 2022 and 21 and 22 June 2023, to determine the EcoStatus of the Rapid 3 and Intermediate EWR sites respectively. The process included the following:

- Description of site localities within the catchment (EWR and field verification sites);
- Type of historical and existing information availability for each site (EWR and field verification sites);
- Characterisation and evaluation of each site in terms of both the drivers and responses identified (*i.e.,* habitat availability, aquatic biota, water quality) and associated advantages and disadvantages of each component (EWR and field verification sites);
- Reference conditions for the aquatic biota (EWR sites only);
- Description of both site and upstream impacts (EWR and field verification sites);
- Completion of the EcoStatus 4 model resulting in an overall PES category and score coupled with an explanation for each component (EWR sites only);
- A comparison using the previous PES results from preceding Reserve studies (mentioned above) was undertaken to compare the final selected PES identified during this study from the EcoStatus Model 4 and reasons for the potential deviations;
- Assessment of the PES ecological trends from 2014 for each component (aquatic biota and riparian and instream habitat integrity) (EWR sites only);
- Evaluation/ comparison of the EIS;
- Discussion and finalisation of the REC (for all Rapid 3 and Intermediate EWR sites), as well as the Target Ecological Category (TEC) (for Intermediate sites only).

4.6 Eco-categorisation Volume 2 (pre-requisite for this volume 1 report)

Please note that the following Report number *WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report – Volume 2* must be read in conjunction to this report. The Volume 2 includes all summaries of models and results/data for all EWR sites for the various components as follows:

- Appendix A: Diatom summary results
- Appendix B: Fish inventory and FRAI Models
- Appendix C: SASS5 data and MIRAI Models
- Appendix D: Riparian vegetation inventory and VEGRAI Models
- Appendix E: Summary of IHI Models
- Appendix F: EcoStatus Models
- Appendix G: Summary of HAI Models
- Appendix H: GAI Models
- Appendix I: Summary of EI-ES Models

Please note, that all completed electronic models (MIRAI, FRAI, VEGRAI, GAI and HAI) have been packaged and submitted to DWS for their records within a folder.

5. ECO-CATEGORISATION: INTERMEDIATE RESERVE SITES

5.1 MTHA01_I: Mthatha River (Lower)

Sample Date	7 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	MTHA01_I	**IUA**	IUA_T03
River	Mthatha	**IUA description**	Lower Mthatha
Altitude (m.a.s.l.)	6m	**Prioritised RU**	R_RU15_I
Latitude	-31.92622055	**Longitude**	29.13647331
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T20G
Level 2 EcoRegion	31.01	**SQ Reach**	T20G-06794
Geomorphological zone	E (0.003)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology			
(Figure 5-1)		(Figure 5-2)	

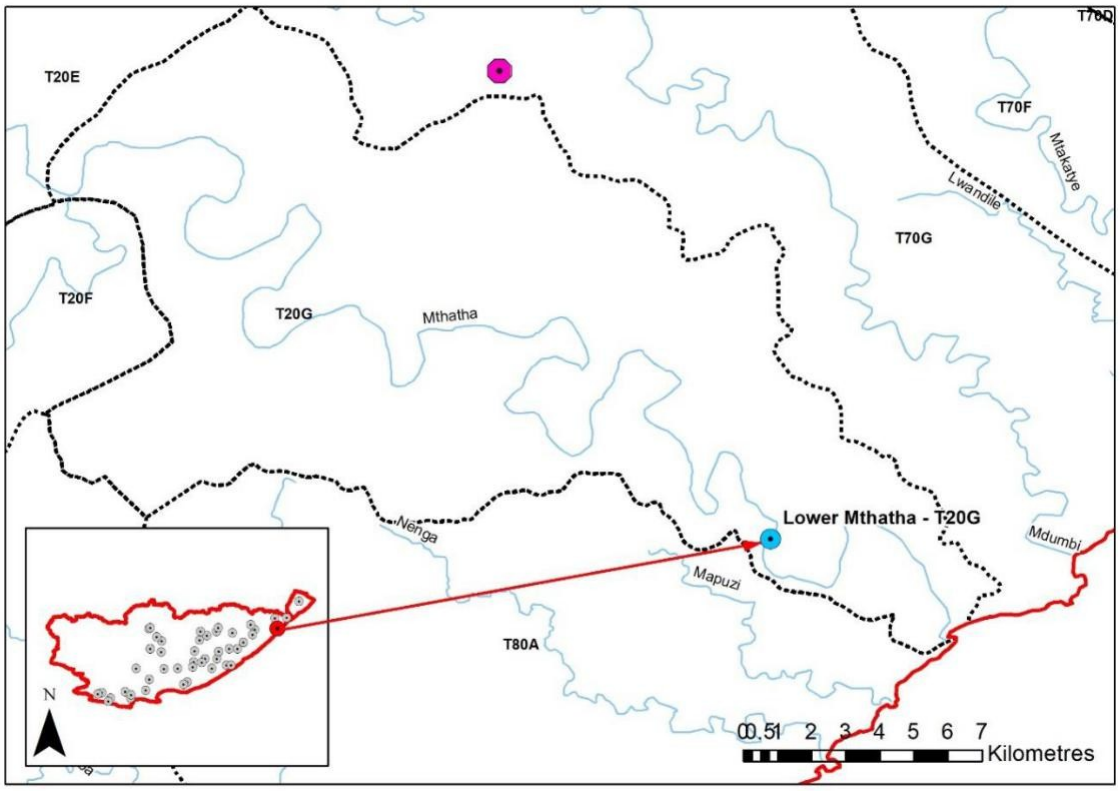


Figure 5-1: Location of site MTHA01_I (Lower Mthatha) in relation to the study area *(pink dot represents an existing WWTW)*

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)

Drone images could not be taken owing to the rainfall conditions at the time of the survey.





Figure 5-2: Site photographs of the lower Mthatha EWR site

Site Description:

The site is located near the Ntshilini Catholic Church and Sidabadabeni and is 6km from the coastline.

The site is located along a partly confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by boulder, cobble and gravel sediment types. Large gravel and cobble bars alternate along the active channel. Benches are composed of silt and sand. There is low embeddedness along riffles, runs and pools. There are signs of erosion along the channel margins and on the flood benches, with very little signs of sediment deposition. A silt drape is visible on the boulder, cobble and gravel where velocities are low in pool habitats.

Owing to constant rainfall conditions at the time of the May 2023 survey, saw the Mthatha River in flood and burst banks. Consequently, the biological component could not be conducted, nor could the cross-section or discharge be remeasured. Only slope and water levels were measured, and the riparian vegetation component conducted.

Biota habitats available
During the September 2022 survey, all biotopes, except for marginal and in-stream aquatic vegetation, was present. The marginal vegetation was limited owing to undercut banks along both banks. Fish habitats included slow-shallow (SS), slow-deep (SD), fast-shallow (FS) and fast-deep (FD).

Riparian vegetation
Owing to the system being flooded at the time of assessment, the marginal zone was inundated and not visible, with portions of the flood benches on both banks also flooded. Vegetation protruding from the water surface included *Miscanthus ecklonii, Sesbanea punicea, Gomphostigma virgatum* and sedges. Flood benches were overgrazed with *Cynodon dactylon* and *Hemarthria altissima* forming lawns, and were heavily invaded by alien weeds, *S. punicea,* and *Senna didymobotrya*. *Miscanthus eckloniii* also occurred along flood benches and toward the channel. Vegetation surrounding upstream pool habitats included overhanging *Ficus sur, Combretum caffrum* and *Cestrum laevigatum*, with some mud drapes also visible. The gently sloping macro-channel banks were highly disturbed and severely invaded by perennial alien species, including *S. punicea, S. didymobotrya, Lantana camara, C. laevigatum* and vegetation removal was high.

Site impacts:

- Upstream towns and villages
- WWTW
- Bridge
- Alien invasive plant species (riparian zone) (lantana)
- Upstream weir
- Algae and fine silt layer over stones biotope
- Erosion
- Cattle trampling and grazing

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.77	*Was not measured as system was in flood*
EC (µS/cm)	764.1	
TDS (g/l)	0.3362	
DO (mg/l)	7.67	
DO% (%)	85.8	
Clarity (cm)	45	
Temperature (°C)	20.8	
Salinity (ppt)	0.25	
Discharge (m^3/s)	0.959	

DIATOMS*

No. species	SPI**	Categorisation (quality)	%PTV***	%Deformed cells****
September 2022				
30	15.5	B (Good)	6.9	4
Dominant Species	*Achnanthidium spp.*			
Preference	Moderate to good quality waters			

**Refer to Appendix A of Report number WEM/WMA7/00/CON/RDM/1823 (a): Eco-categorisation Report-VOLUME 2*

***Specific Pollution sensitivity Index (>17: A-high water quality; 13-17: B-good water quality; 9-13: C-moderate water quality; 5-9: poor water quality; and <5: E critical water quality) (adapted from Eloranta & Soininen, 2002)*

****The percentage of pollution tolerant valves (<20: site free from organic pollution; 21-40: some evidence of organic pollution; 41-60: Organic pollution likely to contribute significantly to eutrophication; and >61: Site is heavily contaminated with organic pollution (adapted from Kelly, 1998)*

*****Deformed cells: a red flag (>2%) showing potential harmful pollutants within the water column. These toxins have the potential to disturb the cell walls morphogenesis and the silica which is then laid down incorrectly in the cell wall causing changes in the cell outline or in the striae patterns of the species. Therefore, a lack to no deformed cells suggests heavy metals are not a consistent issue at the site.*

The above applies throughout the report

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2	• Simple channel form	• Directly downstream of a bridge near the interface with the estuary
Fish	3	• Good representation of velocity-depth classes • Various cover features present • Low-level weir to concentrate fish	• Seasonal limitations • River flooded during second survey
Macroinvertebrates	3	• SIC, SOOC, GSM • Varying flow conditions during the September 2022 survey • DWS REMP Site code: T2MTHA-MDUMB	• Limited marginal vegetation and no instream aquatic vegetation • Undercut banks • High suspended sediment concentration and coverage over SIC and SOOC biotopes
Riparian vegetation	3	• Range of habitats present at the site. • Good diversity of riparian plant indicators	• Marginal zone and portions of flood bench inundated at the time of assessment. • High levels of disturbance and vegetation removal • High levels of AIP
Geomorphology	3.25	• Range of geomorphic features and sediment types present at the site	• Disturbances at the site due to sand mining and cattle crossing/watering point

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation
Fish						• FROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records • DWS REMP Site code: T2MTHA-MDUMB • September 2022 river survey
Macroinvertebrates						• One river survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: T2MTHA-MDUMB
Hydrology						• Monthly hydrology available for natural and present day
Geomorphology						• Historical and recent air photos available • No literature for the site or system
Riparian vegetation						• Riparian vegetation data collected during field verification visits.

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1938 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Single survey (September 2022)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity • Green Drop Reports 2011, 2013 and 2021. Data available for the WWTW upstream, in Mthatha • 2022 Diatom results. • NCMP Data Site T2H005Q01(2007-2018, n=220)

** 0 (no information) to 4 (large amount of data available)*

Reference Conditions	
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla bicolor bicolor, Anguilla marmorata, Anguilla mossambica, Awaous aeneofuscus, Enteromius anoplus s.l., Gilchristella aestuaria, Glossogobius callidus, Glossogobius giuris, Microphis fluviatilis, Monodactylus argenteus, Monodactylus falciformis, Mugil cephalus, Pseudomyxus capensis, Oreochromis mossambicus, Redigobius dewaali*

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Atyidae, Paleomonidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Polymitarcyidae, Prosopistomatidae, Trichorythidae, Calopterygidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Lestidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Hydropsychidae >2spp, Philopotamidae, Polycentropodidae, Hydroptilidae, Leptoceridae, Pisuliidae, Dytiscidae, Elmidae, Gyrinidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae
Riparian vegetation	This site occurs within the Indian Ocean Coastal Belt Biome, Indian Ocean Coastal Belt Bioregion, and the Transkei Coastal Belt vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone is expected to be dominated by non-woody vegetation, mainly grasses and sedges, but with a scattered woody component comprising *Salix mucronata* and *Gomphostigma virgatum*. The flood benches are expected to be a mixture of woody and non-woody species, predominantly riparian, with grasses, sedges and smaller obligate species such as Cape Willow. The reference state is expected to be dominated by both riparian and terrestrial trees and shrubs forming a dense and distinct riparian corridor with an understorey of shade-loving grasses.
Hydrology	Monthly natural flows available for period 1920 to 2009
Geomorphology	In its reference condition, the Mthatha River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle or pool-rapid reach types. Sand and gravel bars can be present in pools and along the margins of the riffles. Narrow inset benches composed of sand and gravel and flood benches of sand, gravel and cobble could be present as a result of freshets and infrequent floods.
Physical-chemical	Reference Physical-chemical data for the site could not be obtained. The diatoms data were used to infer the reference condition. Diatoms results indicated moderate to good quality water conditions, suggesting minimal change from reference condition. % Deformed cells, however, indicated a source of high inorganic pollution at the site not expected to have been present under reference conditions.

COMPONENT	PES category & score	Flow (F)/ Non-flow (NF)	EXPLANATION
Fish (FRAI)[a]	C (70.0)	F/NF	• Several dams along the river reach upstream (flow modification) • Loss of seasonal flows • Presence of alien *Cyprinus carpio* • Sediment inputs

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow (F)/ Non-flow (NF)**	**EXPLANATION**
Macroinvertebrates (MIRAI)[b]	C (66.0%)	F/NF	• Several dams along the river reach upstream (flow modification) • Loss of seasonal flows • Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope • High sedimentation concentrations
Riparian vegetation (VEGRAI)[c]	D (53.7%)	F NF	• The Umtata Dam upstream is likely to cause some flow regulation and reduced flood peaks. • Overgrazing and clearing for access, pump stations and agriculture. • High levels of AIP: in addition to annual alien weeds, *Sesbanea punicea, Solanum torvum* and *Lantana camara* were common and dominant in places.
Geomorphology (GAI)[d]	C (66.3%)	33% flow related	• Widespread erosion in the catchment, especially in the upper catchment. • Several dams in the upper to middle catchment along the Mthatha River. • Sand mining of flood benches and trampling by livestock along the banks destabilizes the geomorphic features at the site. • Inset benches are eroded and the bed appears armoured • Silt drape and coarse particle embeddedness in low-velocity biotopes due to high suspended sediment concentrations
Hydrology (HAI)[e]	B (87.1%)	F	• Mthatha Dam in upper reaches reducing floods • Releases for hydropower resulting in more constant flows
Diatoms/Physical-chemical[f]	B (15.5)*	NF	• Moderate to good quality waters. • Site located approximately 10km from the ocean • Closest impact on Physical-chemical status of this stretch is the town of Mthatha more than 100km upstream. • The impacts from the town of Mthatha are diluted with the Zimbane, Cumngce and Ngqungqu confluencing downstream. • This stretch of the river is mostly rural areas an no significant agricultural activities occur here.
ECOSTATUS (PES)[g]	D	Riparian vegetation is the driver of the EcoStatus result (categorised as a D) primarily owing to excessive alien invasive species within riparian zone.	

**Based on diatom SPI*

[a] *Refer to Appendix B of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report– Volume 2*

[b] *Refer to Appendix C of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report– Volume 2*

[c] *Refer to Appendix D of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report– Volume 2*

[d] *Refer to Appendix H of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report– Volume 2*

[e] *Refer to Appendix G of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report– Volume 2*
[F] *Refer to Appendix A of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report– Volume 2*
[g] *Refer to Appendix F of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report– Volume 2*
The above applies throughout the report

Component: PES and causes	
	Causes Present/Absent
Fish[a]	The reach associated with the EWR supported various velocity-depth classes as well as cover features, with riffle-run habitat present at the cross section and long deep pools present both upstream and downstream of the EWR cross-section. Upstream of the cross-section, a low-level weir was present that likely acted as an upstream movement barrier to some degree but would be easily drowned out during high flows. The EWR site is located at or close to the freshwater-estuarine interface zone, with several estuarine-dependent species collected at the time of the September 2022 assessment. During the same assessment, the highest abundance and widest range of size class for *Anguilla marmorata* were noted as was several *Anguilla mosambica*, supporting the importance of the reach as a migratory route for eels. No survey could be conducted during the May 2023 field survey due to a flood event. Application of the FRAI model utilising data collected during the September 2022 assessment as well as taking into consideration collection data from recent River EcoStatus monitoring studies, it was determined that the fish assemblage was in a moderately modified state (Ecological Category C), with drivers remaining comparatively unchanged to that perceived under reference conditions. However, increases in the contributions of flow modification, physical-chemical, migration and the potential impact of alien fish species relative to reference conditions were noted, with the migration metric considered a significant diver owing to the strong presence of migratory eels.

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	100.00	100.00
COVER	98.36	99.05
FLOW MODIFICATION	70.30	82.83
PHYSICAL-CHEMICAL	44.32	55.76
MIGRATION		93.46
IMPACT OF INTRODUCED		21.10
FRAI	PRESENT	
FRAI (%)	70.0	
EC: FRAI	C	

Component: PES and causes

Causes Present/Absent

Macroinvertebrates

The Mthatha River experienced the flood event in February 2023. However, during the May 2023 survey, the system was once again in flood, causing the banks to burst due to heavy rains. As a result, the scientific assessment of the flood's impact on the system was not possible. Nonetheless, the MIRAIs were conducted using data obtained from this study's September 2022 survey, as well as surveys conducted by the DWS in July and October 2022. DWS also conducted a survey in January 2023, however it was not possible to survey due to excessively high flows.

From an aquatic macroinvertebrate habitat perspective, the system is primarily influenced by the diverse range of hydraulic conditions present, including moderate to fast-flowing rapid-riffle complexes, as well as some slow-flowing areas within the marginal zones. During the September 2022 survey, both banks were dominated by a cobble substrate or eroded, resulting in the absence of marginal vegetation. Consequently, the macroinvertebrate community with a preference for vegetation was mostly absent. The community recorded during the last hydrological year primarily preferred moderately fast-flowing water, cobbles, and moderate water quality. Several sensitive taxa were recorded within the assemblage, including Perlidae, Baetidae >2spp, Heptageniidae, Leptophlebiidae, Hydropsychidae >2spp, Philopotamidae, and Psephenidae. Additionally, a high abundance of Paleomonidae was recorded, which had previously been observed in 2005 and as a single individual in 2021. All of these taxa have a preference for moderate to high water quality, cobbles, and moderately fast to very fast-flowing water. Conversely, there were also several taxa recorded with low to very low requirements for unmodified physical-chemical conditions, with varying flow and habitat preferences, indicating some water quality impairments at this site. During this survey, the stones biotope was observed to be covered with a high layer of algae and fine silt, likely due to nutrient overloads from the upstream WWTW. Furthermore, several taxa with a high frequency of occurrence were expected but not recorded in the last hydrological year, mostly with a preference for standing water, vegetation (which was mostly absent), and the cobbles biotope. These taxa also had low requirements for unmodified physical-chemical conditions.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	67.5	*0.270*	18.2039	3	85
HABITAT	H	64.3	*0.317*	20.4267	1	100
WATER QUALITY	WQ	56.7	*0.286*	16.1905	2	90
CONNECTIVITY & SEASONALITY	CS	88.3	*0.127*	11.2169	4	40
						315
INVERTEBRATE EC				66.0381		
INVERTEBRATE EC CATEGORY				C		

Overall, despite the presence of several sensitive taxa, water quality appeared to be the primary driver of the community response within this system (56.7%). Habitat modification (64.3%), likely due to the absence of marginal vegetation, and flow modification (67.5%) were the subsequent drivers of the system. The Average Score per Taxon (ASPT) value calculated for the community in September 2022 was 5.9, indicating that the community mainly consisted of tolerant taxa (Dickens and Graham, 2002). Consequently, the aquatic macroinvertebrate community was determined to represent moderately modified conditions (Ecological Category C, 66.0%).

Riparian vegetation

The marginal zone was flooded at the time of assessment, with some plant tips breaking the surface of the water indicating the presence of *Miscanthus ecklonii* and *Cyperus dives*, indicating non-woody dominance, but with the alien woody species, *Sesbania punicea*. The lack of protruding woody vegetation or taller trees supports the non-woody dominance. *Salix mucronata* and *Gomphostigma virgatum* were not visible but could have been present as expected. The flood bench was mostly alluvial although scour in places resulted in mixed bedrock / alluvial habitats. Non-woody vegetation dominated, aided by high grazing pressure and comprised a mixture of tufted and creeping grasses and sedges (*M. ecklonii, Cynodon dactylon, Hemarthria altissima*), with scattered shrubs in places. In addition to annual alien weeds, *Sesbanea punicea, Solanum torvum and Lantana camara* were present. The macrochannel bank was predominantly alluvial in nature, gently sloping for the most part and dominated by dense woody vegetation, mostly alien. The banks were highly disturbed with notable vegetation removal and severely invaded by alien plant species. Less accessible banks at pool habitats were more indigenous and provided overhanging cover at pools. In addition to annual alien weeds, *Sesbanea punicea, Solanum torvum* and *Lantana camara* were abundant.

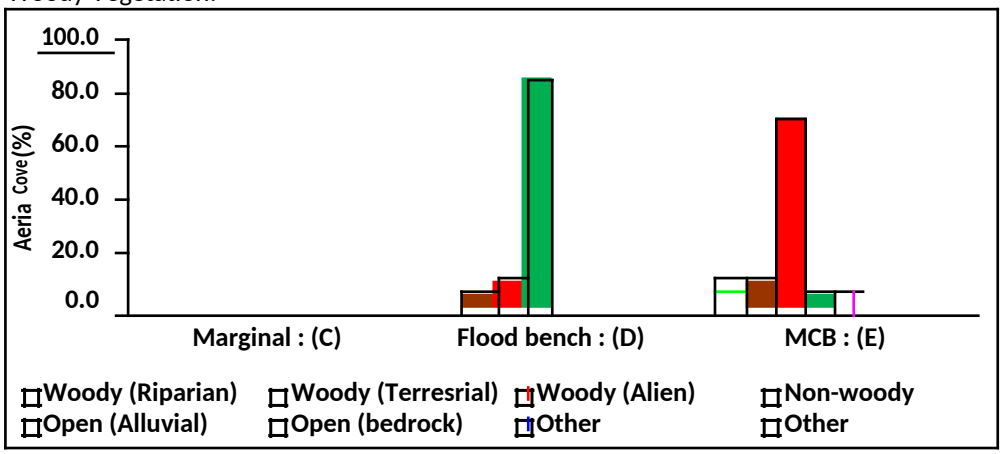
Overall PES:

LEVEL 4 ASSESSMENT	**Mthatha_MTHA01_I**					**14 May 2023**
RIPARIAN VEGETATION ECMETRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal	70.0	26.3	1.0		37.5	Weighted according to extent
Flood bench	48.6	18.2	3.3		37.5	Weighted according to extent
MCB	36.9	9.2	3.1		25.0	Weighted according to extent
LEVEL 4 VEGRAI (%)						53.7
VEGRAI Category	**Ecological**					**D**
AVERAGE CONFIDENCE						2.5
	Sub-zone					
	Marginal	**Flood bench**	**MCB**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	70.0	48.6	36.9	not assessed	not assessed	not assessed
EC (Zone)	**C**	**D**	**E**			
Confidence (Zone)	1.0	3.3	3.1			

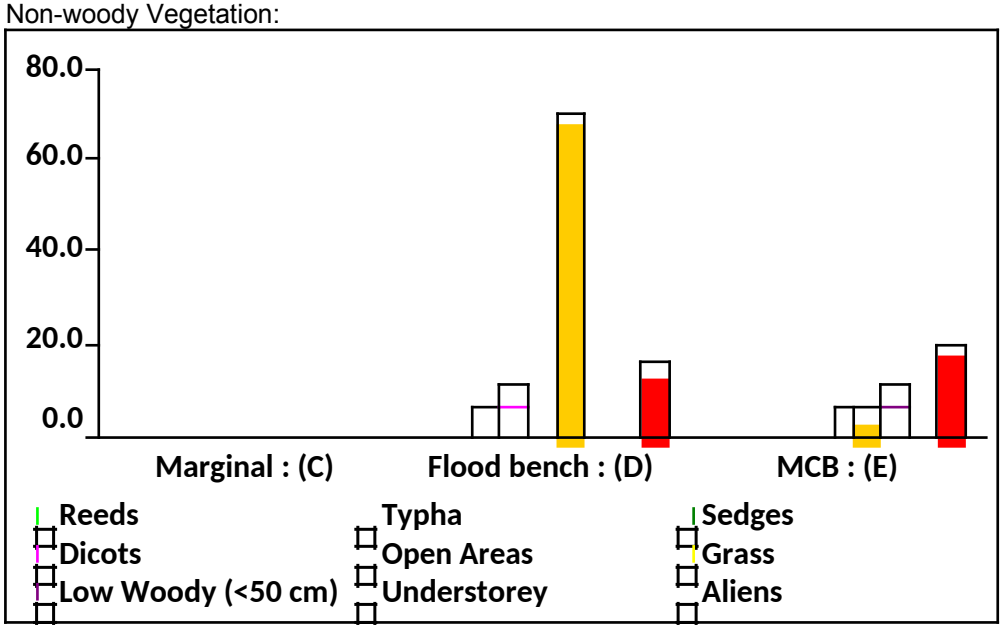
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

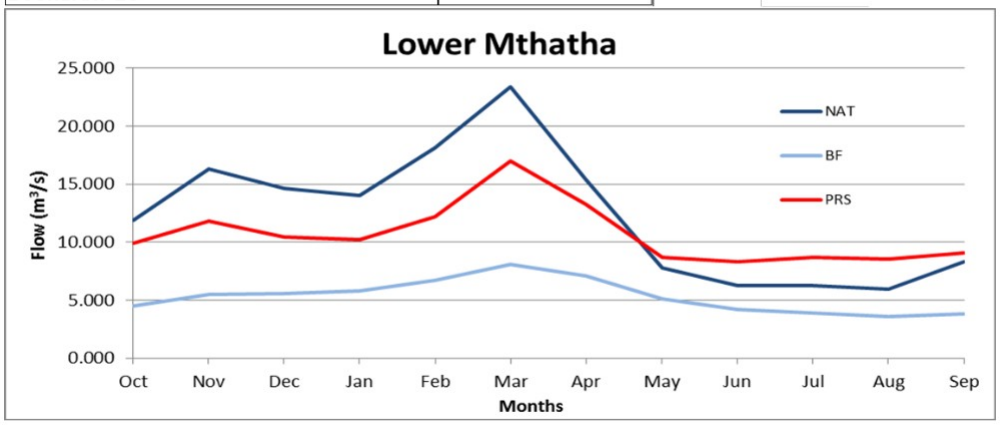


Component: PES and causes

Causes Present/Absent

Hydrology[d]

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	**Rank**	**%wt**	**RATING**	**CONFIDENCE**
LOW FLOWS	2.00	90.00	2.00	3.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	2.00	85.00	0.50	2.00
MODERATE EVENTS	3.00	80.00	2.50	3.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	4.00	70.00	2.00	3.00
HYDROLOGY SCORE	**73.53**			
HYDROLOGY ECOLOGICAL CATEGORY	**C**			
BOUNDARY EC				



Component: PES and causes

Causes Present/Absent

Geomorphology

The broad geomorphology, as classified by the geomorphic zone, of the lower Mthatha River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. The Mthatha, First Falls and Second Falls Dams trap flow and sediment from the upper catchment. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the catchment significantly. This results in increased flashiness of flows and increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the coarser habitats. Sand mining in the Mthatha area and near the field site drives resuspension of fine sediment during periods of low flow which settles out on coarser habitats.

Sand mining of inset and flood benches, agriculture on higher flood benches and trampling by livestock along the banks destabilizes the geomorphic features at the site.

Inset benches are eroded and the bed appears armoured due to recent flooding, possibly due to scour directly downstream of the bridge and cattle crossing the river at the site.

FINAL DRIVER STATUS GEOMORPHOLOGY							
SCORING GUIDELINES	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*						
GEOMORPHOLOGY DRIVERS							
COMPONENTS	RANK	RELATIVE WEIGHTING (%)	RATING	WEIGHT	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
System Connectivity	1.00	100.00	1.73	0.43	0.75	58.67	2.83
Sediment balance	2.00	70.00	2.00	0.30	0.61	14.00	2.75
Bed & bank stability	3.00	60.00	1.24	0.26	0.32	12.63	2.95
TOTALS		230.00		1.00	1.68		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					66.30		
HABITAT DRIVER CATEGORY					C	33.06	2.84
					WEIGHED SCORE	FLOW RELATED	CONFIDENCE
Morphological change					1.50	23.33	2.72
HABITAT CHANGE STATUS					70		
HABITAT CHANGE CATEGORY					C		

[a] *Refer to Appendix B of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2 for the FRAI model*

[b] *Refer to Appendix C of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2 for the MIRAI model*

[c] *Refer to Appendix D of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2 for the VEGRAI model*

[d] *Refer to Appendix G of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2 for the HAI model*

[e] *Refer to Appendix H of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2 for the GAI model*

The above applies throughout the report

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Stable	• Drivers unchanged due to impacts remaining unchanged (no new	3

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
		developments and since PES, 2014, Google Earth)	
Macroinvertebrates	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth) • No additional bed modification / erosion (localised) • Habitat availability remains good • Monitoring at the DWS REMP site continues to assess trends	5
Riparian vegetation	Decline	High levels of invasive alien plant species, and likely to increase if left unchecked.	4
Hydrology	Stable	No new water resource developments in recent years	3
Geomorphology	Stable	Dams trap some of the sediment produced by increased erosion and sand mining and cattle crossings are localised due to steep terrain and inaccessibility	3
Physical-chemical	Stable	Diatoms indicate a moderate to good water quality, except for an inorganic pollutant source. Organic pollution from upstream is heavily reduced before reaching the site.	3
ECOSTATUS (PES)	Stable		

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR DEVIATION**
ECOSTATUS	C	C	• Driven by the riparian vegetation component (D category): • High AIP throughout the riparian vegetation

**Cognisance was taken when comparing the PES, 2014 and the EcoStatus 2023. The PES, 2014 was based on various components, while the EcoStatus 2023 was only based on fish, macroinvertebrates and riparian vegetation, or for Rapid 3 sites, the riparian habitat integrity was used as a surrogate. The reason for deviation is thus provided.*

The above applies throughout the report

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
High, High	High, High

** Refer to Appendix I of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2 for the detailed table and rationale*

The above applies throughout the report

Physical-chemical state of the system
Site downstream of Mthatha, and the Mthatha WWTW, which discharges into the system. pH in the current surface was elevated, but still within acceptable range. Conductivity was also slightly elevated but also still within acceptable range. The Green Drop report showed that Mthatha WWTW upstream had a 41% sludge and effluent compliance. The town of Mthatha and the WWTW are the major sources of impacts upstream. However, located more than 100km upstream, and with various tributaries, the impacts from Mthatha at this site are minimal as observed in diatom resulted which indicated good water quality at this site.

Status (PES)		
C	B/C	• F: The current hydropower releases taking place during the dry season, which is unnatural for the system and providing artificial ques for the fish, followed by limited releases during the wet seasons. Therefore, consider more freshets for this system to ensure this REC of a B/C is achieved; • NF: Removal of the high AIP within the riparian zone and management thereof, thus if the above can be achieved, this will improve the overall EcoStatus health; and • NF: Improvement of water quality – the river is under stress and hence requires the upgrade and proper maintenance of the associated upstream WWTW, to reduce the volume and load of nutrients entering the system.

Important to note that various recommendations/interventions have been summarised, with the aim to improve the EcoStatus (PES) and achieve the REC. These have been split between:

1. *Flow (F) interventions: whereby to what extend can the impacts/influences be mitigated i.e implementing operating rules for instream dams to release the EWR, or at least a baseflow to aid in improved flows; and*
2. *Non-Flow (NF) interventions, being those that could potentially be rehabilitated and/or restored (i.e. Waste Water Treatment Works (WWTW)).*

This applies throughout the report for the REC.

OVERALL ASSESSMENT

Table 5-1: Overall EcoStatus assessment for MTHA01_I (Lower Mthatha)

River	**Lower Mthatha**
EWR Site Code	**MTHA01_I**
Driver component	**PES**
HAI	C
Diatoms	
GAI	C
Response component	**PES**
FRAI	C
MIRAI	C
VEGRAI	D
Ecostatus	**C**
EI	High
ES	High
REC	B/C

The overall EcoStatus for this EWR site was categorised as a C, thus the system is in a moderately modified condition, with loss and change of natural habitat and biota have occurred in terms of frequencies of occurrence and abundances (**Table 5-1**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats, while the upstream dams trap a portion of the coarser bedload, reducing the extent of gravel and cobble bars. At the site, disturbance along the margins, such as sand mining, trampling, removal of biomass, are widespread, leading to degradation of the habitat associated with inset benches and banks.

The overall state of the fish assemblage within the assessed reach was determined to be moderate, with a high diversity of velocity-depth classes and cover features present. While no singular driver could be identified, results do however reflect the importance as a migratory corridor for eels moving from the estuarine environment to the freshwater environment. Although several sensitive macroinvertebrates were recorded, with a preference for both good water quality and fast to very fast flow conditions, the majority of the community responded and were driven primarily by water quality modifications. The

overall state of the riparian vegetation was driven down by greater impacts along the macro-channel banks and accessible areas on the flood benches with high level of disturbance, vegetation removal and dense, in places dominant, alien invasive species.

It is suggested that a REC of a B/C (close to largely natural) can be achieved, should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-1**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Ensure the upstream movement of fish species is not impacted in any way through the development or disturbance of instream connectivity integrity. Where any new activities are proposed, appropriate fishways are to be implemented;
- Any future land use activities within upstream catchment should be managed to prevent degradation of the ecological health of the system and deterioration of the water quality (buffer zones to be implemented for future proposed developments);
- Sand mining should be managed for the catchment;
- Alien weed infestation eradication implementation programme; and
- Catchment management (cattle grazing and trampling).

5.2 MBAS01_I: Mbhashe River (Middle)

Sample Date	8 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	MBAS01_I	**IUA**	IUA_T02
River	Mbhashe	**IUA description**	Lower Mbhashe
Altitude (m.a.s.l.)	392	**Prioritised RU**	R_RU14_I
Latitude	-31.95809842	**Longitude**	28.47223807
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T13C
Level 2 EcoRegion	31.01	**SQ Reach**	T13C-06941
Geomorphological zone	E (Slope 0.003)	**PES (DWS, 2014)**	
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-3) AND SITE PHOTOGRAPHS (Figure 5-4)

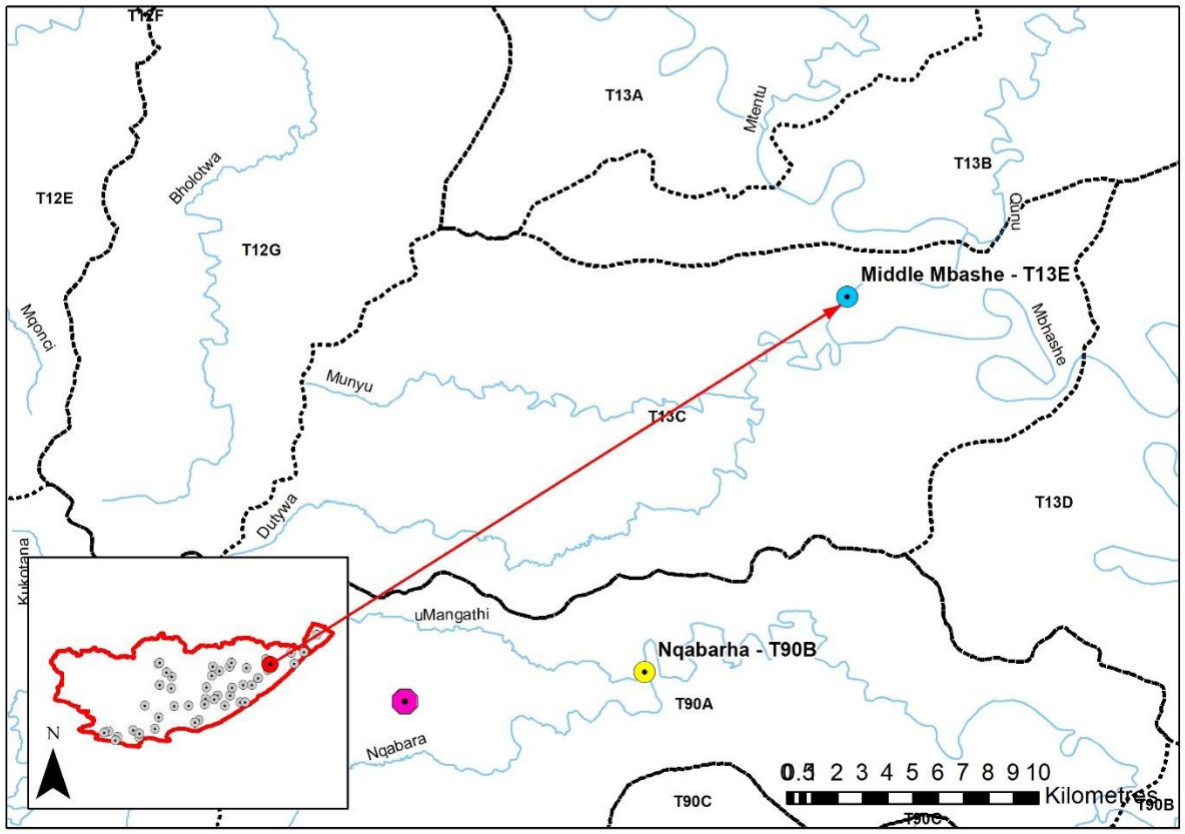


Figure 5-3: Location of site MBAS01_I (Middle Mbhashe) in relation to the study area *(yellow dot indicates a Rapid 3 EWR site and pink a WWTW)*

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)

Drone images could not be taken owing to the rainfall conditions at the time of the survey.





Figure 5-4: Site photographs of the middle Mbhashe EWR site

Site Description:

The site is located near the eMgudwane and is 4km (straight distance) from the N2.

The site is located along a partly confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle or pool-rapid reach type, often with long pools, and is dominated by boulder, cobble and sand sediment types. Benches are composed of silt and sand. There is high embeddedness along riffles, runs and pools. There are signs of erosion and deposition along the channel margins and on the flood benches. Large sand bars form along the pools and there is a fine sand or silt drape across boulder and cobble habitats where flow velocities are low. Grazing and trampling takes place along the banks and flood features.

Biota habitats available
Biotopes available for aquatic macroinvertebrates were dominated by the boulders, SIC and SOOC habitat, GSM was available in pockets along the right banks, as well as within the interstitial spaces amongst the SOOC. Sand benches (mud) were mostly along the right bank. There was no instream aquatic vegetation, and very limited marginal vegetation. Varying flow velocity and depth classes were available for fish, namely SD, SS, FS and FD.

Riparian vegetation
The marginal zone and portions of the flood benches had been scoured or removed from recent floods. Marginal zone vegetation was sparse and scattered and comprised clumps of *Phragmites mauritianus, Cyperus longus* or scattered remnants of *Gomphostigma virgatum.* Flood benches were a mix of scoured bedrock/boulder/cobble, mostly unvegetated and consolidated alluvia with overgrazed lawns dominated by *Cynodon dactylon.* The left bank was steep, with *C. dactylon, Agrostis lachnantha,* scattered trees, mostly *Combretum caffrum* or *Vachellia karroo* and a band of *V. karroo* seedlings and saplings. The right bank had been altered with artificially piled rocks and incised by a lateral tributary feeding into the main channel just upstream of the site. As such, vegetation was artificially aligned and comprised mostly alien shrub species including *Sesbanea punicea, Lantana camara, Senna didiymobotrya* and *Solanum torvum.*

Site impacts:

- Erosion
- Cattle trampling and grazing
- Upstream water transfer from Ncora Dam (Tsomo River in S5) to Collywobbles hydropower located downstream
- Sediment mining
- Upstream rural settlements and town

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.50	8.49
EC (µS/cm)	231.8	305.0
TDS (g/l)	0.1666	0.237
DO (mg/l)	8.22	8.96
DO% (%)	90.8	91.6

Clarity (cm)	77	22
Temperature (°C)	20.0	16.36
Salinity (ppt)	0.12	0.18
Discharge (m^3/s)	5.81	20.83

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
September 2022				
25	15.8	B (Good)	2.3	0
Dominant Species	(1) *Achnanthes thienemannii Hustedt*			
	(2) *Achnanthidium spp.*			
Preference	(1) Limited research on this diatom species however the specialists feel that it may be indicative of low nutrient/low EC (previously identified in high mountainous streams in SA and Lesotho)			
	(2) Moderate to good quality waters			
May 2023				
21	14.7	B (Good)	1.2	1
Dominant Species	*Achnanthes thienemannii Hustedt*			
Preference	Limited research on this diatom species however the specialists feel that it may be indicative of low nutrient/low EC (previously identified in high mountainous streams in SA and Lesotho)			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	2.5	• Simple channel form • Easy access	• Near bridge • Significant change in gradient downstream
Fish	4	• Various velocity-depth classes present • DWS REMP Site code: T1MBHA-MVEZO	• No marginal/instream or overhanging vegetation present • Seasonal constraints
Macroinvertebrates	4	• SIC, SOOC, GSM • Varying flow conditions • DWS REMP Site code: T1MBHA-MVEZO	• Limited marginal vegetation and no instream aquatic vegetation • High algae content and suspended sediment coverage over SIC and SOOC biotopes
Riparian vegetation	4	• Both banks accessible • Reasonable diversity of habitats • Reasonable representation of riparian indicators	• Recent flood scour and removal of vegetation • High grazing pressure • Manipulation of right bank
Geomorphology	3.1	• Reasonable diversity of morphological features and sediment types	• Near road access with higher pressure of mining, trampling and stock watering

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Two observations
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: T1MBHA-MVEZO • September 2022 river survey (May 2023 rained out)
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: T1MBHA-MVEZO
Hydrology						• Monthly hydrology available for natural and present day
Geomorphology						• Historical and recent air photos • No literature available for system
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1942 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity • 2022 diatom results • 2023 diatom results • NCMP data site T1H004Q01 (2000-2017, n=307)

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla marmorata, Anguilla mossambica, Awaous aeneofuscus, Enteromius anoplus s.l., Glossogobius callidus, Monodactylus falciformis, Mugil cephalus*
Macroinvertebrates	Porifera, Turbellaria, Oligochaeta, Hirudinea, Amphipoda, Potamonautidae, Atyidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Oligoneuridae, Polymitarcyidae, Prosopistomatidae, Trichorythidae, Calopterygidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Lestidae, Platycnemidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae 2spp, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Lepidostomatidae, Leptoceridae, Pisuliidae, Sericostomatidae, Dytiscidae, Elmidae, Gyrinidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Blepharoceridae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Muscidae, Psychodidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Physidae, Planorbinae, Thiaridae, Corbiculidae,Sphaeridae,Unionidae.
Riparian vegetation	This site occurs within the Savanna Biome, Sub-Escarpment Savanna Bioregion, and the Eastern Valley Bushveld vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. In the marginal zone the present state represents the reference state well, mostly non-woody and with low vegetation cover, scattered and clumped and exposed to flooding disturbance. The reference state is expected to be a mixture of woody and non-woody vegetation with higher cover by sedges and riparian woody species. In keeping with Eastern Valley Bushveld vegetation, the macro-channel bank is expected to be dominated by a mixture of riparian and terrestrial woody species, with dense trees and shrubs, and some open areas covered by grasses.
Hydrology	Monthly natural flows available for period 1920 to 2009

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Geomorphology	In its reference condition, the Mbhashe River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle or pool-rapid reach types. Localised bedrock anastomosing reaches will be present. Sand and gravel bars can be present in pools and along the margins of the riffles, but much lower levels of embeddedness and silt cover would be expected. Narrow inset benches composed of sand and gravel and flood benches of sand, gravel and cobble could be present as a result of freshets and infrequent floods.
Physical-chemical	No historical physical-chemical data could be obtained for the site (records only began in the year 2000). Diatom results indicated good water quality, suggesting that current physical-chemical properties at the site resemble those of reference conditions – low nutrient and low electrical conductivity.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	D (46.2%)	F/NF	• Flow and water quality modifications owing to flows in the Mbhashe supported through releases from the Ncora Dam and the Colly Wobbles Hydropower Scheme • Dominance of translocated non-native fish from the Orange catchment
Macroinvertebrates (MIRAI)	C (67.2%)	F/NF	• Flow modifications owing to flows in the Mbhashe supported through releases from the Ncora Dam • Water quality changes/flow modifications owing to the Colly Wobbles Hydropower Scheme • Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope • High sedimentation concentrations over biotopes
Riparian vegetation (VEGRAI)	C/D (58.9%)	F NF	• Upstream water transfer from Ncora Dam (Tsomo River in S5) has likely increased flows in this zone. • Vegetation removal by wood removal, grazing and browsing, fence lines and access paths (human and livestock), road and bridge, and rock piling along the right bank to stabilise sediments. • In addition to annual alien weeds, *Nicotiana glauca, Sesbanea punicea* and *Lantana camara.*
Geomorphology (GAI)	C (62%)	28% flow related	• Increased erosion across the catchment with increased connectivity between sediment sources and the channel. • These drives increased silt loads resulting in silt deposition of coarser substrates (silt drapes and embedded coarse sediment). • Sediment deposition and erosion enhanced along channel margins due to increased sediment availability and disturbances related to trampling, continuous grazing and channel access.
Hydrology (HAI)	B (84.7%)		• Limited water use in the catchment due to its rural setting

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Transfer of water from Ncora Dam (Tsomo River) to MbasheRiverforhydropowergeneration downstream at Collywobbles
Diatoms/Physical-chemical	B (15.8)	NF	• Potentially low nutrient/low EC • Moderate to good quality waters • Largely rural setting in the catchment with limited impacts on the physical-chemical status of this stretch of the river
ECOSTATUS (PES)	C/D	Driven by alien invasive fish species (category D)	

Component: PES and causes

Causes Present/Absent

The reach of the Mbashe River is considerably modified in terms of both flow and water quality, owing to the upstream hydropower, and resulting in some degree of loss of native fish species and seasonal migration cues. Whoever, the confirmed presence of one species of eels within the reach during the September 2022 assessment suggests that connectivity to the lower reaches is to some degree still present, although flow and water quality modifications are likely to be impacting migratory species negatively. In addition, several smaller native fish species confirmed within the reach during recent REMP surveys does suggest that the native fish assemblage is at least to come degree represented. However, the dominance of the fish assemblage by translocated *Labeobarbus aeneus* from the Orange River catchment during REMP monitoring studies as well as the likely presence of the translocated *Tilapia sparmannii* and the alien *Cyprinus carpio* is a major driver of the ecological state of the fish assemblage. Consequently, the ecological state of the fish assemblage within the reach was considered to be largely modified (Ecological Category D).

Fish

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	93.12	83.01
COVER	100.00	100.00
FLOW MODIFICATION	39.42	46.40
PHYSICAL-CHEMICAL	33.28	45.40
MIGRATION		62.22
IMPACT OF INTRODUCED		51.85
FRAI	PRESENT	
FRAI (%)	46.2	
EC: FRAI	D	

Component: PES and causes

Macroinvertebrates

Following a recent flood event in the Mbhashe River, where flows exceeded 400m3/s and the macrochannel reached its bank full capacity, it became evident that the system underwent a significant reset. Sediments were mobilised, and deposits were observed on the flood benches. However, despite the flood event, the boulders, SIC and SOOC remained heavily embedded.

Overall, the system is primarily influenced by the diverse range of hydraulic conditions present, including areas with very fast-flowing rapid-riffle complexes. The GSM biotope was found between the interstitial zones of the SIC and SOOC biotopes, as well as along muddy margins along the banks. Although parts of the banks are dominated by bedrock and boulder substrates, continuous cattle grazing and trampling along both banks upstream contribute to extensive bank erosion, thereby limiting the presence of marginal vegetation.

The aquatic macroinvertebrate community recorded during the previous hydrological year represented mainly standing and moderately fast-flowing water, cobbles, and low to very low water quality. Despite the presence of numerous sensitive taxa, including Perlidae, Baetidae >2spp, Heptageniidae, Leptophlebiidae, Trichorythidae, Psephenidae, and the reappearance of Oligoneuridae (last recorded in 2017 and 2020), evidence of water quality impairments was observed. Out of the expected 22 and 17 taxa with a low and very low requirement for unmodified physical-chemical conditions, 14 and 9 taxa were recorded respectively, in the macroinvertebrate assemblage. It is likely that upstream sediment mining and rural settlements/towns are compromising water quality. Furthermore, Physidae (Gastropoda) was recorded in relatively high abundances (≥10 - ≤100), which deviates from the reference conditions. Physidae is a highly tolerant alien invasive taxon with a preference for very low water quality, and its dominance needs to be monitored to prevent further proliferation. Taxa that were expected to occur frequently in this reach but which were absent included Prosopistomatidae, Aeshnidae, Hydropsychidae >2spp, and Athericidae, all of which prefer high to moderate water quality conditions. Naucoridae, Ceratopogonidae, Tabanidae, and Corbiculidae were also absent and are known to prefer slow-flowing water, which was limited at the site.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	78.0	*0.288*	22.4791	3	85
HABITAT	H	69.2	*0.305*	21.1059	2	90
WATER QUALITY	WQ	53.6	*0.339*	18.1628	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.068*	5.42373	4	20
						295
INVERTEBRATE EC				67.1715		
INVERTEBRATE EC CATEGORY				C		

Overall, despite the presence of several sensitive taxa, water quality appears to be the primary driver of the community response within this system (53.6%). Habitat modification (69.2%) was the second most influential factor, likely due to the scarcity of marginal vegetation caused by bank erosion and the prevalence of bedrock/boulder substrates. Flow modification had the least impact, accounting for 78% of the drivers. The Average Score per Taxon (ASPT) calculated for the communities in September 2022 and May 2023 was 5.6 and 6.5 respectively, indicative of a community mainly tolerant of the elements (Dickens and Graham, 2002). Consequently, the aquatic macroinvertebrate community was determined to represent moderately modified conditions (Ecological Category C, 67.2%).

Riparian vegetation

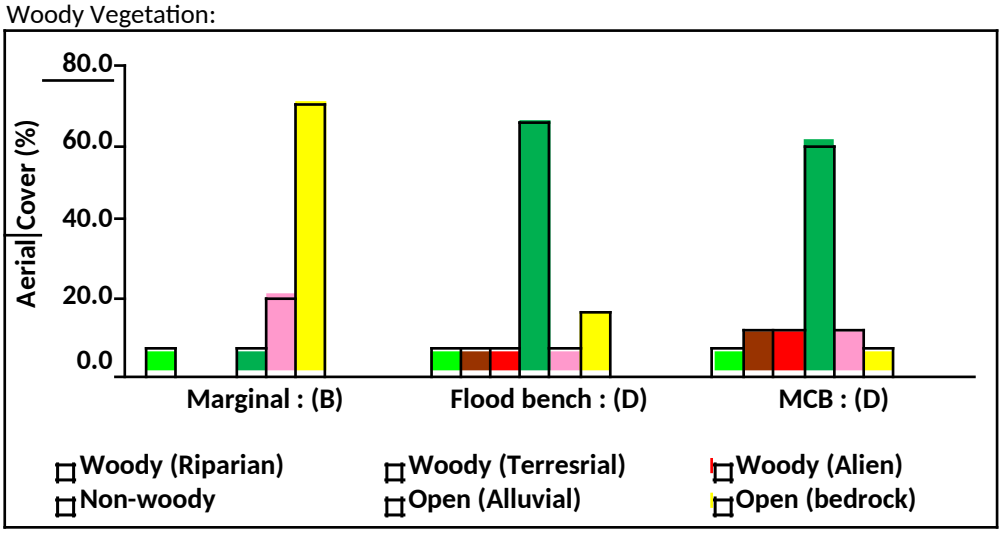
The marginal zone had been highly disturbed at the time of assessment due to recent large floods with resultant scour and loss of vegetation. Nevertheless, the zone was dominated by mostly unvegetated bedrock/ cobble/ boulder habitats with localised deposited sediments, as yet unvegetated. The vegetation that was present, was scattered clumps of reeds (*Phragmites mauritianus*), sedges (*Cyperus longus, Schoenoplectus decipiens)*, grasses (*Miscanthus ecklonii*) and a few woody individuals (*Gomphostigma virgatum*). The flood bench displayed high levels of grazing and trampling pressure and had been exposed to erosion from floods and some bank slumping. Dominant habitats along the flood benches were alluvial deposits over bedrock / boulder and dominated by non-woody vegetation, mostly well vegetated lawns from grazing comprising mostly *Cynodon dactylon*. Exposed, non-vegetated, bedrock/ boulder habitats also existed. In addition to annual alien weeds, other alien species included *Sesbanea punicea* and *Lantana camara*. The macochannel bank differed between left and right banks. The left bank was steep and dominated by dense clumps of woody vegetation (riparian, indigenous terrestrial and alien) mixed with grazed areas of the grass *C. dactylon*. The right bank was gently sloping, had been manipulated (presumably with the building of the bridge), with a distinct absence of trees, except along steeper banks surrounding pools. Alien species coverage was high and included *Nicotiana glauca* and *Lantana camara.*

Overall PES:

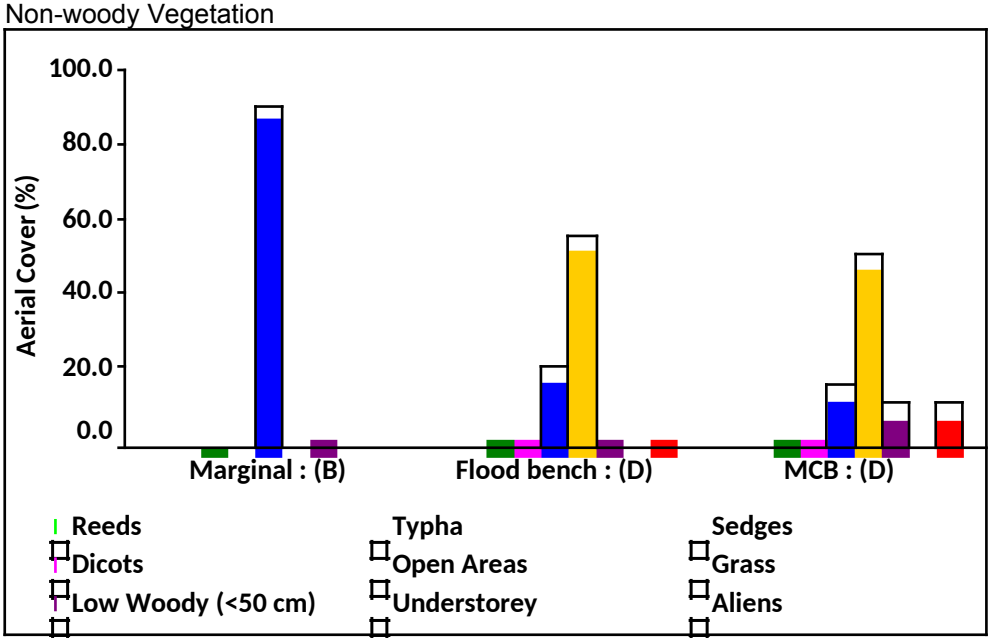
LEVEL 4 ASSESSMENT	**Mbhashe _MBAS01_I**					**13 May 2023**
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal	82.4	27.5	3.1		33.3	Weighted according to extent
Flood bench	46.9	20.8	3.3		44.4	Weighted according to extent
MCB	47.6	10.6	3.3		22.2	Weighted according to extent
LEVEL 4 VEGRAI (%)						58.9
VEGRAI Ecological Category						**C/D**
AVERAGE CONFIDENCE						3.2
	Sub-zone					
	Marginal	**Flood bench**	**MCB**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	82.4	46.9	47.6	not assessed	not assessed	not assessed
EC (Zone)	**B**	**D**	**D**			
Confidence (Zone)	3.1	3.3	3.3			

Component: PES and causes

Woody Vegetation:



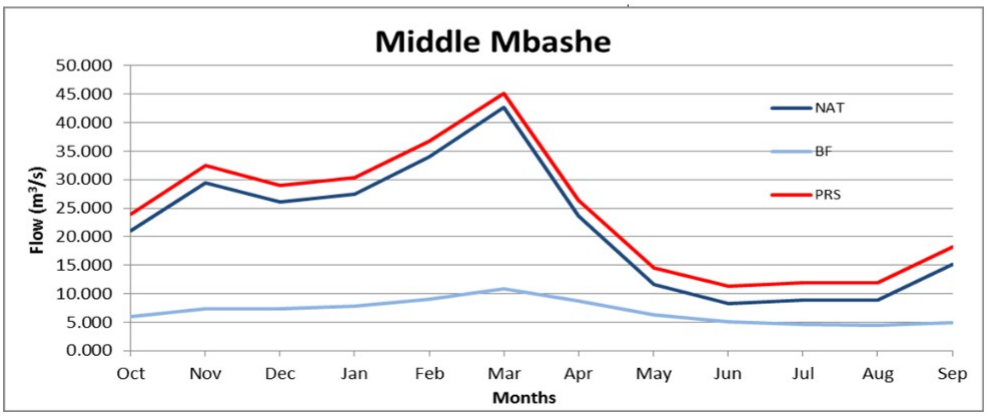
Non-woody Vegetation



Component: PES and causes

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	**Rank**	**%wt**	**RATING**	**CONFIDENCE**
LOW FLOWS	2.00	90.00	2.00	3.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	2.00	85.00	0.00	4.00
MODERATE EVENTS	3.00	70.00	1.00	3.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	4.00	60.00	1.00	2.00
HYDROLOGY SCORE	**84.69**			
HYDROLOGY ECOLOGICAL CATEGORY	**B**			
BOUNDARY EC				



Component: PES and causes

Geomorphology

The broad geomorphology, as classified by the geomorphic zone, of the lower Mbhashe River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the catchment significantly. This results in increased flashiness of flows and increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the coarser habitats.
Sand mining in the catchment and near the field site drives resuspension of fine sediment during periods of low flow which settles out on coarser habitats.
Sand mining of inset and flood benches and trampling by livestock along the banks destabilizes the geomorphic features at the site.

FINAL DRIVER STATUS GEOMORPHOLOGY							
SCORING GUIDELINES	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*						
GEOMORPHOLOGY DRIVERS							
COMPONENTS	RANK	RELATIVE WEIGHTING (%)	RATING	WEIGHT	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
System Connectivity	1.00	100.00	1.60	0.42	0.67	59.33	2.97
Sediment balance	2.00	90.00	2.30	0.38	0.86	3.00	3.00
Bed & bank stability	3.00	50.00	1.87	0.21	0.39	12.63	2.82
TOTALS		240.00		1.00	1.92		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					61.63		
HABITAT DRIVER CATEGORY					C	28.48	2.95
					WEIGHED SCORE	FLOW RELATED	CONFIDENCE
Morphological change					2.06	5.56	2.78
HABITAT CHANGE STATUS					58.88889		
HABITAT CHANGE CATEGORY					D		

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Decline/stable	• Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
Macroinvertebrates	Decline/stable	• Outbreak of Simuliidae is of a concern (September 2022) and dominating the macroinvertebrate assemblage (changes in natural flow regimes – hydropower). However, owing to recent floods, the SIC biotopes were scoured and populations reduced considerably during the May 2023 survey. • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Riparian vegetation	Stable/decline	• AIP low on most features, but may increase	3
Hydrology	Stable	No new water resource developments in recent years	3
Geomorphology	Decline	• Ongoing pressures likely to maintain degradation at catchment and site level	2.5
Physical-chemical	Stable	• Impacts of erosion and silt loading will likely affect site during floods. Largely rural setting, subsistence farming practices surrounding. No large-scale impacts likely to cause a decline in the short-term.	2
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR DEVIATION**
ECOSTATUS	B	C/D	• Driven by the fish component (D category) • High non-native fish species (*Labeobarbus aeneus* (Small mouth Yellowfish) - BAEN) – large predators than naturally expected in this system.

EIES, 2014	**Re-assessed, 2023**
High, Moderate	Moderate, Moderate

Physical-chemical state of the system
pH elevated. Other parameters measured during assessment were within acceptable range. Largely rural setting, with no WWTW identified in the area. Impact on the state of the system will likely be a result of increased silt loads, especially during flooding events.

C/D	C/D	• Most components were non-flow related, thus maintain the EcoStatus as a C/D.

OVERALL ASSESSMENT

Table 5-2: Overall EcoStatus assessment for MBAS01_I (Lower Mbhashe)

River	Lower Mbhashe
EWR Site Code	**MBAS01_I**
Driver component	**PES**
HAI	B
Diatoms	B
GAI	C
Response component	**PES**
FRAI	D
MIRAI	C
VEGRAI	C/D
Ecostatus	**C/D**
EI	Moderate
ES	Moderate
REC	**C/D**

The overall EcoStatus for this EWR site was categorised as a C/D, thus the system is in a close to moderately modified condition most of the time (**Table 5-2**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats. At the site, disturbance along the margins, such as sand mining, trampling, removal of biomass, are widespread leading to degradation of the habitat associated with inset benches and banks.

The ecological state of the fish assemblage was largely driven by the loss of indigenous fish species as a result of flow modifications and water quality modifications as well as the dominance of *Labeobarbus aeneus*, a fish species that has been translocated from the Orange River system through various inter— basin transfer schemes. Some sensitive macroinvertebrate taxa were recorded with a preference for both good water quality and fast to very fast flow conditions. However, the majority of the community responded and were driven by water quality modifications. Simuliidae were identified to be in their outbreak densities during the September 2022 survey, however following recent floods, the system was reset, SIC scoured which lowered their population to more expected abundances. The riparian vegetation along the marginal zone was in a better condition than the flood bench and banks, mostly due to less grazing and alien plant species, both of which contributed to the poorer conditions on higher features and banks.

It is suggested that a REC of a C/D (close to moderately modified condition most of the time) and a C (moderately modified) can be achieved, should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-2**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Sand mining should be managed within the catchment to reduce impacts to riparian and instream habitat;
- Any future land use activities within upstream catchment should be managed to prevent degradation of the ecological health of the system and deterioration of the water quality (buffer zones to be implemented for future proposed developments).

5.3 BKEI01_I: Black Kei River

Site upgraded from a Rapid 3 to an Intermediate due to numerous impacts observed in the upper catchment

Sample Date	11 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	BKEI01_I	**IUA**	IUA_S02
River	Black Kei	**IUA description**	Black Kei
Altitude (m.a.s.l.)	872	**Prioritised RU**	R_RU24_I
Latitude	-32.11819532	**Longitude**	27.06884273
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	S32K
Level 2 EcoRegion	18.02	**SQ Reach**	S32K-07057
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-5) AND SITE PHOTOGRAPHS (Figure 5-6)

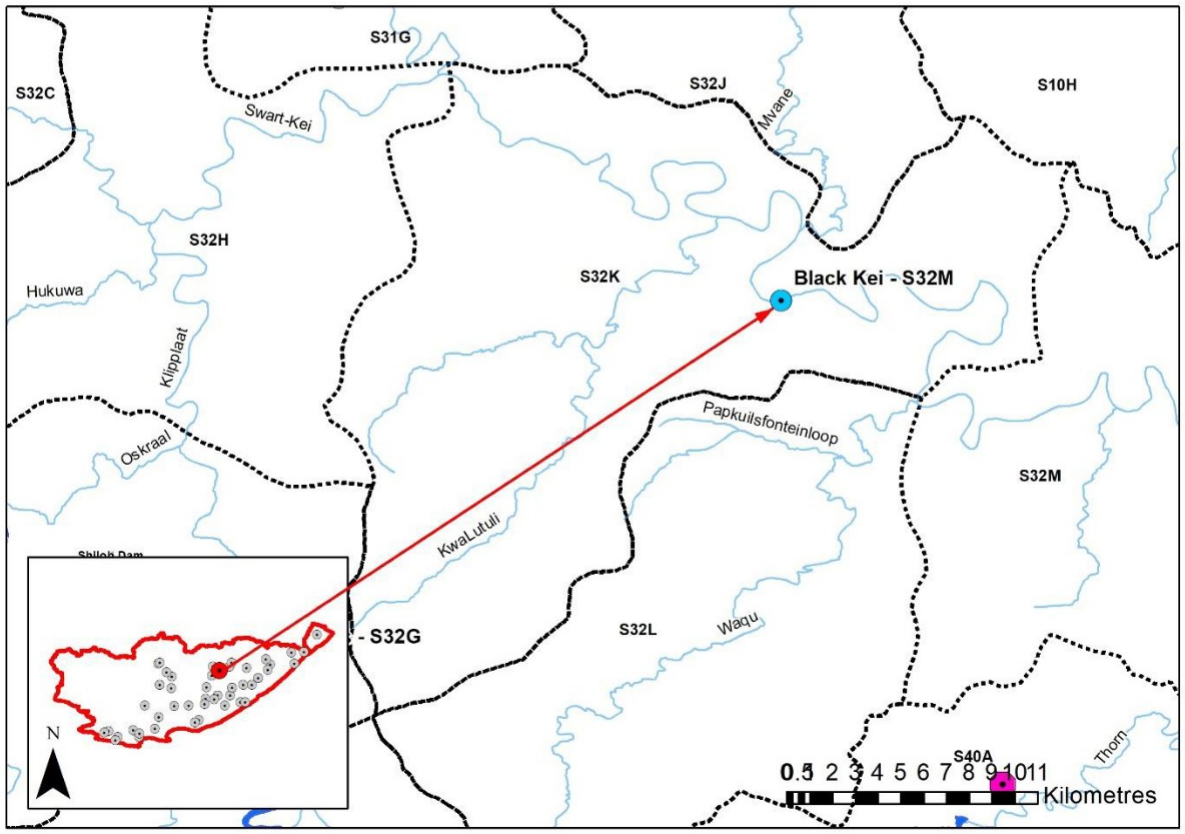


Figure 5-5: Location of site BKEI01_I (Black Kei) in relation to the study area *(pink dot represents an existing WWTW)*

Site Photographs: Survey 1 (September 2022)





Site Photographs: Survey 2 (May 2023)






Figure 5-6: Site photographs of the Black Kei EWR site

Site Description:

The site is located near Tylden, about 4 km upstream from the N6.

The site is located in a partly confined valley setting with a single channel and narrow flood features. The channel is straight to wandering, incised into the surrounding landscape and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and sand sediment types at the site. There are significant bedrock sections with localised bedrock steps. Benches are composed of sand. There is embeddedness of cobble and gravels where flow velocities are lower. There is widespread grazing along the banks and flood zones, with trampling evident at the site.

Following the flood event that took place in February 2023, clear evidence of bank collapse and further bank erosion was observed, particularly along the left bank. This was exasperated by the continued cattle trampling and grazing along that bank.

Biota habitats available
Biotopes available for aquatic macroinvertebrates included a combination of bedrock, SIC and SOOC. Marginal vegetation was limited in September 2022, and owing to further extensive bank erosion following the floods, there was no marginal vegetation to sample in May 2023. GSM was sampled along the banks (mostly mud). Fish habitats included SD, SS, FD and FS.

Riparian vegetation
The site was heavily disturbed by overgrazing, trampling and vegetation clearing and as such has extensively eroded, especially along the marginal zone, during the recent floods. Most of the marginal zone has been scoured or removed by floods or is denuded due to trampling disturbance. That which remains is dominated by non-woody sedges or grasses, with a small population of *Salix mucronata* that has remained on the right bank. Banks, inset benches and flood benches are similarly impacted by trampling and grazing, have become fragmented and are eroding or slumping in several areas. Most bank woody species have been removed or are alien. Alien species include *Salix fragilis, S. babylonica, Melia azedarach, Lantana camara* and *Gleditsia tracanthos*. The floodplain is dominated by *Miscanthus ecklonii,* with extensive deposition of new sediments from the recent floods and is highly invaded by alien plant species, mainly *S. fragilis* and *Arundo donax.*

Site impacts:

- Water quality impacts (sewage)
- Erosion
- Cattle trampling and grazing
- Abstraction and irrigation
- Dams on tributaries

- Exotic vegetation within the riparian zone (*Salix* sp., Honey Locust, Syringa)

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.57	8.69
EC (µS/cm)	434.7	808
TDS (g/l)	0.3272	0.633
DO (mg/l)	7.16	10.07
DO% (%)	75.6	102.4
Clarity (cm)	15	51
Temperature (°C)	17.8	16.07
Salinity (ppt)	0.24	0.48
Discharge (m^3/s)	1.11	3.76

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
September 2022				
38	13.3	B (Good)	29.1	1.25
Dominant Species	*(1) Eolimna subminuscula (Manguin) Moser, Lange-Bertalot & Metzeltin*			
	(2) Nitzschia dissipata (Kützing) Grunow			
Preference	(1) A cosmopolitan species common in electrolyte-rich, strongly polluted rivers and flowing waters.			
	(2) A cosmopolitan species found in waters of moderate to high electrolyte content, not present in waters of low electrolyte content.			
May 2023				
13	7.3	D (poor)	87.9	1
Dominant Species	*Nitzschia frustulum (Kützing) Grunow*			
Preference	A cosmopolitan species found in electrolyte-rich and brackish waters. Tolerant of high conductivity, fluctuations in osmotic pressure and of critical levels of pollution.			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2	• Simple channel form • Easy access	• Trampling along channel margin can lead to changes in channel shape
Fish	2	• Simple channel form • Various velocity-depth classes available	• Fast-flowing and deep water limiting sampling

		• Various substrate classes • DWS REMP Site code: S3BKEI-TURNS (further downstream of this site EWR site, however within same Ecoregion Level 2 and geoclass)	
Macroinvertebrates	4	• SIC, SOOC, marginal vegetation and GSM available • Varying flow velocities • DWS REMP Site code: S3BKEI-TURNS (further downstream of this site EWR site, however within same Ecoregion Level 2 and geoclass)	• No instream aquatic vegetation • High turbidity • Bank erosion
Riparian vegetation	3	• Both banks and all features were accessible • Riparian indicators available on all features	• Recent flood scour and vegetation removal • High level of alien plant species • Severe grazing and trampling pressure with resultant bank erosion and slumping
Geomorphology	3.25	• Moderate range of morphological and sediment types	• Local crossing point for cattle, so some additional disturbances at the site compared to the reach

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						•Two flow observations
Fish						•FFROC (Kleynhans; 2008) •PES-EI-ES Assessment (DWS, 2014) •GBIF Collection Records (although limited) •DWS REMP Site code: S3BKEI-TURNS (further downstream) •Current two river survey (September 2022 and May 2023)
Macroinvertebrates						•Current two river survey (September 2022 and May 2023) •PES-EI-ES Assessment (DWS, 2014) •River Eco-status Monitoring Programme (REMP) river database (inverts) •DWS REMP Site code: S3BKEI-TURNS (further downstream of this site EWR site, however within same Ecoregion Level 2 and geoclass)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydrology						• Monthly hydrology available for natural and present day
Geomorphology						• Historical and recent air photos • No literature on the system
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1938 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity. • REMP *in situ* water quality data • 2022 diatom results. • 2023 diatom results • NCMP data site S3H013 (2003-2023, n=420)

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Fish	*Anguilla mossambica, Enteromius anoplus s.l.*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Prosopistomatidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Protoneuridae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Empididae, Ephydridae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Physidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae,
Riparian vegetation	This site occurs within the Grassland Biome, Sub-Escarpment Grassland Bioregion, and the Tsomo Grassland vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone would have notably less trampling disturbance with higher bank and bar integrity. It would be well vegetated and dominated by non-woody vegetation, mostly grasses, sedges and broad-leafed obligates with scattered pockets of woody vegetation such as Cape willow. Along the macro-channel bank, its likely there would have been more representation by woody riparian species, but these would not have dominated the zone. Bank integrity would be intact and cover by non-woody vegetation would have been higher. The floodplain would have been dominated by non-woody vegetation for most of its extent with terrestrial species towards the edges. The currently notable woody component, which is alien, would have been absent, and non-woody cover would have been higher although deposition of new sediment following recent floods was prevalent.
Hydrology	Monthly natural flows available for period 1920 to 2009
Geomorphology	In its reference condition, the Black Kei River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle or pool-rapid reach types. Pools would be much longer compared to riffles/rapids. Localised bedrock reaches can be present with anastomosing channels. Sand and gravel bars can be present in pools and along the margins of the riffles, but lower levels of embeddedness and silt cover would be expected. Narrow inset benches and flood benches/floodplain of sand and gravel could be present as a result of freshets and larger infrequent floods.
Physical-chemical	No historical data could be obtained for the site (data records began in 2003). Diatoms data indicated organic pollution and high electrolyte concentration at the site. Under reference conditions, low nutrient and electrolyte concentrations are expected to be prevalent at this site.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	E (23.5%)	F/NF	• Flow modification due to the presence of several dams within the upper to middle catchment

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Water quality modification • Dominance of translocated *Labeobarbus aeneus*, with translocated *Clarias gariepinus* and alien *Cyprinus carpio* also present
Macroinvertebrates (MIRAI)	D/E (40.7%)	F/NF	• Dams along some tributaries of the Black Kei mostly for irrigation (flow modification) • Bank erosion thus hampering marginal vegetation biotope. • High sedimentation concentrations over biotopes • High turbidity
Riparian vegetation (VEGRAI)	D (48.6%)	F/NF	• Influenced by the Bonkolo Dam upstream, but only slightly due to distance away, which is likely to cause some regulation, altered flooding frequency and duration and reduced flood peaks. • Extreme trampling and grazing pressure with associated bank slumping and erosion, and selected wood removal. • AIP: *Arundo donax, Salix fragillis, Melia azedarach, Salix babylonica* and Honey Locust.
Geomorphology (GAI)	C (72%)	19% flow related	• Frequent erosion throughout catchment with localised increases in connectivity to the channel. • Several dams in the upper to middle catchment reducing bedload. Several weirs along lower catchment. • Localised trampling along the flood features and banks. • Silt drapes and moderate embeddedness observed in slow flowing biotopes.
Hydrology (HAI)	C (62.5%)		• All flow components impacted due to water use and dams in the upstream catchment
Diatoms/Physical-chemical	C (10.3)	NF	• Electrolyte-rich i.e., high electrical conductivities, strongly polluted rivers and flowing waters. • Leading drivers of physical-chemical include the WWTW in Queenstown and the agricultural activities downstream. • Erosion was also noted to be one drivers of the physical-chemical status of the system.
ECOSTATUS (PES)			

Component: PES and causes				
	Causes Present/Absent			
Fish	Indigenous species to the catchment were noted to contribute only approximately 10% of the catch across the September 2022 and the May 2023 assessment. While the reach is expected to support a naturally low fish diversity under reference conditions, the dominance of non-native (translocated and alien) fish species within reach will out-compete the native fish species. In addition, flow modifications, water quality impairment and elevated sediment input were likely contributing to the seriously modified state (Ecological Category E) of the fish assemblage within the reach.			

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	96.65	87.46
COVER	100.00	89.67
FLOW MODIFICATION	34.58	43.46
PHYSICAL-CHEMICAL	35.57	50.00
MIGRATION		70.59
IMPACT OF INTRODUCED		100.00
FRAI	PRESENT	
FRAI (%)	23.5	
EC: FRAI	E	

Component: PES and causes

Causes Present/Absent

Macroinvertebrates

Following the recent flood event in February 2023 within the Black Key River system, the recorded flows have remained higher compared to the measurements taken during the September 2022 survey. Consequently, new sediment deposits were observed in the riparian zone. The floods, combined with ongoing cattle trampling and overgrazing, resulted in severe bank collapse on the left bank and continued erosion on the right bank. Consequently, there was no marginal vegetation owing to the above, while boulders, SIC, SOOC, and GSM were available for sampling with varying fast-flowing rapid-riffle complexes.

During the September 2022 and May 2023 surveys, a total of 12 and 11 taxa were recorded respectively, resulting in a community consisting of 16 taxa. The collected aquatic macroinvertebrate community was determined to be representative of moderately modified conditions (Ecological Category C, 61.6%).

The macroinvertebrate community in this reach, except for Baetidae >2spp, exhibited a preference for low to very low requirements for unmodified physical-chemical conditions, a range of velocity metrics, and cobbles. Of particular concern in this stretch was the persistent abundance of Simuliidae, which was recorded in high abundances during both surveys, despite the flood event which was thought to have reset the system. The high abundance of Simuliidae indicates a system with limited flow fluctuations, constant and high flow velocities, and impaired water quality conditions. The absent macroinvertebrate community included Turbellaria, Oligochaeta, Potamonautidae, Hydracarina, Perlidae, Caenidae, Heptageniidae, Chlorocyphidae, Naucoridae, Notonectidae, Veliidae, Hydropsychidae >2spp, Leptoceridae, Elmidae, Psephenidae, Tabanidae, Lymnaeidae, and Corbiculidae. These taxa predominantly prefer cobbles, with some having high to moderate requirements for unmodified water quality and a range of flow velocities. Notably, the community that prefers slow-flowing water was entirely absent from the recorded community.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	34.8	*0.333*	11.6129	2	95
HABITAT	H	45.8	*0.351*	16.0636	1	100
WATER QUALITY	WQ	41.1	*0.316*	12.9782	3	90
CONNECTIVITY & SEASONALITY	CS	80.0	*0.000*	0	4	0
						285
INVERTEBRATE EC				40.6547		
INVERTEBRATE EC CATEGORY				D/E		

Overall, the community was primarily influenced by flow modification (34.8%) due to the dominating presence of Simuliidae, which thrives in constant high flows within the system. Water quality accounted for 41.1% of the driving factors, followed by habitat modifications (45.8%). However, all three metrics raise concerns: excessively high flows, impaired water quality, and the absence of the marginal vegetation biotope, which eliminates taxa preferring this habitat. The ASPT (Average Score per Taxon) for the communities identified in September 2022 and May 2023 was 4.9 and 5.3, respectively, indicating that the community mainly consisted of tolerant taxa (Dickens and Graham, 2002). However, the ASPT value recorded during the May 2023 survey should be interpreted with caution as only single individuals of Hydropsychidae, Leptophlebiidae, and Trichorythidae were recorded. These low abundances may be a consequence of the flooding event and the ongoing recolonization of the community in the system.

Riparian vegetation

The marginal zone was predominantly alluvia and had been highly disturbed by intense grazing and trampling pressure with extensive bank erosion and slumping. The zone was dominated by non-woody vegetation with pockets of *Salix mucronata* associated with inset benches or more protected areas. Dominant species were *Cyperus sexangularis, C. longus, Cynodon dactylon, Miscanthus ecklonii* and *Salix mucronata*. Alien species included *Arundo donax* and *Salix fragillis*. The macrochannel bank was predominantly alluvial, confining the channel and was dominated by non-woody vegetation, mostly grasses and sedges, with the woody component mostly absent or alien. Grazing and trampling pressure was also extreme with extensive bank erosion and slumping. Dominant species included *M. ecklonii, C. dactylon, Schoenoplectus corymbosus,* with some *Celtis africana* and several alien species. Alien invasive plant species included *Arundo donax, Salix fragillis, Melia azedarach, Salix babylonica* and Honey Locust. Dominant habitats along the floodplain were alluvial and dominated by grasses, mainly *M. ecklonii* and *C. dactylon,* but with a notable presence of alien woody riparian species, notably *Salix fragilis*. Open newly deposited sediment was common throughout, with scour from recent floods and intensive grazing and trampling pressure.

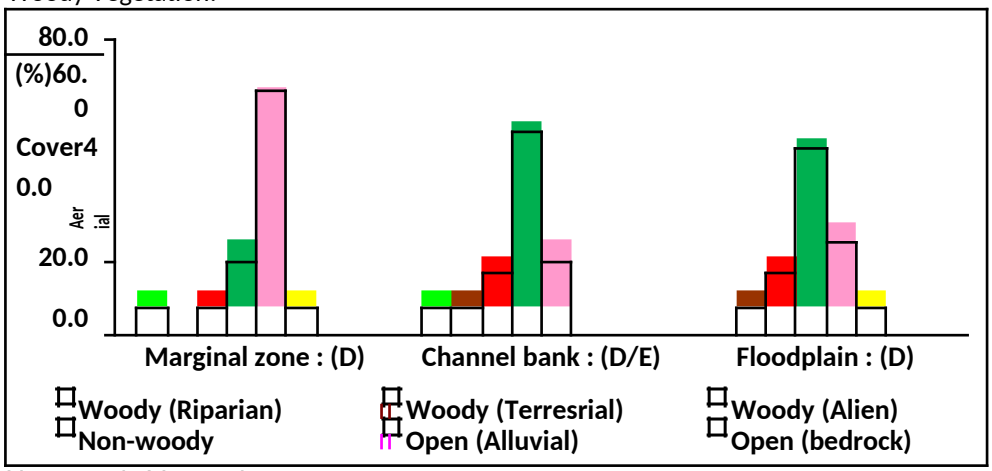
Overall PES:

LEVEL 4 ASSESSMENT	**Black Kei_BKEI01_I**					**10 May 2023**
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal zone	46.9	2.2	3.5		4.8	Weighted according to extent
Channel bank	41.8	14.9	3.4		35.7	Weighted according to extent
Floodplain	52.9	31.5	2.4		59.5	Weighted according to extent
LEVEL 4 VEGRAI (%)						48.6
VEGRAI Category	**Ecological**					**D**
AVERAGE CONFIDENCE						3.1
	Sub-zone					
	Marginal zone	**Channel bank**	**Floodplain**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	46.9	41.8	52.9	not assessed	not assessed	not assessed
EC (Zone)	**D**	**D/E**	**D**			
Confidence (Zone)	3.5	3.4	2.4			

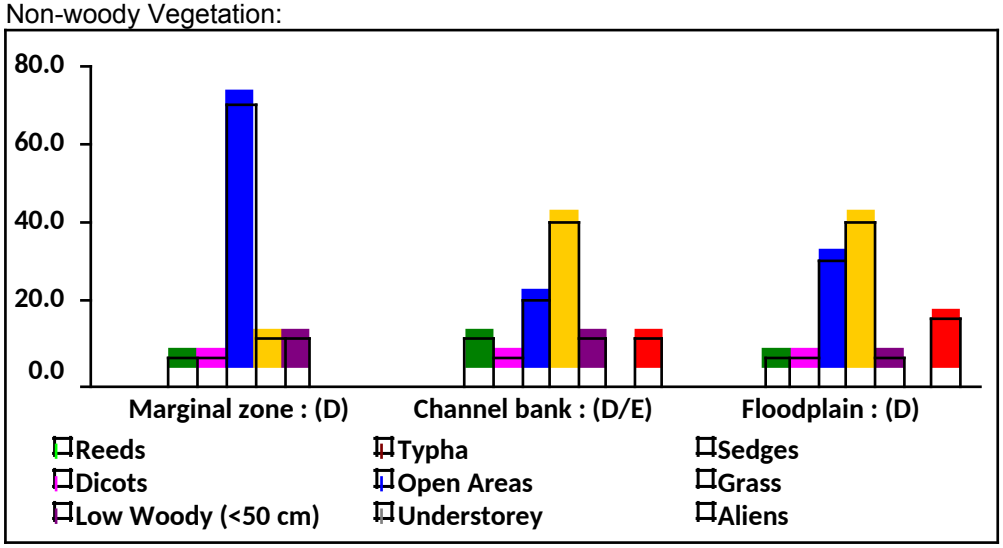
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

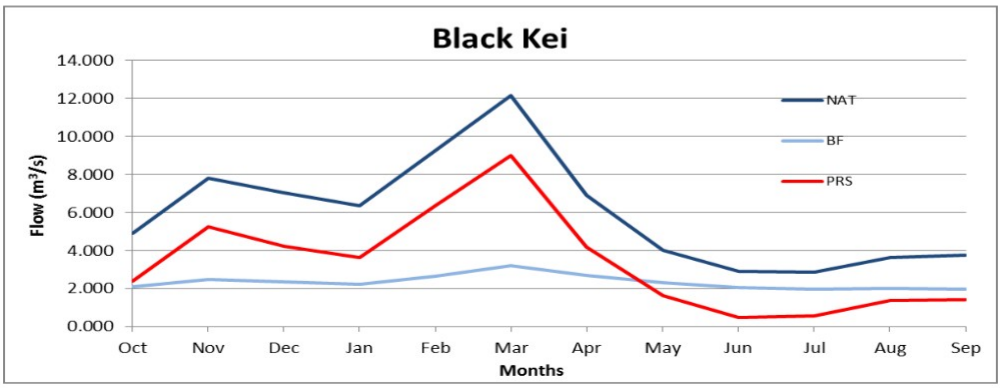


Component: PES and causes

Causes Present/Absent

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	Rank	%wt	RATING	CONFIDENCE
LOW FLOWS	2.00	85.00	4.00	3.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	3.00	75.00	0.00	3.00
MODERATE EVENTS	2.00	90.00	3.00	3.00
EVENT HYDROLOGY(HIGH FLOWS-FLOODS)	3.00	75.00	2.50	2.00
HYDROLOGY SCORE	62.47			
HYDROLOGY ECOLOGICAL CATEGORY	C			



Component: PES and causes

	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Black Kei River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the catchment significantly. This results in increased flashiness of flows and increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the coarser habitats. Trampling and frequent grazing by livestock along the banks destabilizes the geomorphic features at the site.

FINAL DRIVER STATUS GEOMORPHOLOGY

This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.

SCORING GUIDELINES

GEOMORPHOLOGY DRIVERS

COMPONENTS	RANK	RELATIVE WEIGHTING (%)	RATING	WEIGHT	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
System Connectivity	1.00	100.00	1.62	0.43	0.70	65.50	2.82
Sediment balance	2.00	70.00	1.45	0.30	0.44	10.00	2.90
Bed & bank stability	3.00	60.00	1.00	0.26	0.26	16.84	2.95
TOTALS		230.00		1.00	1.41		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					71.90		
HABITAT DRIVER CATEGORY					C	35.92	2.88

	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
Morphological change	1.56	18.89	3.00
HABITAT CHANGE STATUS	68.88889		
HABITAT CHANGE CATEGORY	C		

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Decline/Stable	• Although water quality within the reach was likely to deteriorate over time, non-native fish has become established and are widespread within the catchment	3
Macroinvertebrates	Decline/Stable	• Outbreak of Simuliidae is of a concern (September 2022) and dominating the macroinvertebrate assemblage (high turbid waters and constant high flows). However, owing to recent floods, the SIC biotopes were scoured and populations	2.5

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
		reduced considerably during the May 2023 survey. • Water quality is of a concern due to failing WWTW, urban areas.	
Riparian vegetation	Decline	• The alien plant species present are invasive and likely to increase if left unchecked. • Current trampling pressure is causing loss of habitats which will continue over time.	3.5
Hydrology	Stable	No new water resource developments in recent years	3
Geomorphology	Stable	• Possible balance reached between higher silt loads and reduced bedload.	3
Physical-chemical	Stable	• Land use has remained relatively similar over the years, suggesting no additional impacts on the system. Modifications to physical-chemical nature of the system are largely driven by urban runoff, failing wastewater treatment works and agricultural activities upstream. These activities have been present in the area for a long time, suggesting a modified but stable physical-chemical status.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR DEVIATION**
ECOSTATUS	C	D/E	• Primarily driven by the fish (E category) due to non-native fish species • Macroinvertebrates (limited biotopes i.e no marginal vegetation and the community being further driven by constant low flows (high densities of Simuliidae recorded in September 2022) • High AIP within the riparian vegetation • High trampling pressure causing bank slumping

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
Large scale agricultural activities practised upstream, likely to result in nutrient loading in the system. Bulk of the nutrient loading is expected to be from the Queenstown WWTW which has been reported to receive less than 43% of sewage since 2013, meaning that 57% of the sewage is lost to nearest

watercourses including the Komani River, which is a tributary of the Black Kei River. During both field assessments, the pH was elevated, but still within limits. Clarity was higher on the second sampling trip. The EC and TDS were also higher (almost two times greater) in the second sampling trip compared to the first sampling trip.

Status (PES)		
D/E	D	• F: Increase event hydrology (high-flows floods) particularly to ensure those floods take place on the floodplain to reset the riparian zone; • F: Ensure moderate events (freshets) – this may potentially improve the macroinvertebrate component and controlling the Simuliidae densities; • F: Priority wetlands identified within the same primary catchment area was W_RU13 (S32D) and W_RU12 (S32E) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this primary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas; • NF: Clearing of the AIP within the riparian zone; and • NF: Land management of the catchment (cattle trampling and grazing) to avoid further bank erosion.

OVERALL ASSESSMENT

Table 5-3: Overall EcoStatus assessment for BKEI01_I (Black Kei)

River	Black Kei
EWR Site Code	**BKEI01_I**
Driver component	**PES**
HAI	C
Diatoms	D
GAI	C
Response component	**PES**
FRAI	E
MIRAI	D/E
VEGRAI	D
Ecostatus	**D/E**
EI	Moderate
ES	Moderate
REC	**D**

The overall EcoStatus for this EWR site was categorised as a D/E, thus the system is in a close to largely modified condition most of the time. The resilience of the system is under severe stress and may be lost permanently if adverse impacts continue (**Table 5-3**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats. At the site, disturbance along the margins, such as trampling and alien vegetation are widespread leading to degradation of the habitat associated with inset benches and banks.

From a fish community perspective, the dominance of non-native fish species within the system in association with flow modification and water quality impairment has resulted in a seriously modified fish assemblage relative to reference conditions. Velocity-depth classes however remain widely represented within the reach.

The macroinvertebrate community was highly compromised and primarily influenced by flow modification, due to the dominating presence of Simuliidae in September 2022 (thrives in constant high flow). Although these populations were reduced following the floods in February 2023. The community further responded to water quality (diatoms indicative of poor water quality as well), being compromised by failing WWTW and surrounding urban areas. The riparian vegetation was largely compromised from expected reference conditions with the main causes being alien plant species, particularly perennial invasive species, vegetation clearing from both human and livestock activities and severe trampling pressure resulting in loss of habitats.

It is suggested that a REC of a D (largely modified) and a C/D (close to moderately modified conditions most of the time) can be achieved, should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-3**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Catchment management (cattle grazing and trampling);
- Agricultural activities upstream to be adequately managed; and
- Upstream WWTW to be serviced, maintained so sewage can be treated adequately.

5.4 GKEI01_I: Great Kei River

Sample Date	15 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	GKEI01_I	**IUA**	IUA_S03
River	Great Kei	**IUA description**	Lower Great Kei
Altitude (m.a.s.l.)	159m	**Prioritised RU**	R_RU13_I
Latitude	-32.50811888	**Longitude**	27.966289
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S70A
Level 2 EcoRegion	16.06	**SQ Reach**	S70A-07524
Geomorphological zone	E (slope 0.003)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-7) AND SITE PHOTOGRAPHS (Figure 5-8)

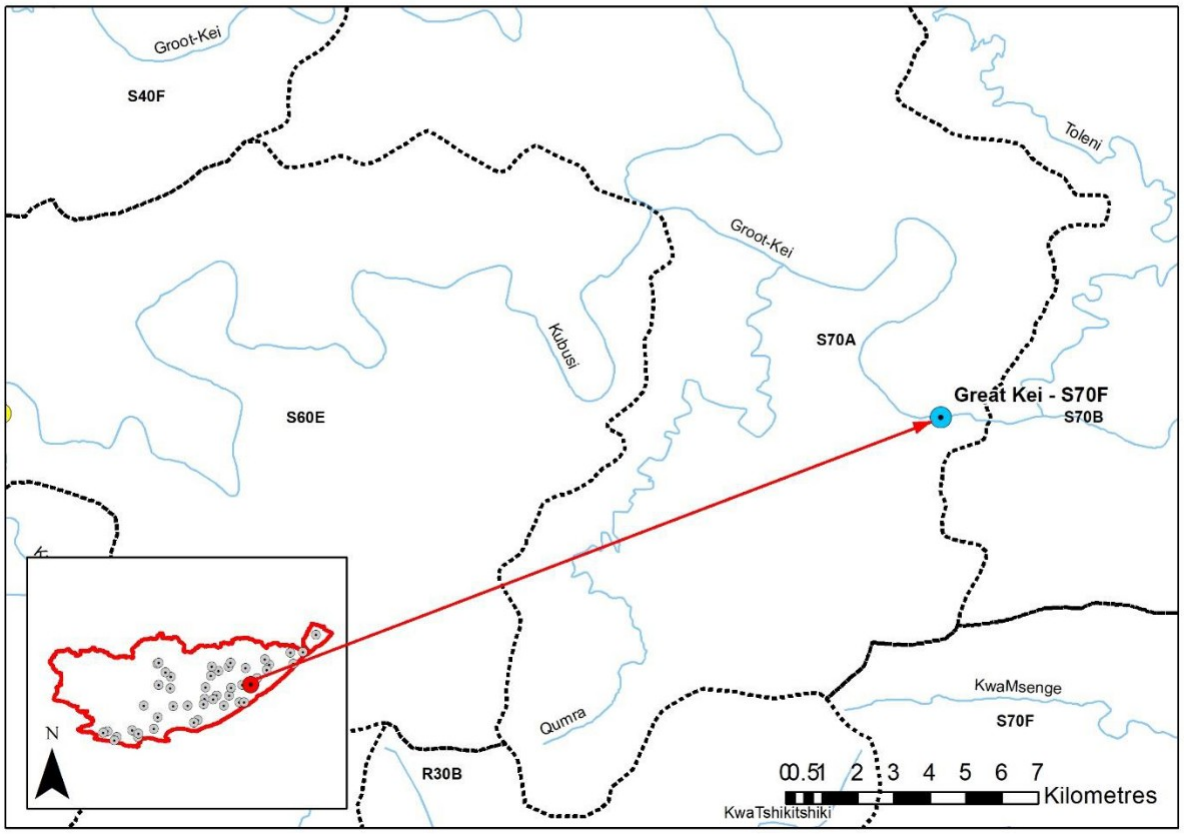


Figure 5-7: Location of site GKEI01_I (Great Kei) in relation to the study area

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)



Figure 5-8: Site photographs of the Great Kei EWR site

Site Description:

The site is located near KwaDlephu, 1.3 km upstream of the Great Kei N2 bridge.

The site is located along a confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. Localised braid bars form multi channels associated with steeper boulder habitats. It follows a pool-riffle or pool-rapid reach type, often with long pools, and is dominated by boulder, cobble, sand and silt sediment types. Benches are

composed boulder and cobble bars with thick sand deposits. There is high embeddedness along the margins of the riffles with silt drapes across the bed sediment along runs and pools. There are signs of erosion and deposition along the channel margins and on the flood benches, grazing and trampling is widespread.

Following the flood event which took place in February 2023, it was clearly observed that this reach of the Great Kei has been positively reset. Considerable sediment deposits were observed along both banks and terrestrial species (i.e *Vachellia robusta (Splendid* Thorn) flooded out along the riparian marginal zone. The boulders and SIC, SOOC have been scoured and a considerable difference in the population of Simuliidae larvae, which previously smothered and dominated the biotopes.

Biota habitats available
All biotopes were available for macroinvertebrates, although marginal vegetation was limited owing to undercut banks along both banks during both surveys. Fish habitats included SS, SD, FS and FD.

Riparian vegetation
The marginal zone had been mostly scoured out by recent floods with only remnants of vegetation clumps scattered between bedrock/boulder/cobble with newly deposited alluvia in-between. Vegetation comprised mostly *Cyperus longus, Gomphostigma virgatum* and *Hemarthria altissima,* although the latter had been grazed to form lawns. Flood benches and the floodplain were extensively covered by new, mostly unvegetated sediment deposits from recent floods and flood damage and flood-related plant deaths were extensive. The *Vachellia robusta* population which had dominated the floodplain before has been vastly reduced, although much remained, and dominance persisted. Other floodplain species included *Ficus sur, Combretum caffrum, Gymnosporia buxifolia* and *Lantana camara.* The banks were dominated by thickets of *L. camara* and wood removal and overgrazing were extensive.

Site impacts:

- Cattle trampling and grazing.
- Sand mining.
- Vegetation removal.
- Agriculture and irrigation upstream
- Exposed banks and bank erosion including eroded gullies.

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.75	8.63
EC (µS/cm)	474.2	533
TDS (g/l)	0.3384	0.399
DO (mg/l)	8.02	8.90
DO% (%)	84.0	94.5
Clarity (cm)	59	27
Temperature (°C)	20.3	18.14
Salinity (ppt)	0.24	0.30

Discharge (m^3/s)		3.84		17.37
DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
September 2022				
31	14.5	B (Good)	7.5	0
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preference	Nutrient and salinity increases (eutrophication)			
May 2023				
27	12.9	B (Good)	18.9	2
Dominant Species	*(1) Achnanthidium sp.*			
	(2) Cocconeis placentula var. euglypta (Ehrenberg) Grunow			
	(3) Encyonopsis minuta Krammer & Reichardt			
Preference	Moderate to good water quality conditions			
	Nutrient and salinity increases (eutrophication)			
	Moderately motile, common in circumneutral water (low nutrient concentration)			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	2	• Simple channel form • Good site access	• Erosion at site during wet season
Fish	3	• Variety of velocity-depth classes present • DWS REMP Site code: S7GKEI-KEIBR (likely further downstream)	• Large system with multiple sampling approaches required to effectively sample • Cover elements were largely dominated by substrate and water column
Macroinvertebrates	4	• SIC, SOOC • Varying flow velocities • DWS REMP Site code: S7GKEI-KEIBR	• Limited to no marginal vegetation and instream aquatic vegetation • Limited GSM owing to substrate dominated by cobbles. • instream aquatic vegetation • SIC and SOOC highly embedded, thus limited scouring of the biotopes • Simuliidae outbreak observed during the September 2022 survey (smothering SIC biotope) • Sand mining (localised erosion)
Riparian vegetation	3	• Both banks accessible • Reasonable diversity of habitats • Reasonable representation of riparian indicators	• Recent flood scour and removal of vegetation/terrestrial vegetation die off

Site Evaluation			
			• Severe grazing and trampling pressure • Scour and close proximity to weir located downstream
Geomorphology	3.25	• Reasonable range of morphological and sediment types	• Localised disturbances such as trampling and sand mining at the site

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Two observed flows with good range
Fish						• FROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: S7GKEI-KEIBR (likely further downstream) • Current two river survey (September 2022 and May 2023)
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: S7GKEI-KEIBR
Hydrology						• Monthly hydrology available for natural and present day • Daily data from gauging weir downstream
Geomorphology						• Limited literature on the system • Historical and recent aerial images available
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1938, 1966 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism.

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity. • REMP *in situ* water quality data • NCMP data site S7H004Q01 (2000-2022, n=768) • 2022 diatom results. • 2023 diatom results

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Acanthopagrus berda, Anguilla bicolor bicolor, Anguilla marmorata, Anguilla mossambica, Awaous aeneofuscus, Enteromius anoplus s.l., Gilchristella aestuaria, Glossogobius callidus, Monodactylus falciformis, Mugil cephalus, Pseudomyxus capensis, Oreochromis mossambicus*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Atyidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Oligoneuridae, Polymitarcyidae, Prosopistomatidae, Telagonodidae, Trichorythidae, Calopterygidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae,Veliidae,Hydropsychidae>2spp,Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Helodidae, Hydrophilidae, Psephenidae, Athericidae, Blepharoceridae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Physidae, Planorbinae, Thiaridae, Corbiculidae, Sphaeridae.
Riparian vegetation	This site occurs within the Savanna Biome, Sub-Escarpment Savanna Bioregion Bioregion, and the Eastern Valley Bushveld vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone, mid-channel bar and flood benches is expected to be dominated by non-woody vegetation, excluding reeds, although a woody

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
	component is also expected including the rheophyte *Gomphostigma virgatum* and the marginal zone obligate *Salix mucronata*. The reference state of the flood benches is expected to be a mixture of woody and non-woody species, with open areas that are maintained by floods. Since this is a flood driven feature the overall biodiversity should be high, with high cover being reset by floods every now and then. The reference state along the macro-channel bank is expected to be dominated by dense riparian thicket, without alien species, and with greater riparian representation.
Hydrology	Monthly natural flows available for period 1920 to 2009
Geomorphology	In its reference condition, the Great Kei River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle or pool-rapid reach types. Localised braided sections can be present. Sand and gravel bars can be present in pools and along the margins of the riffles, but much lower levels of embeddedness and silt cover would be expected. Narrow inset benches composed of sand and gravel and flood benches of sand, gravel and cobble could be present as a result of freshets and infrequent floods.
Physical-chemical	Site reference data could not be obtained. Diatom results were used to infer the reference conditions of the site. Diatom results indicate that site is free from organic an organic pollution, suggesting that the physical-chemical nature at the site has not deviated significantly from the reference conditions. The system is currently characterised by periodic salinity and nutrient increases, which are expected to have been absent under reference conditions. The diatom results indicate moderate to good quality water, suggesting that the system has not substantially deviated from reference condition.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	D (47.5%)	F/NF	• The flow modifications are primarily owing to a number of dams in the upper catchment, including the transfer of water from Wriggleswade Dam to the Buffalo catchment. • Water quality modification • Dominance of translocation *Labeobarbus aeneus and Clarias gariepinus* and alien *Cyprinus carpio*
Macroinvertebrates (MIRAI)	C (65.1%)	F/NF	• Major flow modifications (correlated to the September 2022 observed Simuliidae outbreak). • The flow modifications are primarily owing to a number of dams in the upper catchment, including the transfer of water from Wriggleswade Dam to the Buffalo catchment. • Bank erosion thus hampering marginal vegetation biotope. • High sedimentation concentrations over biotopes • High turbidity
Riparian vegetation (VEGRAI)	C/D (58.2%)	F	• Gubu, Xonxa, Ncora, Tsojana and Bonkolo Dams upstream of site, some quite far but likely with some flood peak reduction and flow regulation. • Encroachment by woody terrestrial species high.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
		NF	• Extensive flood disturbance, scour and sediment deposition, have obscured other impacts somewhat but clear examples of wood removal, slash and burn, and high levels of grazing and trampling pressure occur at the site. • About 10% of the area are comprised of alien species both annual weeds and perennial invasive species such as *Melia azedarach* and *Lantana camara.*
Geomorphology (GAI)	C (68%)	32% flow related	• Widespread erosion in the catchment, especially in the upper catchment. • Several dams in the upper catchment. • Sand mining of flood benches and trampling by livestock along the banks destabilizes the geomorphic features at the site. • Inset benches are eroded and bed appears armoured. • Silt drape and coarse particle embeddedness in low velocity biotopes due to high suspended sediment concentrations.
Hydrology (HAI)	C/D (60.7)		• All flow components, especially baseflows impacted due to water resource developments in all the major tributaries
Diatoms/Physical-chemical	B (13.7)		• System is prone to nutrient and salinity increases (eutrophication). • Water is of moderate to good quality, with low nutrient concentrations.
ECOSTATUS (PES)			

Component: PES and causes				
	Causes Present/Absent			
Fish	Surveys conducted as part of the present study as well as for REMP purposes has confirmed the dominance of several non-native fish species within the reach, including *Labeobarbus aeneus, Clarias gariepinus, Tilapia sparrmanii* and *Cyprinus carpio*, resulting in a greatly reduced diversity of native species. In addition, flow modifications and water quality impairment were likely contributing the largely modified state (Ecological Category D) of the fish assemblage within the reach. The presence of a low-level weir located downstream of the cross-section is further likely to act to some degree as a barrier for movement for fish with estuarine affinities lower in the system, although it is unlikely to impact migration of eel species to a large extent.			

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	86.52	84.79
COVER	100.00	100.00
FLOW MODIFICATION	64.84	78.69
PHYSICAL-CHEMICAL	27.19	41.80
MIGRATION		61.90
IMPACT OF INTRODUCED		54.87
FRAI	PRESENT	
FRAI (%)	47.5	
EC: FRAI	D	

After the recent flood event in the Great Kei River, where flows surpassed 500m^3/s and the macrochannel reached its bank full capacity, it became apparent that the system underwent a significant reset. Sediments were mobilized and transported downstream, leading to the reshaping of the river and the re-establishment of crucial habitats for macroinvertebrates, such as the less embedded SIC. Furthermore, there was an increased presence of mobilised gravel, resulting in overall improvements to the aquatic ecosystem, including enhanced macroinvertebrate taxa richness and diversity. Prior to the floods, the Simuliidae community dominated the SIC and SOOC biotopes, effectively smothering these habitats due to high turbidity and the lack of flow fluctuations resulting from constant, high flows. However, following the flooding and subsequent river assessment, it was evident that the stones biotope has been scoured and cleaned, effectively removing the dominance of Simuliidae. As a result, during the May 2023 survey, the dominant taxa recorded were Trichorythidae and Hydropschyidae >2spp. While Simuliidae are still present, their population densities have significantly decreased, thanks to the much-needed resetting of the system.

Overall, the system is driven largely by the wide diversity of hydraulic conditions across the system, including fast-flowing rapid-riffle complexes, as well as some slow-flowing areas within the marginal zones. Owing to cattle grazing and trampling particularly along the left bank, those banks became unstable and following the floods, resulted in bank collapse and further scouring out the banks, leaving no marginal vegetation. Even the vegetated island within the micro-channel has been eroded away, with undercut banks and no marginal vegetation available to sample. Consequently, the aquatic macroinvertebrate community with a preference for vegetation, is completed absent from this river reach. The high to moderate flow conditions of the site were supported by the presence of a wide variety of flow-dependent taxa, including Perlidae, Athericidae, Baetidae >2spp, Tricorythidae, Elmidae, Hydropsychiidae>2spp, Heptageniidae, Leptophlebiidae and Psephenidae. All of which have a moderate to high preference for unmodified physical-chemical conditions. However, there were also a high number of taxa recorded which prefer low to very low water quality conditions as well.

There were several taxa expected but not recorded, however with low frequency of occurrences, with the exception of Prosopistomatidae and Chlorocyphidae, both with a preference to cobbles, fast and slow flowing water respectively, but both sensitive to water quality.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	69.9	*0.364*	25.4247	1	100
HABITAT	H	67.9	*0.291*	19.7437	3	80
WATER QUALITY	WQ	56.5	*0.327*	18.4813	2	90
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.45455	4	5
						275
INVERTEBRATE EC				65.1042		
INVERTEBRATE EC CATEGORY				C		

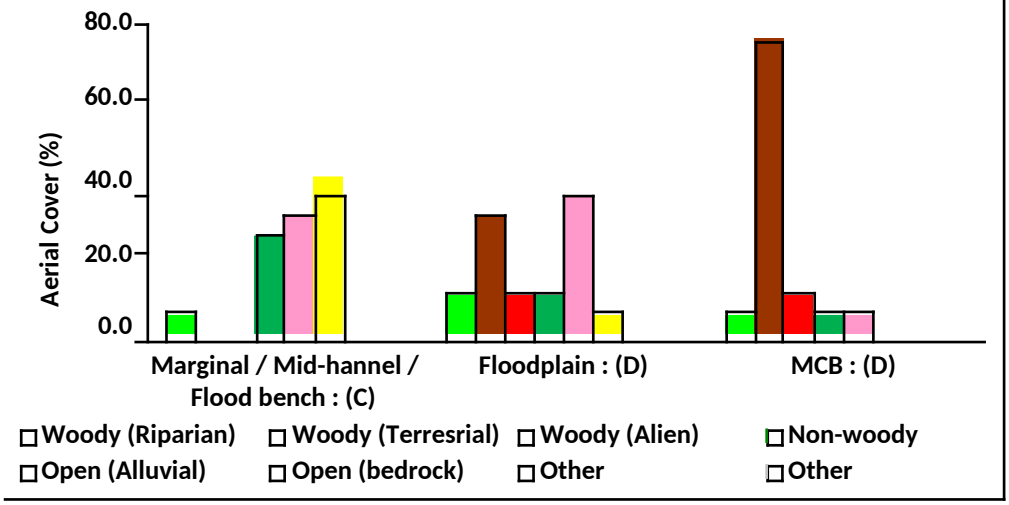
Overall, the community has certainly improved since the floods, with the Simuliidae assemblage being flushed out and no longer dominating and smothering the stones biotope, and prominently providing an opportunity for the macroinvertebrate community to re-colonise and establish according to their specific conditions. Thus, this major flood within the Great Kei River has had positive impacts on the macroinvertebrate community, habitats and water quality, although water quality remains the driver within this system (56.5%), followed by habitat (67.9%), then flow modification (69.9%). The ASPT for the communities identified in September 2022 and May 2023 was 6.2 and 7.3, respectively, indicating the community continuing to comprise of tolerant taxa (Dickens and Graham, 2002), although several sensitive taxa being recorded in May 2023 following the floods representing a positive change

Component: PES and causes	
	Causes Present/Absent
	to the system. The aquatic macroinvertebrate community was determined to be representative of moderately modified conditions (Ecological Category C, 65.1%).
Riparian Vegetation	The marginal zone had been highly disturbed at the time of assessment due to recent large floods and a new flood channel had been eroded. Nevertheless, the mid-channel bar habitats seemed to have been more protected from floods and provided sufficient vegetation characteristics for assessment. Vegetation was fragmented by recent floods and was dominated by non-woody vegetation (mainly *Cynodon dactylon, Cyperus longus, C. textilis, Schoenoplectus paludicola*) and scattered or clumped pockets of woody obligates (mainly *Gomphostigma virgatum, Salix mucronata*). Scoured alluvial bars were either denuded or with overgrazed grass (mainly *C. dactylon*) and cobble/boulder areas with scattered grass and sedge and some *G. virgatum*. AIP comprised annual alien weeds and *Sesbanea punicea*. The floodplain had been highly disturbed at the time of assessment due to recent large floods with extensive new sediment deposits, extreme grazing and trampling pressure and localised sand mining. Dominant habitats along the floodplain were alluvial, undulating, mostly sand on top cobble/ boulder and dominated by woody trees and shrubs with open sandy areas or grazed lawn areas (*C. dactylon*). Vegetation removal (clearing and wood removal) was high. Dominant species included *C. dactylon, Vachellia karroo, V. robusta, Combretum caffrum, Gymnosporia buxifolia.* About 10% of the area comprised alien species, both annual weeds and perennial invasive species such as *Melia azedarach* and *Lantana camara.* The macrochannel bank was predominantly alluvial but not well defined and eroded along the right bank by floods. Dense, woody vegetation dominated and appeared moribund with a high prevalence of alien and terrestrial species. Dominant species incuded *V. karroo, V. robusta, Combretum caffrum, Gymnosporia buxifolia* and common aliens were *Lantana camara* and *Melia azedarach*.

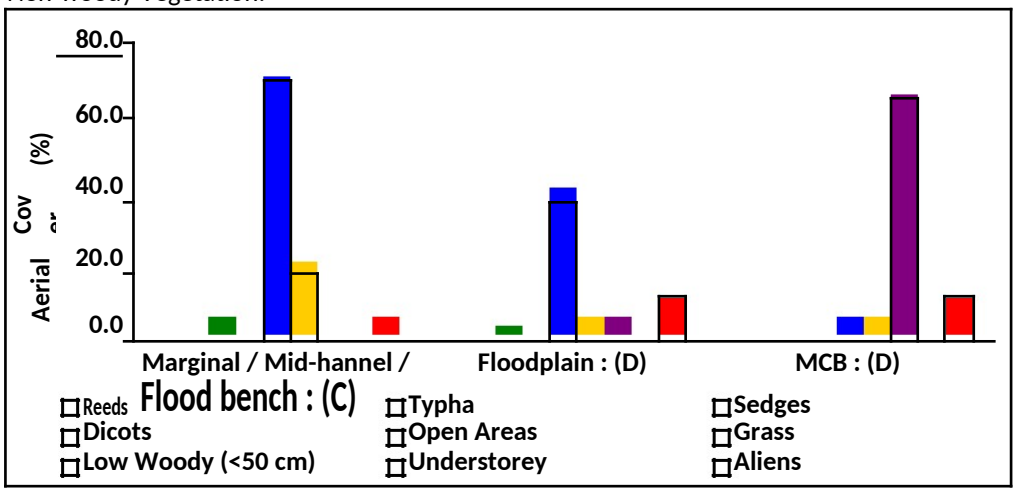
Overall PES:

LEVEL 4 ASSESSMENT	Great Kei_GKEI01_I					12May 2023
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal / Mid-channel / Flood bench	63.8	15.0	3.1		23.5	Weighted according to extent
Floodplain	56.4	33.2	3.3		58.8	Weighted according to extent
MCB	56.7	10.0	3.2		17.6	Weighted according to extent
LEVEL 4 VEGRAI (%)						58.2
VEGRAI Ecological Category						**C/D**
AVERAGE CONFIDENCE						3.2
	Sub-zone Marginal / Mid-channel / Flood bench	**Floodplain**	**MCB**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	63.8	56.4	56.7	not assessed	not assessed	not assessed
EC (Zone)	**C**	**D**	**D**			
Confidence (Zone)	3.1	3.3	3.2			

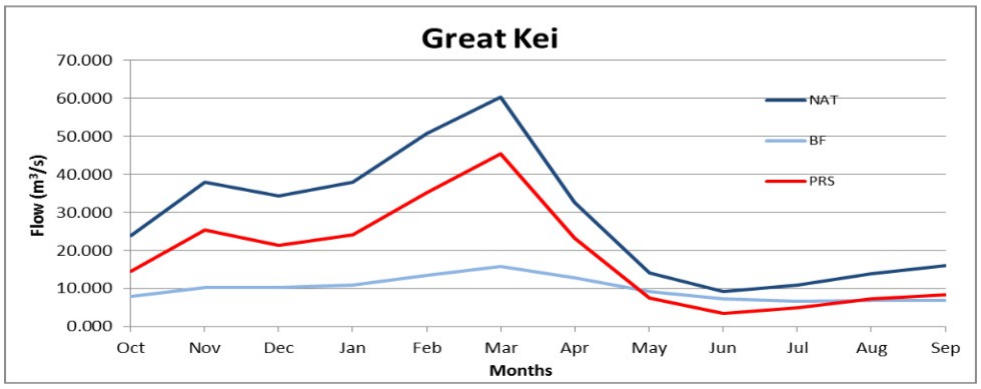
Woody Vegetation:



Component: PES and causes

	Causes Present/Absent
	Non-woody Vegetation: 
Hydrology	HYDROLOGY DRIVER ASSESSMENT INDEX

HYDROLOGY METRICS	Rank	%wt	RATING	CONFIDENCE
LOW FLOWS	2.00	90.00	3.00	3.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	2.00	90.00	0.00	2.00
MODERATE EVENTS	2.00	80.00	4.50	3.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	3.00	75.00	3.00	3.00
HYDROLOGY SCORE	60.69			
HYDROLOGY ECOLOGICAL CATEGORY	C/D			



Component: PES and causes	
	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Great Kei River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the catchment significantly. This results in increased flashiness of flows and increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the coarser habitats. Trampling and frequent grazing by livestock along the banks destabilizes the geomorphic features at the site. Sand mining along the banks add to this disturbance along the banks.

FINAL DRIVER STATUS GEOMORPHOLOGY	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*						
SCORING GUIDELINES							
GEOMORPHOLOGY DRIVERS							
COMPONENTS	**RANK**	**RELATIVE WEIGHTING (%)**	**RATING**	**WEIGHT**	**WEIGHED SCORE**	**FLOW RELATED**	**CONFIDENCE**
System Connectivity	1.00	100.00	1.42	0.43	0.62	56.00	2.83
Sediment balance	2.00	70.00	1.85	0.30	0.56	10.00	2.90
Bed & bank stability	3.00	60.00	1.68	0.26	0.44	16.32	3.13
TOTALS		230.00		1.00	1.62		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					67.63		
HABITAT DRIVER CATEGORY					C	31.65	2.93
					WEIGHED SCORE	**FLOW RELATED**	**CONFIDENCE**
Morphological change					1.56	21.11	2.72
HABITAT CHANGE STATUS					68.88889		
HABITAT CHANGE CATEGORY					C		

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Decline/Stable	• Although water quality within the reach was likely to deteriorate over time, non-native fish has become established and are widespread within the catchment	3
Macroinvertebrates	Decline/stable	• Outbreak of Simuliidae is of a concern (September 2022) and dominating the macroinvertebrate assemblage (high flows). However, owing to recent floods, the SIC biotopes were scoured and populations reduced considerably during the May 2023 survey.	2.5
Riparian vegetation	Decline	• The alien plant species prevalent at site have the potential to invade and increase.	3

		• Terrestrialisation is prevalent at the site but has been rectified to some extent by recent floods. Without frequent floods this may resume to the detriment of riparian species.	
Hydrology	Stable	• Limited water resource developments planned in smaller tributaries	3
Geomorphology	Stable	• Erosion rate and trapping by dams are assumed to be stable. Site erosion and deposition appears in balance.	3
Physical-chemical	Stable	• The intensity of the agricultural activities upstream has remained relatively the same over time. No discharges into the river were identified from satellite imagery. Diatom results also show minimal deviation from natural conditions.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR DEVIATION
ECOSTATUS	C	C/D	• Driven by the fish (D category) and riparian vegetation (C/D category) components. • Extensive terrestrialisation on flood features. • Dominance of non-native fish species • Movement barrier owing to the downstream weir – thus an impact on the fish community along this reach.

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, Moderate	High, Moderate

Physical-chemical state of the system
pH elevated, but still within acceptable range. All other parameters measured *in situ* were within acceptable limits. Some nutrient loading is expected from the agricultural activities upstream.

C/D	C	• F: Increased event hydrology (high flows-floods) needs to be more frequent – this may potentially improve the riparian vegetation component; • F: Moderate events (freshets) – this may potentially improve the macroinvertebrate component and controlling the Simuliidae densities. Chapter 10 of this report provides a dedicated chapter regarding the potential management of Simuliidae populations in these catchment areas in relation to setting floods/freshets; • NF: Land management (cattle trampling and grazing); and

		• NF: Unauthorised and illegal sand mining operations should be investigated which are taking place upstream from this EWR site.

OVERALL ASSESSMENT

Table 5-4: Overall EcoStatus assessment for GKEI01_I (Great Kei)

River	**Great Kei**
EWR Site Code	**GKEI01_I**
Driver component	**PES**
HAI	C/D
Diatoms	B
GAI	C
Response component	**PES**
FRAI	D
MIRAI	C
VEGRAI	C/D
Ecostatus	**C/D**
EI	High
ES	Moderate
REC	**C**

The overall EcoStatus for this EWR site was categorised as a C/D, thus the system is in a close to moderately modified condition most of the time (**Table 5-4**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats, while the dams upstream trap a portion of the coarser bedload, reducing the extent of gravel and cobble bars. At the site, disturbance along the margins, such as sand mining, trampling, removal of biomass, are widespread leading to degradation of the habitat associated with bars, benches and banks.

From the biotic perspective, the dominance of non-native fish species within the system in association with flow modification and water quality impairment, has resulted in a largely modified fish assemblage relative to reference conditions. Velocity-depth classes however remain widely represented within the reach, although the presence of movement barriers may limit the occurrence of some fish species. Similarly, the Simuliidae population outbreak was recorded during the September 2022 survey, however these populations were reduced following the floods in February 2023. With varying hydraulic conditions, it was found that the community primarily responded to water quality, followed by habitat due to no marginal vegetation available.

The riparian vegetation at site has been influenced by recent flooding disturbance, which has reduced the clear impacts of terrestrialisation along flood features and banks. Nevertheless, the site remains under pressure from intensive grazing, alien invasive plant species and localised sand mining.

It is suggested that a REC of a C (moderately modified) can be achieved and maintained, should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-4**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Land management (cattle trampling and grazing);
- Unauthorised and illegal sand mining operations should be investigated upstream from this EWR site; and
- Agriculture activities upstream to be managed.

5.5 TSOM01_I: Tsomo River

Sample Date	10 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	TSOM01_I	**IUA**	IUA_S01
River	Tsomo	**IUA description**	Upper Great Kei
Altitude (m.a.s.l.)	769m	**Prioritised RU**	R_RU11_I
Latitude	-32.04397654	**Longitude**	27.82105224
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S50G
Level 2 EcoRegion	16.06	**SQ Reach**	S50J-07011
Geomorphological zone	E (slope 0.004)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-9) AND SITE PHOTOGRAPHS (Figure 5-10)

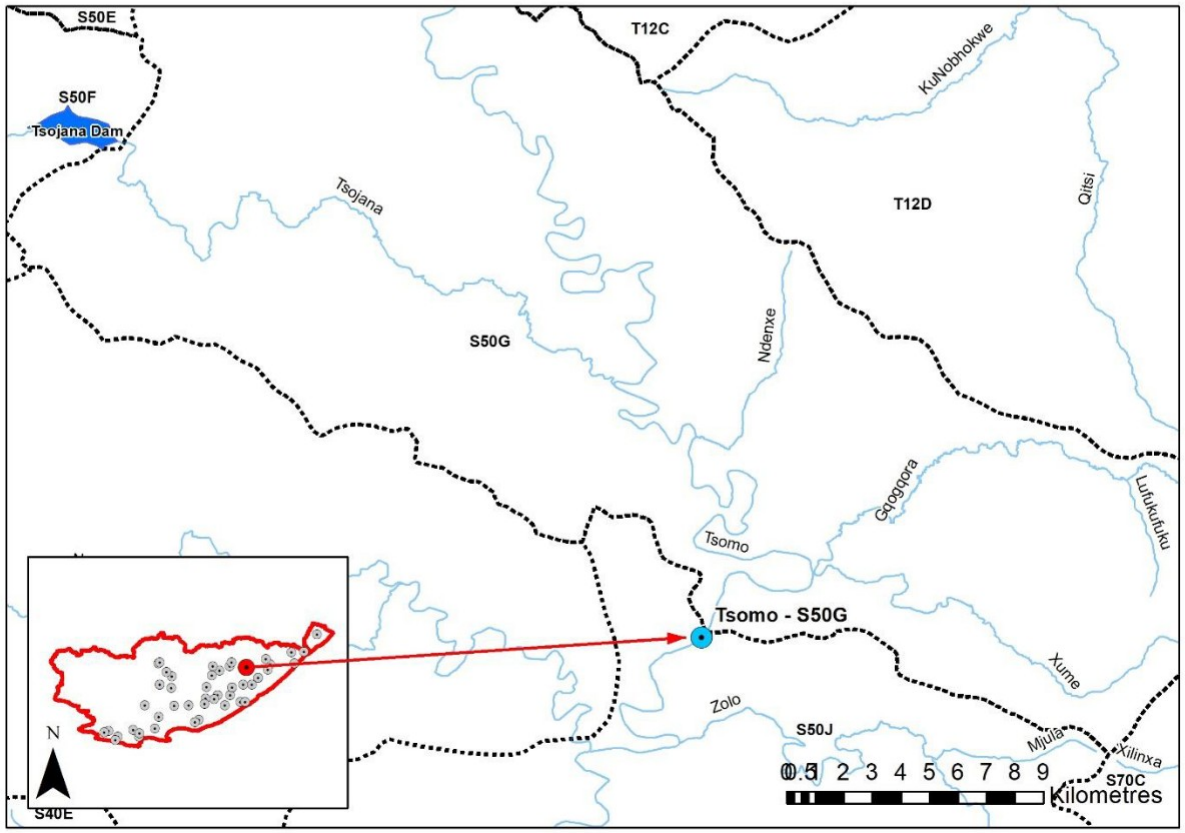


Figure 5-9: Location of site TSOM01_I (Tsomo) in relation to the study area

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)



Figure 5-10: Site photographs of the Tsomo EWR site

Site Description:

The site is located near Tsomo, just downstream of the R409 and gauging weir S5H002.

The site is located in a confined valley setting with a single channel and flood benches along both banks. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and sand sediment types. The boulder, cobble and gravel sediment are largely fixed with small pockets with mobile gravel. There are bedrock sections with localised bedrock steps. It has localised islands where the channel bifurcates

around boulder bars or bedrock. Benches are composed of silt and sand. There is low embeddedness along riffles and rapids, but significant embeddedness along pools or the margins of faster habitats where velocity is lower. Thick organic rich deposits were covering gravel pockets along the riffle where velocities were lower. Bank erosion is widespread, largely due to trampling and grazing. There are recent fine sand deposits along the flood benches, with sand mining along the higher flood features.

Biota habitats available
Aquatic Macroinvertebrate biotopes were dominated by bedrock and boulders, with some SIC, SOOC and GSM. A small pocket on aquatic instream vegetation was sampled in September 2022, however following the floods, part of this biotope was flushed downstream and the rest remained with undercut banks. There was limited to no marginal vegetation owing to lower water levels and undercut banks during both surveys. Varying fish habitats comprised FD, FS, SD and SS.

Riparian vegetation
The site is close to a weir and therefore has a high degree of scour and flood disturbance. Much of the marginal zone has been scoured out as well as a portion of the flood bench on the left bank. The marginal zone is comprised of pockets of sedges scattered across the rapid area or a narrow band around the edges of pools. *Gomphostigma virgatum* is also present in less disturbed cobble areas closer to the pool. The flood bench is also dominated by non-woody vegetation (mainly *Cyperus longus* and *Schoenoplectus*) with extensive areas of newly deposited, unvegetated alluvia from recent floods. A distinct treeline (*Salix mucronata, C. caffrum* and *Senegalia caffra*) marks the end of the flood bench and the start of the banks that are grassed (*Cynodon dactylon*) or have tall trees (*C. caffrum, Celtis africanum, A. mearnsii, A. dealbata*), scattered and in low density. Grazing and trampling pressure is moderate, as is invasion by alien plants species.

Site impacts:

- Upstream weir and water works
- Water quality issues (algae)
- Localised water abstraction
- Macroplastics (nappies)
- Cattle trampling and grazing
- Erosion and bare soils

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.75	8.48
EC (µS/cm)	309.8	268
TDS (g/l)	0.2287	0.211
DO (mg/l)	8.48	9.39
DO% (%)	95.1	94.7
Clarity (cm)	47 cm (estimate)	21
Temperature (°C)	18.8	15.83
Salinity (ppt)	0.17	0.16
Discharge (m^3/s)	0.48	1.35

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
September 2022				
30	15.4	B (Good)	3.2	1.5
Dominant Species	(1) *Achnanthes thienemannii Hustedt*			
	(2) *Achnanthidium spp.*			
Preference	(1) Limited research on this diatom species however the specialists feel that it may be indicative of low nutrient/low EC (previously identified in high mountainous streams in SA and Lesotho)			
	(2) Moderate to good quality waters			
May 2023				
13	16.8	B (Good)	3.0	0
Dominant Species	*Achnanthidium sp.*			
Preference	Moderate to good water quality conditions			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	2.5	• Easy access • Simple channel form • Near gauging weir	• Sand mining and deposition on flood benches affect high flow channel shape
Fish	3	• Reach easily wadable • Presence of a weir upstream likely to concentrate fish moving upstream during summer • Most velocity-depth classes represented	• Limited marginal vegetation
Macroinvertebrates	3	• SIC, SOOC and GSM biotopes available	• Limited marginal vegetation and no instream aquatic vegetation • High algae content smothering SIC biotope • Upstream weir (flow modifications) • High turbidity
Riparian vegetation	3	• Reasonable range of habitat types • Good representation of riparian indicators	• Severe grazing and trampling pressure • Scour and close proximity to weir
Geomorphology	3	• Reasonable range of morphological and sediment types available at the site	• In town close to a weir and road access, thus increased disturbance at and around the site

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Two observations at relatively low discharges
Fish						• PES-EI-ES Assessment (DWS, 2014) • DWS REMP monitoring data • Current two river survey (September 2022 and May 2023)
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)
Hydrology						• Monthly hydrology available for natural and present day flows • Daily flows from gauging weir at the site
Geomorphology						• Historical and recent aerial photos
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1938 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity. • Green Drop Reports 2011, 2013 and 2021 for the Tsomo WWTW. The WWTW, however does not discharge into the system. • 2022 diatom results. • 2023 diatom results • NCMP data site S5H002Q01 (1971-2023 n=236)

** 0 (no information) to 4 (large amount of data available)*

Reference Conditions	
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla mossambica, Enteromius anoplus s.l.*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Atyidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Oligoneuridae, Polymitarcyidae, Prosopistomatidae, Telagonodidae, Trichorythidae, Calopterygidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Veliidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Helodidae, Hydrophilidae, Psephenidae, Athericidae, Blepharoceridae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Physidae, Planorbinae, Thiaridae, Corbiculidae, Sphaeridae.
Riparian vegetation	This site occurs within the Grassland Biome, Sub-Escarpment Grassland Bioregion, and the Tsomo Grassland vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone is expected to be well covered by non-woody vegetation, and dominated by sedges, grasses and broad-leafed riparian obligate species. Similarly flood benches and lateral bars are expected to have high vegetation cover with the same non-woody species being common and dominant in places, but also with a woody component, mostly scattered riparian obligate species such as *Salix mucronata* and *Combretum caffrum*. The macro-channel bank is expected to be a mixture of woody and non-woody vegetation given its occurrence with the Tsomo Grassland vegetation type, but a distinct riparian tree line and woody banks comprising both riparian and terrestrial species should be common.
Hydrology	Monthly natural flows available for period 1920 to 2009
Geomorphology	In its reference condition, the Tsomo River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle or pool-rapid reach types. Localised braided and bedrock sections can be present. Sand and gravel bars can be present in pools and along the margins of the riffles, but much lower levels of embeddedness and silt cover would be expected. Narrow inset benches

Reference Conditions			
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**		
	composed of sand and gravel and flood benches of sand, gravel and cobble could be present as a result of freshets and larger floods.		
Physical-chemical	A low confidence assessment was performed using historical data (1971-1995, n=14)		
	Physical variables	pH	Reference condition data indicated a 5th percentile of 6.7 and a 95th percentile of 8.4 pH units. As such the Natural (0) limit for pH for the site was re-benchmarked to ≥6.5 ≤8.4 pH units
		EC	Reference site data indicates low conductivities (95th percentile = 26.33mS/m), falling within the natural range of the standard DWA (2008) benchmark. As such the standard benchmarks were used to rate change in EC
		Temperature	No historical records are available for the site. DWA (2008) benchmark tables were used for a low confidence, qualitative assessment of temperature reference conditions.
		Clarity	There are no clarity/turbidity records available for reference condition assessment. Reference condition is taken as that qualitatively described in the DWA (2008) benchmark tables.
		Oxygen	No dissolved oxygen records are available for this site. DWA guideline benchmark tables (2008) have been utilised to characterise the site's reference condition.
	Nutrients	PO_4	Reference site indicates relatively low PO_4 concentrations (50th percentile 0,02 mg/l), but still requiring a slight re-benchmark of PO_4, such that 0.02 becomes the A category limit (50th percentile).
		TIN	Reference site indicates TIN concentrations slightly higher than DWA (2008) Natural (0) rating of 0.05 with the 50th percentile equal to 0.07 mg/l. The DWA (2008) Natural (0) was readjusted such that the Natural (0) rating for site was <0.07mg/l.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish (FRAI)	E (33.9%)	F/NF	• Flow modifications and water quality impairment, particularly nutrients and sewage • Presence of movement barriers • Dominance of translocation *Labeobarbus aeneus*, with translocated *Clarias gariepinus* and alien *Cyprinus carpio* also present
Macroinvertebrates (MIRAI)	C (62.5%)	F/NF	• High nutrients resulting in vast algae coverage over instream biotopes (September 2022), although this had been scoured away following the May 2023 floods.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Dams and weirs in the upper and middle catchment (and just upstream of the EWR site) (flow modification). • Cattle trampling and grazing (bank erosion) thus hampering marginal vegetation biotope.
Riparian vegetation (VEGRAI)	C/D (61.6%)	F NF	• Influenced by the Ncora and Tsojana Dams upstream which are likely to cause some regulation, altered flooding frequency and duration and reduced flood peaks, as well as the close by weir. • Extreme trampling and grazing pressure with associated bank slumping and erosion, with scour from the nearby weir. • AIP - Wattle, both *Acacia mearnsii* and *A. dealbata*.
Geomorphology (GAI)	D (58%)	32% flow related	• Widespread erosion in the catchment. • Several dams in the upper to middle catchment with several weirs along the lower catchment. • Sand mining of flood benches and trampling by livestock along the banks destabilizes the geomorphic features at the site. • Inset benches are eroded and bed appears armoured. • Silt drape and coarse particles embedded in low velocity biotopes due to high suspended and organic sediment concentrations.
Hydrology (HAI)	D (54.7%)		• All flow components, especially moderate and large flood events impacted by upstream dam developments
Physical chemical/Diatoms	B (16.1)	NF	• Low nutrient/low EC • Moderate to good quality waters. • Relatively less developed area, limiting the impacts at this stretch of the river. • WWTWs at Tsomo does not discharge into the river. • Several dams and weirs upstream also act as sinks which would mean less pollutants reaching this stretch of the river. • Moderate to good water quality water that has not substantially deviated from the reference conditions.
ECOSTATUS (PES)	D (57.8%)		

Component: PES and causes				
	Causes Present/Absent			
Fish	Indigenous species to the catchment were noted to contribute less than 5% of the catch across the September 2022 and the May 2023 assessment. While the reach is expected to support a naturally low fish diversity under reference conditions, the dominance of non-native (translocated and alien) fish species within reach will out-compete the native fish species. In addition, flow modifications, water quality impairment and elevated sediment input as well as the presence of movement barriers throughout the system were likely contributing to the seriously modified state (Ecological Category E) of the fish assemblage within the reach.			

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	96.65	82.60
COVER	100.00	84.69
FLOW MODIFICATION	34.58	41.05
PHYSICAL-CHEMICAL	35.57	38.89
MIGRATION		69.44
IMPACT OF INTRODUCED		100.00
FRAI	PRESENT	
FRAI (%)	33.9	
EC: FRAI	E	

Component: PES and causes

	Causes Present/Absent
Macroinvertebrates	During the September 2022 and May 2023 surveys of the Tsomo River, each survey recorded 15 taxa, resulting in a community of 22 taxa. The river exhibited diverse hydraulic conditions, predominantly characterised by bedrock and boulders, with some SIC and SOOC. While sand and mud were present, the abundance of gravel was limited. In the September 2022 survey, there was some marginal vegetation, which was sampled. However, following the floods in February 2023, extensive bank scouring occurred, leading to further erosion and undercut banks along the margins. Consequently, the marginal vegetation was absent during the May 2023 survey. Nevertheless, despite the eroded banks, the in-stream system showed signs of positive restoration, particularly evident in the scouring of the stones biotope. This was supported by the apparent reduction in the Simuliidae population, which had reached outbreak densities (D abundance ->1000 individuals) and which initially had smothered the boulders and SIC during the September 2022 survey. In contrast, the May 2023 survey recorded the Simuliidae population at a lower abundance (B abundance, 10-100 individuals). The initial outbreak densities were likely a result of sustained high flows and poor water quality with high turbidity. The water quality conditions had improved since September 2022, as echoed in the macroinvertebrate assemblage in May 2023. This was evident from the presence of several taxa that prefer unmodified physical-chemical conditions, including Perlidae, Baetidae >2spp, Heptageniidae, Leptophlebiidae, Trichorythidae, and notably, the novel appearance of Prosopistomatidae, which are not commonly recorded in these reaches. This community of taxa also prefers moderately fast to very fast flowing conditions. The sensitive macroinvertebrates absent in both surveys included Chlorocyphidae, Hydropsychidae >2spp, Psephenidae, and Athericidae, all of which have a preference for cobbles and moderately fast to very fast flowing conditions. Furthermore, other taxa expected to occur frequently included those with preferences for very low and low water quality.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	71.5	*0.316*	22.5815	3	90
HABITAT	H	56.7	*0.351*	19.8935	1	100
WATER QUALITY	WQ	63.5	*0.333*	21.1814	2	95
CONNECTIVITY & SEASONALITY	CS	80.0	*0.000*	0	4	0
						285
INVERTEBRATE EC				63.6564		
INVERTEBRATE EC CATEGORY				C		

Overall, the aquatic macroinvertebrate community in the Tsomo River was determined to represent moderately modified conditions (Ecological Category C, 63.7%). Habitat modification played the primary role (56.7%) in driving the community, attributed to the limited presence of marginal vegetation and highly embedded stones biotope. Water quality accounted for 63.5% of the driving factors, followed by flow modification (71.5%). The dominance of Simuliidae in September 2022, which thrives in constant high flows and turbid waters, contributed to the flow modification. The ASPT values for the communities identified in September 2022 and May 2023 was 5.8 and 7.1 respectively. This indicates that the communities mainly consisted of tolerant and moderately tolerant taxa (Dickens and Graham, 2002). The higher ASPT value recorded during the May 2023 survey was primarily due to the inclusion of various sensitive taxa mentioned above, including Prosopistomatidae, which has a sensitivity score of 15 out of 15. This improvement in the overall South African Scoring System version 5 (SASS5) score contributed to the higher ASPT value. Thus overall, an improvement to the system following the flood event and previous survey.

Riparian vegetation

The marginal zone was trampled and well grazed, and had been extensively scoured by recent floods, perhaps exacerbated by the close proximity of the site to the upstream weir The zone comprised a narrow band of sedges and grasses around pools habitats and more extensive on inset benches and lateral bars. At riffle habitats the zone was fragmented and scoured with pockets of sedges and *Gomphostigma virgatum*. Dominant species included *Cynodon dactylon, Cyperus longus, Schoenoplectus corymbosus* and alien species were absent. The flood bench had been completely scoured in places, but mostly close to the weir. The bench was mostly alluvial and dominated by non-woody vegetation, notably grasses and sedges with an absence of riparian broad-leafed forbs. A slight flood bench channel supported a line of riparian and terrestrial trees, notably *Salix mucronata, Combretum caffrum* and *Senegalia caffra* respectively. Extensive newly deposited sediments from recent floods remained mostly unvegetated as yet. *Acacia mearnsii* was a notable alien species. The macro-channel bank was somewhat disturbed with some vegetation removal and some alien plants species (mostly Wattles, both *A. mearnsii* and *A. dealbata*). This alluvial zone was dominated by a mix of woody and non-woody vegetation and was well grassed except for newly deposited sediments from recent floods. There was however a well-defined woody layer, mostly trees but also shrubs and included *Combretum caffrum, Searsia pyroides* var. *pyroides, Senegalia caffra* and *Ziziphus mucronata*.

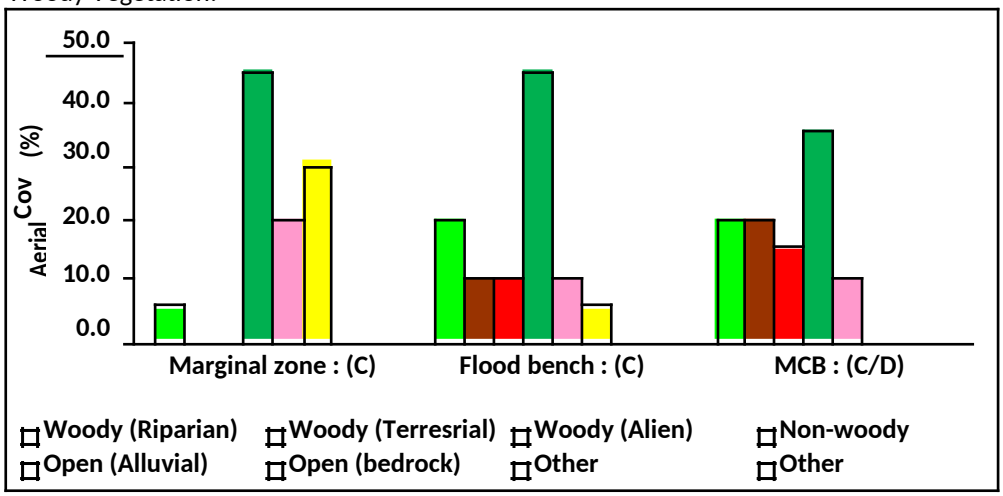
Overall PES:

LEVEL 4 ASSESSMENT	**Tsomo_TSOM01_I**					**11 May 2023**
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal zone	63.1	3.6	3.5		5.7	Weighted according to extent
Flood bench	62.4	23.5	3.3		37.7	Weighted according to extent
MCB	60.9	34.5	2.3		56.6	Weighted according to extent
LEVEL 4 VEGRAI (%)						61.6
VEGRAI Category	**Ecological**					**C/D**
AVERAGE CONFIDENCE						3.1
	Sub-zone					
	Marginal zone	**Flood bench**	**MCB**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	63.1	62.4	60.9	not assessed	not assessed	not assessed
EC (Zone)	**C**	**C**	**C/D**			
Confidence (Zone)	3.5	3.3	2.3			

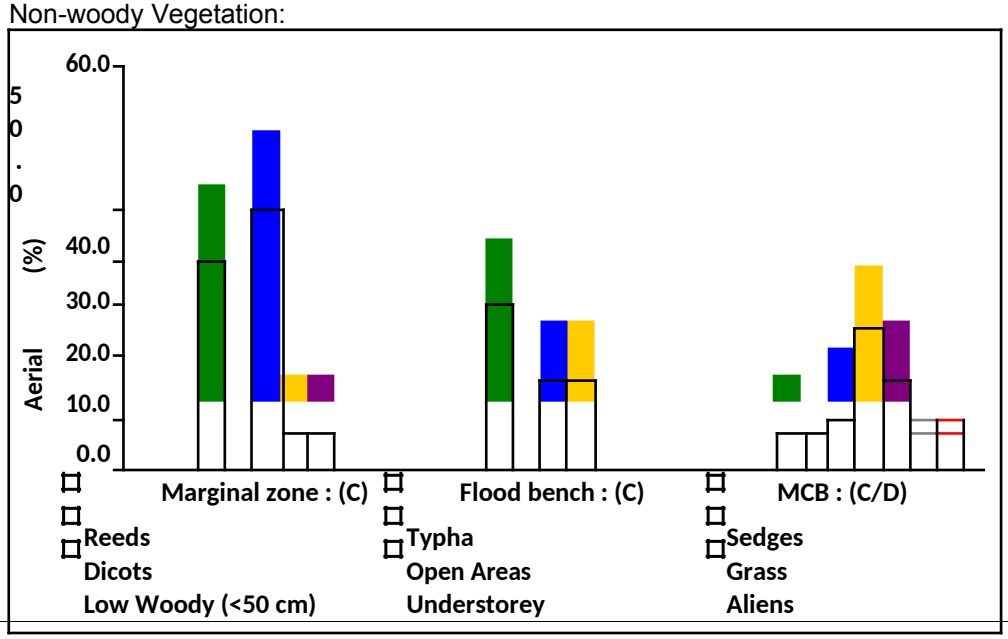
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

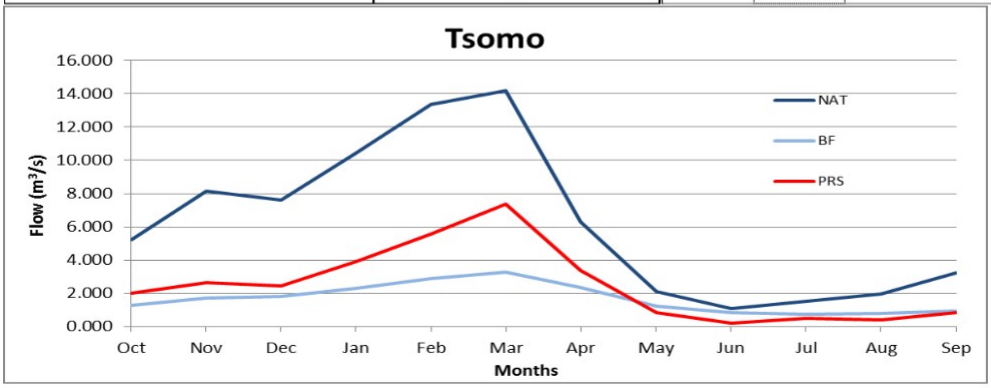


Component: PES and causes

Causes Present/Absent

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	Rank	%wt	RATING	CONFIDENCE
LOW FLOWS	2.00	90.00	3.50	4.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	2.00	90.00	1.50	3.00
MODERATE EVENTS	3.00	85.00	4.00	3.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	4.00	80.00	3.00	3.00
HYDROLOGY SCORE	53.71			
HYDROLOGY ECOLOGICAL CATEGORY	D			



Component: PES and causes	
	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Tsomo River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. Several dams and weirs trap coarse bedload, reducing the extent of coarse sediment habitat. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the catchment significantly. This results in increased flashiness of flows and increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the available coarser habitats. Sand mining, trampling and frequent grazing by livestock along the banks destabilizes the geomorphic features at the site. The inset benches were eroded, possibly due to the proximity to the gauging weir.

FINAL DRIVER STATUS GEOMORPHOLOGY	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*						
SCORING GUIDELINES							
GEOMORPHOLOGY DRIVERS							
COMPONENTS	**RANK**	**RELATIVE WEIGHTING (%)**	**RATING**	**WEIGHT**	**WEIGHED SCORE**	**FLOW RELATED**	**CONFIDENCE**
System Connectivity	1.00	100.00	2.30	0.43	1.00	64.17	3.05
Sediment balance	2.00	70.00	2.45	0.30	0.75	8.00	2.65
Bed & bank stability	3.00	60.00	1.43	0.26	0.37	4.55	3.16
TOTALS		230.00		1.00	2.12		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					57.62		
HABITAT DRIVER CATEGORY					D	31.52	2.96
					WEIGHED SCORE	**FLOW RELATED**	**CONFIDENCE**
Morphological change					2.00	31.11	2.78
HABITAT CHANGE STATUS					60		
HABITAT CHANGE CATEGORY					C		

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Decline/Stable	• Although water quality within the reach was likely to deteriorate over time, non-native fish has become established and are widespread within the catchment and are considered to be largely tolerant	3
Macroinvertebrates	Decline	• Outbreak of Simuliidae is of a concern (September 2022) and dominating the macroinvertebrate assemblage (high turbid waters and constant high flows). However, owing to recent floods, the SIC biotopes were scoured and populations reduced considerably during the May 2023 survey. • Ongoing pressures, particular having an impact on water quality.	3

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Riparian vegetation	Decline	The presence of Wattle species both *Acacia mearnsii* and *A. dealbata*, which are likely to increase over time if not actively managed or removed for use.	3
Hydrology	Stable	No new water resource developments in recent years	3
Geomorphology	Decline	Ongoing pressures at site and in catchment with ongoing development of water abstraction	3
Physical-chemical	Decline	Analyses of the physical-chemical data suggests some spikes in nutrient and salts, noted in more recent years. This is likely a result of the new developments in the area in recent years.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR DEVIATION
ECOSTATUS	D	D	• Driven by the fish component (E category). • Dominance of non-native fish species • Movement barrier owing to the downstream weir – thus an impact on the fish community along this reach. • Driven by the riparian vegetation component (D category). • High trampling pressure resulting in degradation and thus bank scouring and undercut banks. Vegetation removal and high AIP.

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
All parameters measured *in situ* were within acceptable ranges. The pH was, however, elevated. The site is located just upstream of the Tsomo WWTW. The Green Drop Report suggests that the WWTW does not discharge into the river, however, it is hydraulically overloaded operating at 20% over its design capacity. Some impacts on the physical-chemical state are to be expected from the Tsomo town upstream. Diatoms indicated good water quality suggesting that minimal impacts from upstream town of Tsomo.

D	C/D	• F: Improvement of those moderate to low flows could benefit the riparian vegetation and instream components, and ultimately improve the HAI score; • F: Priority wetlands identified within the same primary catchment area was W_RU18 (S50E) and W_RU21 (S50C) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this primary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas; • NF: Clearing of the AIP within the riparian zone; • NF: Land management of the catchment (cattle trampling and grazing) to avoid further bank erosion; and • NF: Unauthorised and illegal sand mining operations to be investigated.

OVERALL ASSESSMENT

Table 5-5: Overall EcoStatus assessment for TSOM01_I (Tsomo)

River	Tsomo
EWR Site Code	**TSOM01_I**
Driver component	**PES**
HAI	D
Diatoms	B
GAI	D
Response component	**PES**
FRAI	E
MIRAI	C
VEGRAI	C/D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**C/D**

The overall EcoStatus for this EWR site was categorised as a D, thus the system is in a largely modified condition (**Table 5-5**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and thick silt deposits over coarser habitats, while the dams upstream trap a portion of the coarser bedload, reducing the extent of gravel and cobble bars. At the site, disturbance along the margins, such as sand mining, trampling, removal of biomass, are widespread leading to degradation of the habitat associated with bars, benches and banks.

From a fish community perspective, the dominance of non-native fish species within the system in association with flow modification, water quality impairment and movement barriers throughout the system has resulted in a seriously modified fish assemblage relative to reference conditions.

In terms of the aquatic macroinvertebrate community, varying hydraulic conditions were present at this site, however poor habitat availability was the driver of the community. The biotopes were dominated by boulders (which is not a preferred biotope for macroinvertebrate), and no marginal vegetation, ultimately eliminating those taxa with a preference for instream and/or marginal vegetation. Interestingly, during the May 2023 survey, a Prosopistomatidae (water specs), which are not commonly recorded in these reaches, were recorded and which are sensitive to any water quality changes. However, this may be correlated to the recent floods and thus potentially flushing the system. A Simuliidae population outbreak was also recorded during the September 2022 survey, however these populations were reduced following the floods in February 2023.

The riparian vegetation at this site is moderately intact except for scoured and eroded areas, mainly due to a combination of high trampling pressure as well as flooding disturbance and the presence of the nearby upstream weir. Some invasive plant species also occur at the site, notable Wattles.

It is suggested that a REC of a C/D (close to moderately modified conditions most of the time) can be achieved and maintained, should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-5**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Any future land use activities within upstream catchment should be managed to prevent degradation of the ecological health of the system and deterioration of the water quality (buffer zones to be implemented for future proposed developments) i.e., proposed Foxwood Dam;
- Alien weed infestation eradication implementation programme;
- Land management (cattle grazing and trampling);
- Wetland rehabilitation should be considered in the catchment; and
- Ensure compliance of the upstream WWTW.

5.6 BUFF01_I: Buffalo River (Middle)

Sample Date	16 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	BUFF01_I	**IUA**	IUA_R02
River	Buffalo	**IUA description**	Buffalo/ Nahoon
Altitude (m.a.s.l.)	162	**Prioritised RU**	R_RU10_I
Latitude	-32.99151874	**Longitude**	27.64057286
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	R20F
Level 2 EcoRegion	31.02	**SQ Reach**	R20F-08045
Geomorphological zone	E (slope 0.004)	**PES (DWS, 2014)**	D
Ecological Importance	High	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-11) AND SITE PHOTOGRAPHS (Figure 5-12)

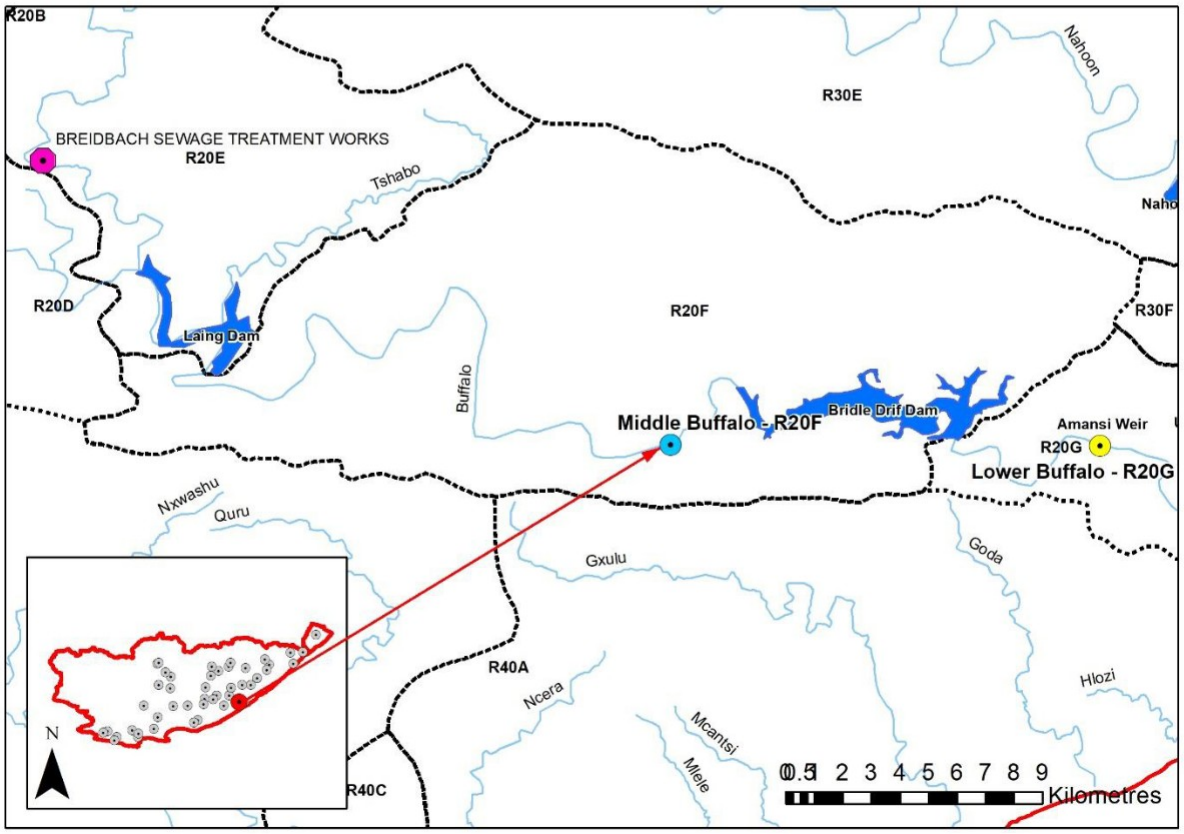


Figure 5-11: Location of site BUFF01_I (Middle Buffalo) in relation to the study area *(yellow dot represents a Rapid 3 EWR site and the pink dot represents an existing WWTW)*

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)







Figure 5-12: Site photographs of the Middle Buffalo EWR site

Site Description:

The site is located downstream of Laing Dam and 1.5 km upstream of Bridle Drift Dam.

The site is located in a partly confined valley setting with a single channel and narrow flood features within a deeply incised macro channel. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and silt sediment types. The banks and benches are composed of cobble, gravel, sand and silt. The gravels and cobbles along the riffle margin have a moderate extent of silt cover, indicating higher

silt loads during higher flows. This can be seen in the pools with thick silt drapes across the various low velocity habitats. Livestock grazing and trampling is widespread. There is widespread erosion along the banks and inset benches. Very localised sand deposition takes place on the lower flood features, with widespread evidence of recent erosion.

Biota habitats available
The biotopes available for aquatic macroinvertebrates included both SIC, SOOC and some marginal vegetation, although limited owing to undercut banks and low flows. The GSM biotope was also limited. Fish habits included SS, FS and SD.

Riparian vegetation
The site has been highly disturbed by both scour from its close proximity to the weir and high grazing and trampling pressure, and also comprises a high degree of invasion by alien plant species, notably *Sesbanea punicea.* The marginal zone is narrow with woody overhang in the pool areas and dominated by non-woody sedges and grasses (*C. textilis, M. ecklonii*) along the riffle/rapid areas and *E. crassipes* (Water Hyacinth) is present in the channel. The flood bench is scoured with scattered tufted grasses (*M. ecklonii*) and a high infestation of alien shrubs (*S. punicea*). Banks are denuded in places, with tall alien species such as Wattle (*Acacia mearnsii, A. dealbata*) and Syringa (*Melia azedarach*), some *Combretum caffrum* and several terrestrial tree and shrub species

Site impacts:

- Weir
- Alien invasive aquatic macrophytes (*Eichhornia crassipes* - Hyacinth)
- Nutrients (algae)
- Bank erosion (left bank)
- Pump station (right bank)
- Cattle trampling and grazing

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.30	8.16
EC (µS/cm)	562	615
TDS (g/l)	0.4052	0.445
DO (mg/l)	9.24	8.30
DO% (%)	102.1	91.0
Clarity (cm)	30	Approx. 70
Temperature (°C)	19.9	19.72
Salinity (ppt)	0.3	0.33
Discharge (m^3/s)	0.11	0.12

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
September 2022				

35	10.9	C (Moderate)	10.2	**2.5**
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preference	Nutrient and salinity increase (eutrophication)			
May 2023				
40	8.7	D (Poor)	8.6	**2.25**
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preference	Nutrient and salinity increases (eutrophication)			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	1.5	• Simple channel form • Easy access • Near gauging weir for discharge reading	• Two observations at very similar discharges
Fish	4	• Easy access • Slow-shallow, fast-shallow and slow-deep velocity depth classes represented • Substrate cover class well represented	• Some areas of deep water pools limited sampling • Limited marginal and aquatic vegetation present
Macroinvertebrates	4	• SIC, SOOC and GSM • Varying flow velocities • DWS REMP Site code: R2BUFF-ZWELI	• Limited marginal and instream aquatic vegetation (substrate dominated by cobbles) • High algae content smothering SIC • Upstream weir (flow modifications)
Riparian vegetation	3	• Both banks accessible • Some riparian indicator species present	• Scoured and eroded site with close proximity to weir • Low confidence representation for riparian flow requirements due to scour • AIP, heavily impacted banks
Geomorphology	2.8	• Mobile bed away from bedrock • Site access	• Eroded site with few morphological features that can be used for setting flows

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability

COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Two observations at similar discharges
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• Current two river survey (September 2022 and May 2023)
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES ASSESSMENT (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: R2BUFF-ZWELI
Hydrology						• Monthly hydrology available for natural and present day • Daily flows from gauge at site
Geomorphology						• Limited literature on the system • Historical and recent air photos
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1938 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity.

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• NCMP water quality data site R2H027 (1994 - 2022, n= 919) • Green Drop Reports 2011, 2013 and 2021. • 2022 diatom results. • 2023 diatom results

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla bicolor bicolor, Anguilla marmorata, Anguilla mossambica, Awaous aeneofuscus, Enteromius mandelai, Gilchristella aestuaria, Glossogobius callidus, Monodactylus falciformis, Mugil cephalus, Pseudomyxus capensis, Oreochromis mossambicus, Sandelia bainsii*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae,Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Belostomatidae, Corixidae, Gerridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Psychodidae, Simuliidae, Syrphidae, Tabanidae, Tipulidae, Ancylidae, Corbiculidae.
Riparian vegetation	This site occurs within the Alany Thicket Biome, the Albany Thicket Bioregion, and the Buffels Mesic Thicket vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone is expected to be dominated by non-woody vegetation, but with the addition of the marginal zone woody obligates, *Gomphostigma virgatum* and *Salix mucronata*, both of which were absent. Less algae and less scour are also expected. The flood bench is expected to be dominated by a mixture of woody (riparian obligates such as *Salix mucronata*) and non-woody vegetation (sedges and grasses), with the absence of alien species and such high grazing pressure. In keeping with Buffels Mesic Thicket vegetation expected for this area, the macro-channel bank is expected to be densely woody, trees and shrubs of both riparian and terrestrial species.
Hydrology	Monthly natural flows available for period 1920 to 2009
Geomorphology	In its reference condition, the Buffalo River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle or pool-rapid reach types. Localised bedrock anastomosing sections can be present with multiple channels. Small sand and gravel bars can be present in pools and along the margins of the riffles. Narrow inset benches composed of sand and gravel and flood benches of sand, gravel and cobble could be present as a result of freshets and larger floods.
Physical-chemical	Diatoms results were used to infer reference physical-chemical conditions as the historical data did not provide the state of the river under reference condition. An adequate assessment of reference conditions could, therefore, not be conducted using the available physical-chemical data. The diatom

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
	results indicated moderate quality water linked to organic and inorganic pollutants. Under natural conditions it is expected that that organic and inorganic pollution would be absent.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	E (28.5%)	F/NF	• Significant flow modification and instream movement barriers due to downstream Bridle Drift Dam and upstream Laing Dam as well as weir immediately upstream resulting in loss of connectivity within the system • Strong presence of translocated *Clarias gariepinus, Labeo umbratus, Tilapia sparrmanii* and alien *Cyprinus carpio* also present
Macroinvertebrates (MIRAI)	C/D (61.6%)	F/NF	• High nutrients resulting in some filamentous algae coverage over instream biotopes. • Nutrient loading potentially owing to discharges from Schornville and Zwelitsha WWTWs upstream. • In-stream dam, large weir and pump station just upstream of EWR site (flow modification). • Localised bank erosion thus hampering marginal vegetation biotope.
Riparian vegetation (VEGRAI)	D (51.2%)	F NF	• Influenced by the Laing Dam upstream which is likely to cause some regulation, altered flooding frequency and duration and reduced flood peaks. Also abstraction from the weir for irrigation. • Vegetation removal from high grazing and trampling pressure (LB not RB), extensive scour from US weir, removal for access roads and paths, clearing for weir and pump house, and selected wood removal. • AIP - Water Hyacinth (*Eichhornia crassipes*) in the channel and *Sesbanea punicea* along the flood benches. Bank species mainly *Melia azedarach, Acacia maernsii, Solanum mauritianum* and *Lantana camara.*
Geomorphology (GAI)	C (67 %)	61 % flow related	• Localised erosion in the catchment producing fine sediment. • Dam and weirs in close proximity reducing bedload input. • Erosion of inset benches and banks, with limited sediment deposition. • Low levels of embeddedness and thin silt drapes forming in slow flowing biotopes.
Hydrology (HAI)	C (70.1%)		• All flow components impacted by increased flows due to releases from upstream dam for water use in East London and surrounding areas
Diatoms/Physical-chemical	C (9.8)	NF	• Nutrient and salinity increase (eutrophication) • Altered physical-chemical state of the system owing to discharge of non-compliant waste by Schornville and Zwelitsha WWTWs upstream.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
ECOSTATUS (PES)	D (48.8%)		

Component: PES and causes	
	Causes Present/Absent

During the course of the September 2022 and the May 2023 field surveys, only 3 of the 11 fish species expected to be present under reference conditions were confirmed within the reach. Although to some degree native fish species were represented, the location of the reach between Bridle Drift Dam (downstream) and Laing Dam (upstream) as well as the presence of an abstraction weir immediately upstream of the cross-section has resulted in the reduction of faster flowing habitat and the loss of connectivity within the system. Consequently, a depauperate native fish assemblage that is tolerant of lentic conditions was present. While the presence of the one catadromous eel species was confirmed during both field surveys, it is likely these specimens are the result of a successful migration of small elvers over the walls of dams downstream. However, the numbers of this species present are likely to present only a small proportion of the numbers expected within the reach under reference conditions.

Furthermore, water quality impairment as a result of catchment activities as well as the of several non-native fish species (including the translocated *Clarias gariepinus, Labeo umbratus* and *Tilapia sparrmanii* and alien *Cyprinus carpio*) were likely to be significant contributing factors to the seriously modified state (Ecological Category E)

Fish

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	90.55	94.06
COVER	100.00	100.00
FLOW MODIFICATION	44.45	55.79
PHYSICAL-CHEMICAL	59.99	65.56
MIGRATION		92.77
IMPACT OF INTRODUCED		55.66
FRAI	PRESENT	
FRAI (%)	28.5	
EC: FRAI	E	

Component: PES and causes

	Causes Present/Absent
Macroinvertebrates	The biotopes within the middle reaches of the Buffalo River comprised boulders, SIC, SOOC, marginal vegetation and GSM, although mud was limited. During the September 2022 and May 2023 surveys, a total of 24 and 28 taxa were recorded respectively, resulting in a community of 32 taxa. The aquatic macroinvertebrate community collected was determined to be representative of moderately modified conditions (Ecological Category C, 61.6%). The macroinvertebrate community representing this reach mostly had preferences for standing and moderately fast flowing water and the cobbles biotope. From a water quality perspective, despite the presence of numerous sensitive taxa, namely Perlidae, Baetidae >2spp, Heptageniidae, Leptophlebiidae and Chlorocyphidae, having very high preferences for unmodified physical-chemical conditions, 14 and 10 taxa (mostly making up the community) were those with low and very low water quality requirements respectively. At the time of both surveys, particularly during the May 2023 survey, there was evidence of nutrient overload within the system. Not only did this include brown algae smothering the SIC and SOOC biotopes, but also the growth of hyacinth along the reach, as well as upstream of the site above the weir, thus supporting the presence of these very tolerant taxa. Taxa expected with high frequencies of occurrences, but which were absent from the site included Potamonautidae, Trichorythidae, Gomphidae, Gerridae, Hydropsychidae >2spp, Dytiscidae, Athericidae, Culicidae and Tabanidae. Although these taxa mostly have a preference for low to very low water quality, they also have differing flow velocities and prefer the cobbles biotope. However, as mentioned above, the smothering of the algae over the stones biotope may be the reason of their absence. Of concern along this reach, is the continued abundances of Simuliidae, which were recorded in a D and C abundances in September 2022 and May 2023 respectively. Accordingly, these high abundances are indicative of a system with no flow fluctuations and constant flows. This is further supported by the discharge volume measuring 0.111m^3/s and 0.118m^3/s in September2022 and May 2023 respectively.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	66.9	*0.327*	21.8897	2	90
HABITAT	H	65.2	*0.291*	18.956	3	80
WATER QUALITY	WQ	53.1	*0.364*	19.3182	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.45455	4	5
						275
INVERTEBRATE EC				61.6185		
INVERTEBRATE EC CATEGORY				C/D		

Consequently, the community was primarily driven by water quality (53.1%), habitat modification owing to the algae smothering the stones biotope (65.2%) and flow modification (66.9%). The ASPT for the communities identified in September 2022 and May 2023 was 5.9 and 5.0, respectively, indicating the community consisted mostly of tolerant taxa (Dickens and Graham, 2002).

Riparian vegetation

The marginal zone was bedrock-controlled, dominated by non-woody vegetation, mainly sedges but with creeping grasses at sediment deposits, well grazed, had a high degree of benthic algae and the presence of Water Hyacinth (*Eichhornia crassipes*). The zone was well scoured due to its close proximity to the upstream weir. Sedges, mainly *Cyperus textilis*, generally formed a narrow band along pools habitats with overhanging woody vegetation, and were scattered between rocky habitats in riffle areas. Grasses were also fragmented in their occurrence, mostly associated with sediment deposits and included *Hemarthria altissima, Miscanthus ecklonii* and *Ischaemum fasciculatum. Cotula nigellifolia* also occurred in the zone. The flood bench was dominated by a mixture of indigenous non-woody vegetation (mainly *Cynodon dactylon, Miscanthus ecklonii, Hemarthria altissima*) and alien woody vegetation (mainly *Sesbania punicea* and *Senna didymobotrya*). The zone was scoured with vegetation removal from both recent floods and due to the close proximity of the weir. Riparian woody species were absent. The maro-channel bank was narrow and steep, alluvial, with erosion and undercutting in places and dominated by mostly woody vegetation comprising a mix of riparian (*Afrocarpus falcatus, Combretum caffrum),* terrestrial *(Vachellia karroo*) and alien species (mainly *Melia azedarach, Acacia maernsii, Solanum mauritianum* and *Lantana camara).*

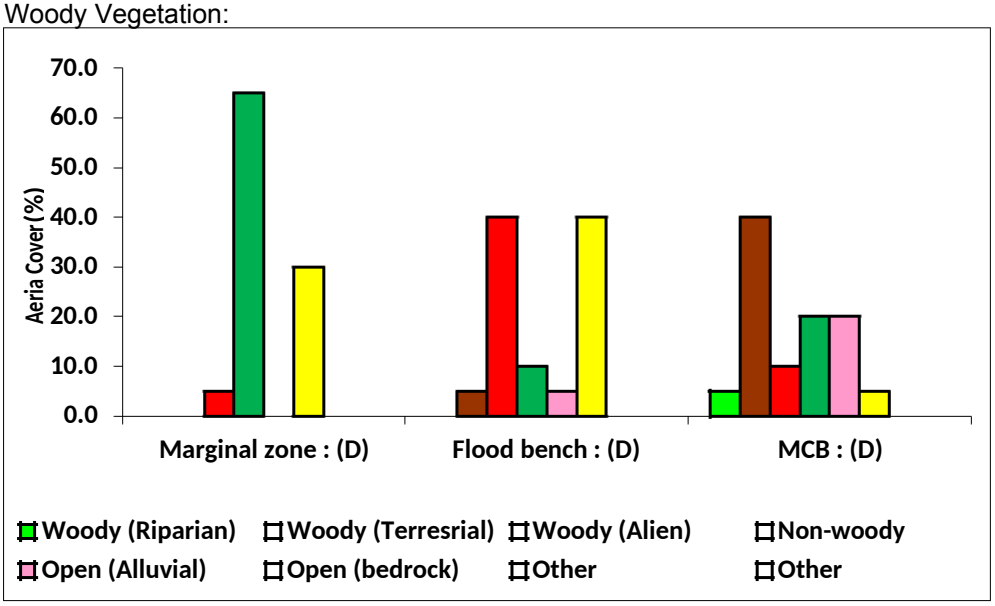
Overall PES:

LEVEL 4 ASSESSMENT	**Middle Buffalo_BUFF01_I**					**09 May 2023**
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal zone	46.6	2.9	3.4		6.3	Weighted according to extent
Flood bench	47.6	26.8	3.4		56.3	Weighted according to extent
MCB	57.3	21.5	2.4		37.5	Weighted according to extent
LEVEL 4 VEGRAI (%)						51.2
VEGRAI Category	**Ecological**					**D**
AVERAGE CONFIDENCE						3.1
	Sub-zone					
	Marginal zone	**Flood bench**	**MCB**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	46.6	47.6	57.3	not assessed	not assessed	not assessed
EC (Zone)	**D**	**D**	**D**			
Confidence (Zone)	3.4	3.4	2.4			

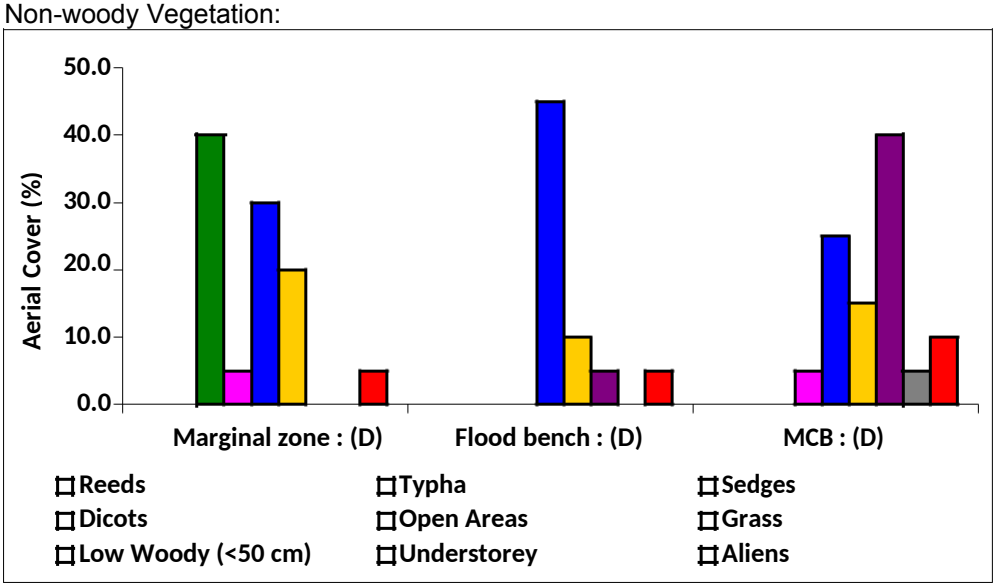
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

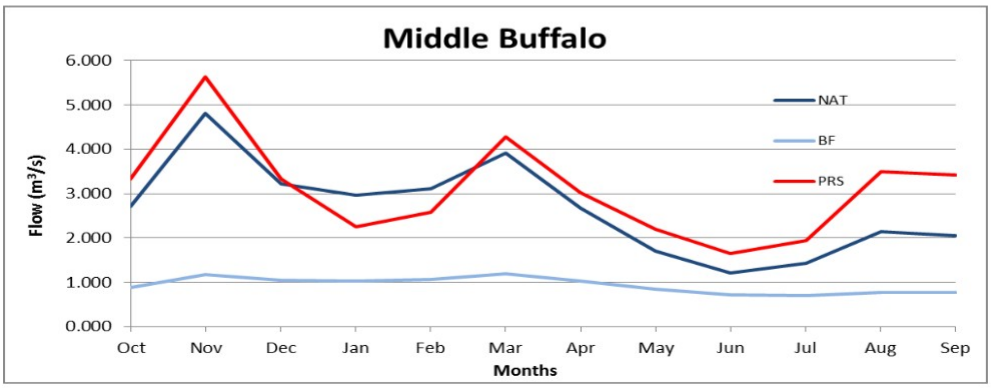


Component: PES and causes

Causes Present/Absent

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	Rank	%wt	RATING	CONFIDENCE
LOW FLOWS	2.00	90.00	3.00	3.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	3.00	80.00	0.00	4.00
MODERATE EVENTS	4.00	70.00	2.00	3.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	5.00	65.00	3.00	2.00
HYDROLOGY SCORE	70.12			
HYDROLOGY ECOLOGICAL CATEGORY	C			



Component: PES and causes	
	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Buffalo River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. Several dams and weirs trap coarse bedload, reducing the extent of coarse sediment habitat along the reach. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the catchment. This results in increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the available coarser habitats. Erosion associated with the weir, trampling and frequent grazing by livestock along the banks destabilize and erodes the geomorphic features at the site.

FINAL DRIVER STATUS GEOMORPHOLOGY	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*						
SCORING GUIDELINES							
GEOMORPHOLOGY DRIVERS							
COMPONENTS	**RANK**	**RELATIVE WEIGHTING (%)**	**RATING**	**WEIGHT**	**WEIGHED SCORE**	**FLOW RELATED**	**CONFIDENCE**
System Connectivity	1.00	100.00	2.33	0.43	1.01	68.67	2.73
Sediment balance	2.00	70.00	1.30	0.30	0.40	21.00	2.60
Bed & bank stability	3.00	60.00	0.89	0.26	0.23	64.77	2.89
TOTALS		230.00		1.00	1.64		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					67.17		
HABITAT DRIVER CATEGORY					C	53.14	2.73
					WEIGHED SCORE	**FLOW RELATED**	**CONFIDENCE**
Morphological change					2.00	61.11	2.72
HABITAT CHANGE STATUS					60		
HABITAT CHANGE CATEGORY					C		

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Decline/Stable	• Although water quality within the reach was likely to deteriorate over time, non-native fish has become established and are widespread within the catchment • The impacts of the dams on the movement of fish species is likely to have stabalised	3
Macroinvertebrates	Decline	• Outbreak of Simuliidae is of a concern (September 2022) and dominating the macroinvertebrate assemblage (high turbid waters and constant high flows). However, owing to recent floods, the SIC biotopes were scoured and populations	3

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
		reduced considerably during the May 2023 survey. • Ongoing pressures, particular having an impact on water quality which the macroinvertebrates are responding to.	
Riparian vegetation	Decline	AIP high, mainly *Eichhornia crassipes, Sesbanea punicea*, *Melia azedarach, Acacia mearnsii, Solanum mauritianum* and *Lantana camara.* These invasive species are likely to increase in the absence of intervention.	3
Hydrology	Decline	• Increased water use and return flows impacting at the site	4
Geomorphology	Decline	• Ongoing bank erosion with very limited deposition along riparian drives degradation	3
Physical-chemical	Decline	• Elevated suspended solids/low clarity signals erosion. Urbanised, industrial and wastewater management establishments upstream will likely be an ongoing source of impacts on the system, especially as the Green Drop Scores of the two WWTWs upstream have been on a steady decline since 2011. NCMP data also shows spikes in nutrient concentrations in recent years.	4
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR DEVIATION**
ECOSTATUS	D	D	• Driven by the fish component (E category). • Dominance of non-native fish species • Downstream dam creating a movement barrier moving upstream

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
High, Moderate	Moderate, Moderate

Physical-chemical state of the system
Clarity low, suggesting high suspended solids. Nutrient enrichment was also noted during the site visit. This is likely a result of the discharge of the Schornville and Zwelitsha WWTWs upstream. The change in 2013 to 2021 flow for the Zwelitsha WWTW is -81%, suggesting that most of the sewage does not make its way into the WWTW, likely ending up in the river. The tributary (Mncotsho) also drains a built-up area where some impacts on the physical-chemical state of the system are expected to arise.

D	D	• Overall, maintain the EcoStatus as a D category; • F: Priority wetlands identified within the same primary catchment area was W_RU15 (R20E) and W_RU26 (R20D) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this primary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas; • F: Improvement of water quality (urgent), which will ultimately improve the instream biotic communities. The river is under stress and hence requires the upgrade and proper maintenance of the associated upstream WWTW, in order to reduce the volume and load of nutrients entering the system; and • NF: Clearing of AIP within the riparian zone and the banks.

OVERALL ASSESSMENT

Table 5-6: Overall EcoStatus assessment for BUFF01_I (Middle Buffalo)

River	Middle Buffalo
EWR Site Code	**BUFF01_I**
Driver component	**PES**
HAI	C
Diatoms	D
GAI	C
Response component	**PES**
FRAI	E
MIRAI	C/D
VEGRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

The overall EcoStatus for this EWR site was categorised as a D, thus the system is in a largely modified condition (**Table 5-6**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats, while the weirs and dams upstream trap a portion of the coarser bedload, reducing the extent of gravel and cobble bars. At the site, disturbance along the margins, such as scour, trampling, removal of biomass, are widespread leading to degradation of the habitat associated with bars, benches and banks.

The presence of these various large impoundments and weirs within the system, as well as the present of no-flow tolerant non-native fish species, has lead to a depauperate native fish diversity within the reach, with those native species present occurring at a lower frequency of occurrence than expected under reference conditions. The macroinvertebrate community mostly responded to impaired water quality, clearly observed from the floating hyacinth along the reach, correlated to nutrient enrichment from upstream and adjacent unmaintained and dysfunctional WWTW.

The riparian vegetation at this site is highly disturbed, with scour along channel habitats and vegetation removal, including clearing and grazing and trampling pressure along flood features and banks. Alien invasive plant species are also abundant.

It is suggested that a REC of a D (largely modified) be achieved, should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-6**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Grazing and trampling should be managed along the riparian zones and in the catchment;

- Serious intervention and compliance for failing WWTW, as the water quality along this reach is of high concern, and of which is the main water source for the town of East London. Accountability and responsibility assigned to the relevant authorities.

5.7 KEIS01_I: Keiskamma River (Upper)

Sample Date	13 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	KEIS01_I	**IUA**	IUA_R01
River	Keiskamma	**IUA description**	Keiskamma
Altitude (m.a.s.l.)	437m	**Prioritised RU**	R_RU09_I
Latitude	-32.80233328	**Longitude**	27.02430956
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	R10E
Level 2 EcoRegion	18.02	**SQ Reach**	R10E-07844
Geomorphological zone	E (0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-13) AND SITE PHOTOGRAPHS (Figure 5-14)

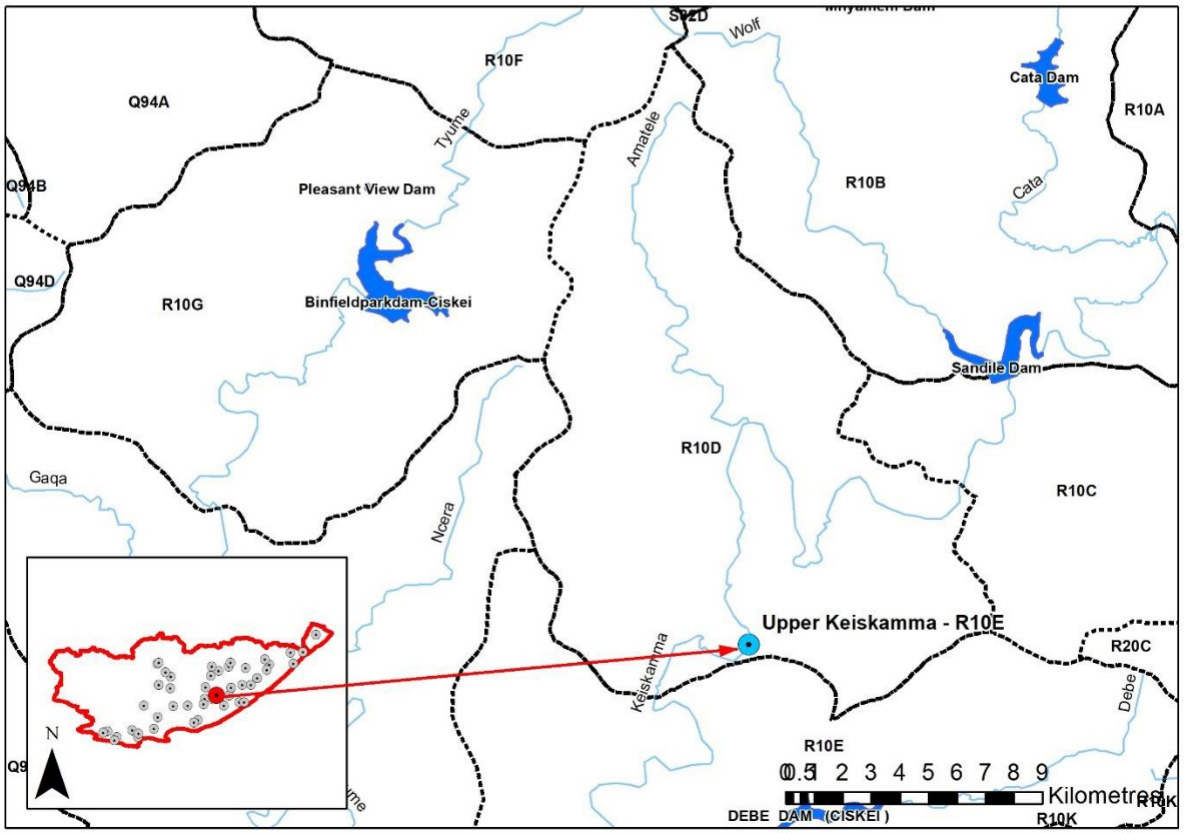
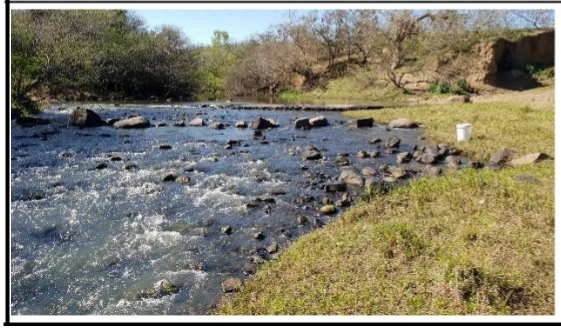
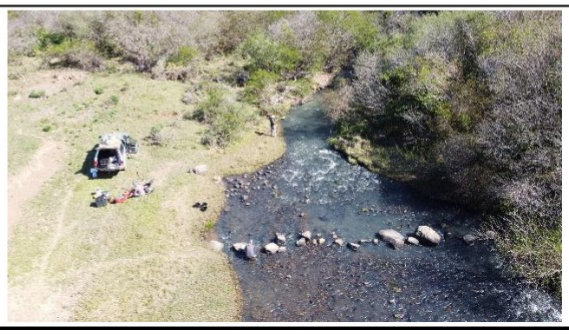


Figure 5-13: Location of site KEIS01_I (Upper Keiskamma) in relation to the study area

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)



Figure 5-14: Site photographs of the Upper Keiskamma EWR site

Site Description:

The site is located near the Fort Cox Agricultural College, about 3 km (straight distance) from the R63.

The site is located in a partly confined valley setting with a single channel and narrow flood features within a deeply incised macro channel. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by cobble, gravel and silt sediment types. The banks and benches are composed of sand and silt. The gravels and

cobbles along the riffle have a significant silt component, indicating high silt loads during higher flows. This can be seen in the pools with thick silt drapes across the various low velocity habitats. Livestock grazing and trampling is widespread, with localised sand mining along the flood features. There are moderate levels of erosion along the banks, but is more severe at the causeway due to altered flow patterns. Woody encroachment is evident along the channel, with sandy lee bars forming behind thick vegetation. Sand deposition takes place on the lower flood features.

Biota habitats available
Good availability of SIC, SOOC and GSM. Marginal vegetation was limited owing to undercut banks. Varying fish habitats comprised FS, SD and SS.

Riparian vegetation
In most places the marginal zone is restricted to a narrow band along the wetted edge, mostly unvegetated due to shading by overhanging woody vegetation rooted on the banks. Where sediment has been deposited and stabilised by vegetation, mainly in the vicinity of the low level crossing, marginal zone vegetation was dominated by non-woody species, mostly sedges (*C. textilis*) and grasses (*I. faciculatum*) that were heavily grazed. Woody marginal vegetation was represented by a single *Salix mucronata* sapling. Inset benches supported similar vegetation with the addition of *Persicaria* and *C. dives*. Alien species were limited to *X. stromarium* seedlings. Flood benches comprised a mix of woody and non-woody vegetation with a high degree of alien invasion (mainly annual and bi-annual weeds, but also *Melia azedarach* and *Sesbanea punicea*) and terrestrialisation (*V. karroo* and *S. caffra*). Erosion was high, as was grazing, disturbance and wood removal. The macro channel bank was steep, confined and dominated by tall, dense and extensive woody vegetation, with terrestrial species in excess of 50%. Recruitment of riparian tree species along the banks was largely absent.

Site impacts:

- Low water bridge
- Cattle trampling and grazing
- Bank erosion
- Nutrient enrichment (algae)
- Silt

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.37	8.01
EC (µS/cm)	185.0	188
TDS (g/l)	0.1402	0.146
DO (mg/l)	9.77	9.06
DO% (%)	102.2	92.8
Clarity (cm)	73	Approx. 70
Temperature (°C)	17.6	16.45
Salinity (ppt)	0.10	0.11
Discharge (m^3/s)	0.37	0.53

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
September 2022				
18	13.2	B (Good)	23.6	1.5
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preference	Nutrient and salinity increase (eutrophication)			
May 2023				
18	16.3	B (Good)	7.2	0.75
Dominant Species	*(1) Achnanthidium sp.*			
	(2) Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot			
Preference	(1) Moderate to good water quality conditions			
	(2) Tolerates critically to strongly polluted waters			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	2	• Easy Access • Simple channel form	• No high flows observed
Fish	4	• Easily wadable • Slow-shallow, fast-shallow and slow-deep velocity depth classes represented • Substrate and overhanging vegetation cover class well represented	• Limited marginal and aquatic vegetation present
Macroinvertebrates	4	• SIC, SOOC, GSM and marginal vegetation • Varying flow velocities • DWS REMP Site code: R1KEIS-BEXEB	• No instream aquatic vegetation • Cattle trampling and grazing (localised erosion impacting on the marginal vegetation biotope)
Riparian vegetation	3.5	• Both banks accessible • Reasonable range of habitat types • Reasonable range of riparian indicators	• Disturbance due to erosion and vegetation clearing
Geomorphology	3	• A range of morphological features and sediment types • Good access	• Disturbances at the site due to crossing and sand mining

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Two flow observations at low discharges
Fish						• FFROC (Kleynhans; 2008)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current two river survey (September 2022 and May 2023) • DWS REMP sites located upstream and downstream of the site
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: R1KEIS-BEXEB (just downstream of this site)
Hydrology						• Monthly hydrology available for natural and present day
Geomorphology						• Historical and recent aerial images
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1938 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity. • REMP water quality data site 1-11021 - Data limited to 2002 to 2019 monitoring period (n=114). • 2022 diatom results. • 2023 diatom results.

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla marmorata, Anguilla mossambica, Enteromius mandelai, Enteromius trevelyani, Glossogobius callidus, Oreochromis mossambicus, Sandelia bainsii*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Notonemouridae, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Prosopistomatidae, Telagonodidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Platycnemidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Corydalidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Blepharoceridae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Empididae, Muscidae, Psychodidae, Simuliidae, Syrphidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Physidae, Thiaridae, Corbiculidae, Sphaeridae.
Riparian vegetation	This site occurs within the Savanna Biome, Sub-Escarpment Savanna Bioregion, and the Bhisho Thornveld vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone is expected to be dominated by non-woody vegetation, mainly grasses, sedges and broad-leafed riparian obligate species. The flood benches are expected to comprise a mix of woody and non-woody vegetation, the mosaic of which is maintained by flooding disturbance and natural grazing and browsing pressure and should be devoid of alien species. In keeping with the Bhisho Thornveld vegetation type, in which this site occurs, the macro-channel bank is expected to be dominated by dense woody thicket comprised of both riparian and terrestrial trees and shrubs.
Hydrology	Monthly natural flows available for period 1920 to 2009
Geomorphology	In its reference condition, the Keiskamma River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle reach types. Localised bedrock can be present with multiple channels. Small sand and gravel bars can be present in pools and along the margins of the riffles. Narrow inset benches composed of sand and gravel and flood benches of sand, gravel and cobble could be present as a result of freshets and larger floods. The riparian vegetation would be less dense as large floods scour sediment and vegetation.

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Physical-chemical	The historical monitoring for the site began in the early 2000s, which does not reflect the reference conditions. Diatoms were used to infer the reference conditions. The diatom results indicated good water quality, with period increases in nutrient and salinity concentrations. Under reference conditions it is expected that the site will have lower nutrient and salinity concentrations.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	E (28.8%)	F/NF	• Flow modification as a result of Sandile Dam upstream • Significant water quality impairment (failing sewage infrastructure) downstream at Middeldrift limiting upstream migration • Various weirs located within the reach
Macroinvertebrates (MIRAI)	C (74.6%)	F/NF	• Sandile Dam upstream mostly used for irrigation (flow modification) • Low lying water bridge (flow modification) • Cattle grazing and trampling resulting in bank erosion thus hampering marginal vegetation biotope. • High silt loads over SIC and SOOC biotopes
Riparian vegetation (VEGRAI)	D (46.6%)	F NF	• Influenced by the Cata and Sandile Dams upstream which are likely to cause some regulation, altered flooding frequency and duration and reduced flood peaks. Also abstraction for irrigation. • Removal of vegetation by wood collection and high grazing and trampling pressure • AIP – mainly *Melia azedarach, Sesbanea punicea* and annual weed species (*Xanthium stromarium* and *Riccunus communis*) • An erosion gully from the road to the channel cuts through the riparian zone.
Geomorphology (GAI)	D (59 %)	42 % flow related	• Widespread continuous grazing and frequent erosional features in the catchment increasing surface erosion. • Sandile Dam ~15 km upstream, trapping large volumes of bedload and high flows. • Sand mining of flood benches and trampling by livestock along the banks destabilizes the geomorphic features at the site. • Inset benches are eroded and bed appears armoured. • Silt drape and coarse particles embedded in low velocity biotopes due to high suspended sediment concentrations.
Hydrology (HAI)	E (30.6%)		Dam development and water use in upper catchment impact on all the flow components

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Diatoms/Physical-chemical	B (14.8)	NF	• Site prone to nutrient and salinity increase (eutrophication). • Diatoms point to good water quality, suggesting periodic nutrient loading, which has not significantly altered the physical-chemical state of the system. • Available water quality data also suggest periods of nutrient increases in the system, usually followed by a decline in the nutrient concentrations. NCMP data post 2019 would have provided a clearer picture whether these nutrient concentrations spikes are frequent in recent years.
ECOSTATUS (PES)	D (52.0%)		

Component: PES and causes	
	Causes Present/Absent
Fish	During the course of the September 2022 and the May 2023 field surveys, only 2 of the 7 expected fish species were collected within the reach, with the numbers of fish collected suggesting a depauperate fish assemblage to be present. REMP monitoring studies conducted upstream of the reach and immediately downstream of Sandile Dam note the presence of *Enteromius mandelai* and *Enteromius trevelyani*, although their presence within the reach associated with the EWR site could not be confirmed. It is likely that the EWR site's proximity to Middeldrift as well as the agriculture and sediment input into the system downstream of Sandile Dam are likely contributing factors. In addition, the likely presence of several non-native fish species within the reach, including *Labeo umbratus, Clarias gariepinus* and *Tilapia sparrmanii* was expected to impact the fish assemblage present. Of particular concern however was the confirmed input of raw sewage into the system downstream of the EWR site at Middeldrift which would limit fish movement within the system and greatly impact upstream migration.

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	83.54	86.49
COVER	100.00	100.00
FLOW MODIFICATION	29.30	39.84
PHYSICAL-CHEMICAL	72.02	79.15
MIGRATION		81.66
IMPACT OF INTRODUCED		66.54
FRAI	PRESENT	
FRAI (%)	28.8	
EC: FRAI	E	

Component: PES and causes

	Causes Present/Absent
Macroinvertebrates	The Upper Keiskamma River biotopes were composed of SIC, SOOC, GSM, and marginal vegetation. A total of 32 and 34 taxa were recorded during the September 2022 and May 2023 surveys, respectively, resulting in a community of 41 taxa. The aquatic macroinvertebrate community collected was found to represent moderately modified conditions (Ecological Category C, 74.6%). The macroinvertebrate community at this site had a preference for standing to moderately fast flowing waters, cobbles, and moderate to very low water quality. Despite the presence of numerous sensitive taxa, including Baetidae >2spp, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, and Athericidae, all with a preference for cobbles, moderately fast to very fast flowing water, and good water quality, there was some evidence of water quality impairments. This was owing to 19 taxa within the assemblage had a preference for low requirements for unmodified physical-chemical conditions, and 10 taxa were recorded with a preference for very low requirements. Interestingly thought, a novel appearance of Pyralidae was recorded at this site, which has a preference for moderately fast to very fast flowing water, cobbles, and high preference for unmodified physical-chemical conditions. Two individuals of Psephenidae were also recorded, with the last appearance of this taxon being recorded in 2021. Psephenidae has a preference for moderately fast flowing water, cobbles, and moderate requirements for unmodified physical-chemical conditions. Overall, the macroinvertebrate community remained consistent between the two surveys conducted in September 2022 and May 2023, with some taxa differing and new taxa being recorded. However, overall, the community remained representative of good flow and habitat availability, with several taxa being an indicator of water quality deterioration. INVERTEBRATE EC METRIC GROUP / METRIC GROUP CALCULATED SCORE / CALCULATED WEIGHT / WEIGHTED SCORE OF GROUP / RANK OF METRIC / %WEIGHT FOR METRIC GROUP FLOW MODIFICATION (FM): 77.6 / *0.327* / 25.39 / 2 / 9 HABITAT (H): 85.3 / *0.291* / 24.8211 / 3 / 8 WATER QUALITY (WQ): 63.1 / *0.364* / 22.9354 / 1 / 10 CONNECTIVITY & SEASONALITY (CS): 80.0 / *0.018* / 1.45455 / 4 / 27 INVERTEBRATE EC: 74.6011 INVERTEBRATE EC CATEGORY: C Consequently, the community was primarily driven by water quality (63.1%), then flow modification (77.6%) and habitat modification (85.3%). The ASPT for the communities identified in September 2022 and May 2023 was 5.1 and 6.0, respectively, indicating the community consisted mostly of tolerant taxa (Dickens and Graham, 2002), although with the exception of numerous sensitive taxa recorded at this site.

Riparian vegetation

The marginal zone was mostly narrow with non-vegetated steep banks around pool habitats with a high degree of woody overhang, or well vegetated alluvial inset bars dominated by non-woody vegetation, mostly sedges and grasses (*Cyperus textilis, C. longus, Miscanthus ecklonii, Ischaemum fasciculatum* and *Fuirena hirsuta*) but with a small scattered woody component (*Salix mucronata*). Some terrestrial species were recruiting in the zone (*Vachellia karroo*) and alien species were limited to annual weeds (*Xanthium strumarium*). The flood benches were mostly alluvial lateral deposits / bars with flood channels and well vegetated where erosion had not taken place. The site seems to have cultural importance with evidence of potentially ritualistic use. The flood bench was highly disturbed, mainly due to erosion, but also from trampling pressure, clearing for access and longitudinal traversing of the zone. Vegetation was a mix of woody and non-woody but was more dominated by woody species. Dominant species included *Vachellia karroo, Senegalia caffra, Ziziphus mucronata, Cynodon dactylon, Cyperus dives* and *Persicaria madagascariensis* while alien species included *Melia azedarach, Sesbanea punicea* and annual weed species (*Xanthium stromarium* and *Riccunus communis*).The macrochannel bank was predominantly alluvial, steep and confining and dominated by woody vegetation, mostly tall trees and shrubs with a generally well-defined understorey. Riparian species included *Combretum caffrum* and *Ficus ingens*, while terrestrial species included *V. karroo, S. caffra, Z. mucronata and Celtis africana.* Invasive alien species were infrequent and mainly *Melia azedarach*.

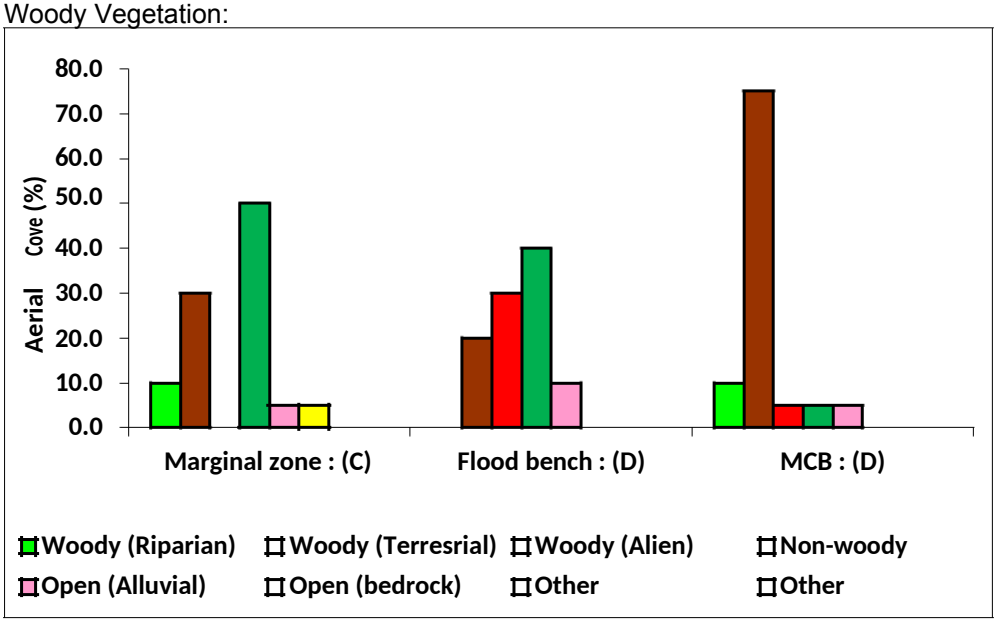
Overall PES:

LEVEL 4 ASSESSMENT	**Upper Keiskamma_KEIS01_I**					**08 May 2023**
RIPARIAN VEGETATION ECMETRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal zone	64.1	2.5	3.5		3.8	Weighted according to extent
Flood bench	46.1	26.6	3.3		57.7	Weighted according to extent
MCB	45.6	17.5	2.4		38.5	Weighted according to extent
LEVEL 4 VEGRAI (%)						46.6
VEGRAI Category	**Ecological**					**D**
AVERAGE CONFIDENCE						3.0
	Sub-zone					
	Marginal zone	**Flood bench**	**MCB**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	64.1	46.1	45.6	not assessed	not assessed	not assessed
EC (Zone)	**C**	**D**	**D**			
Confidence (Zone)	3.5	3.3	2.4			

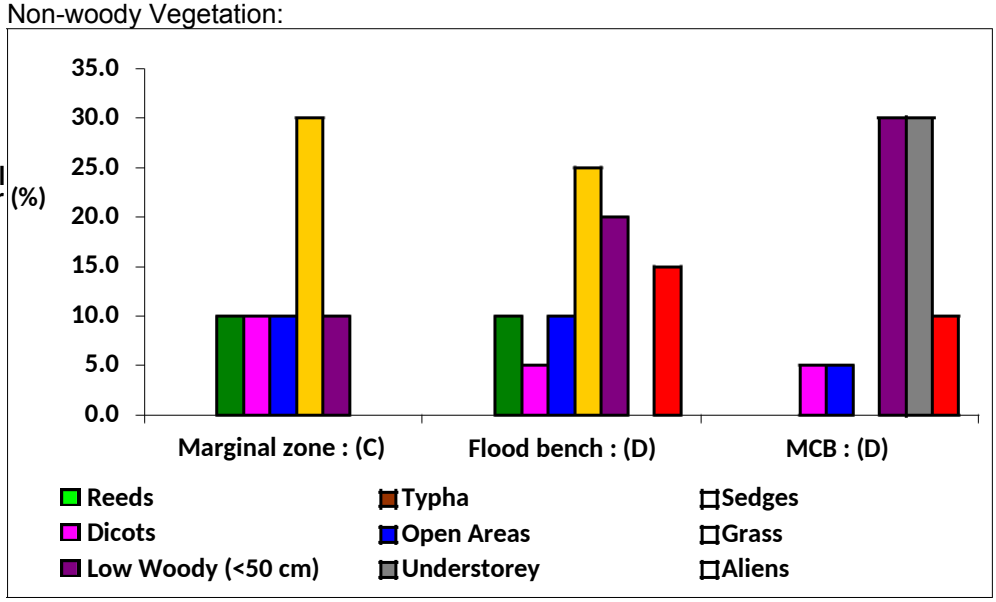
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

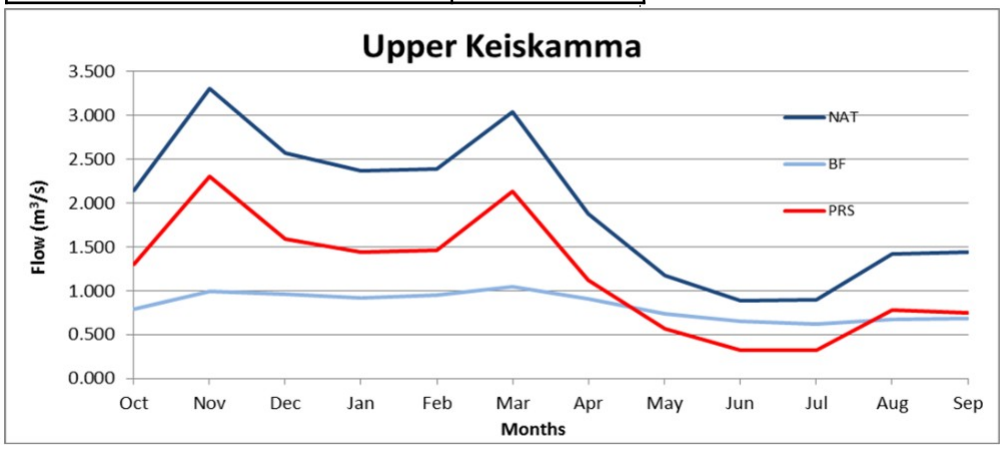


Component: PES and causes

Causes Present/Absent

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	**Rank**	**%wt**	**RATING**	**CONFIDENCE**
LOW FLOWS	2.00	90.00	3.00	3.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	3.00	85.00	1.00	3.00
MODERATE EVENTS	4.00	80.00	3.00	2.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	4.00	80.00	4.00	3.00
HYDROLOGY SCORE	**57.93**			
HYDROLOGY ECOLOGICAL CATEGORY	**D**			
BOUNDARY EC				



Component: PES and causes	
	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Keiskamma River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. The Sandile Dam traps coarse bedload, reducing the extent of coarse sediment habitat along the reach. High flows are less frequent, leading to a contracted channel with dense bank vegetation. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the lower catchment significantly. This results in increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the available coarser habitats. Erosion associated with the low water crossing, trampling and frequent grazing by livestock along the banks destabilize and erode the geomorphic features at the site.

FINAL DRIVER STATUS GEOMORPHOLOGY	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*						
SCORING GUIDELINES							
GEOMORPHOLOGY DRIVERS							
COMPONENTS	**RANK**	**RELATIVE WEIGHTING (%)**	**RATING**	**WEIGHT**	**WEIGHED SCORE**	**FLOW RELATED**	**CONFIDENCE**
System Connectivity	1.00	100.00	2.42	0.43	1.05	68.39	2.81
Sediment balance	2.00	70.00	2.05	0.30	0.62	14.00	2.75
Bed & bank stability	3.00	60.00	1.50	0.26	0.39	29.09	2.84
TOTALS		230.00		1.00	2.07		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					58.66		
HABITAT DRIVER CATEGORY					D	41.58	2.80
					WEIGHED SCORE	**FLOW RELATED**	**CONFIDENCE**
Morphological change					2.00	38.89	2.78
HABITAT CHANGE STATUS					60		
HABITAT CHANGE CATEGORY					C		

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
Macroinvertebrates	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Riparian vegetation	Stable	• AIP was low in terms of perennial species and was mostly annual weeds.	3
Hydrology	Stable	• No recent water resource developments	3

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Geomorphology	Stable	• Site has possibly adjusted to the fine sediment input, lack of bedload and reduced floods scouring the riparian vegetation	3
Physical-chemical	Stable	• Land use has not changed in the area in recent years.The only significant activity immediately upstream is the Fort Cox Agricultural College. Surroundings are largely rural and no WWTW were identified.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR DEVIATION**
ECOSTATUS	D	D	• Driven by the fish component (E category). • Dominance of non-native fish species • Upstream Sandile Dam creating a movement barrier upstream, as well as a physical-chemical barrier • Further driven by the Riparian vegetation component • High grazing, trampling pressure, high AIP and erosion • Significant increase in terrestrial and/or alien woody abundance since 1930, thus marginal zone has become shaded out.

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
The system is prone to nutrient concentration spikes at times. Diatoms suggest good water quality, indicating that the elevated nutrient concentrations are periodic and not sustained over long periods. *In-situ* water quality was comparably between the two site assessments, suggesting. Clarity/visibility, conductivity and TDS all indicated good water quality.

D	D	• Overall, maintain EcoStatus as a D category; • F: The present baseflows are considerably lower than the natural flows and highly concerning. Thus, if the flows can be improved, the REC can be reassessed for improvement, as the aquatic health of the system will also be improved; • F: Increase event hydrology (high-flows floods) particularly to ensure those floods take place on the floodplain to reset the riparian zone (terrestrial

		woody composition). Furthermore, will improve the fish ques and will overall improve the water quality along the reach; • F: Ensure moderate events (freshets) – this may potentially improve the macroinvertebrate component and reset the biotopes; • NF: Removal of the high AIP within the riparian zone and management thereof; and • NF: Land management of the catchment (cattle trampling and grazing) to avoid further bank erosion.

OVERALL ASSESSMENT

Table 5-7: Overall EcoStatus assessment for KEIS01_I (Keiskamma)

River	**Upper Keiskamma**
EWR Site Code	**KEIS01_I**
Driver component	**PES**
HAI	D
Diatoms	
GAI	D
Response component	**PES**
FRAI	E
MIRAI	C
VEGRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

The overall EcoStatus for this EWR site was categorised as a D, thus the system is in a largely modified condition (**Table 5-7**). The degradation of the local catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats, while the Sandile Dam upstream trap a large portion of the coarser bedload, reducing the extent of gravel and cobble bars. Flood flows are reduced, leading to a contracted channel with infrequent reset events to renew habitats. At the site, disturbance along the margins, such as sand mining, trampling, removal of biomass, woody encroachment are widespread leading to degradation of the habitat associated with bars, benches and banks.

The fish assemblage within the reach was considered to be depauperate, with habitat fragmentation, water quality deterioration, flow modification and the expected presence of several non-native fish species identified as contributing factors. Conversely, the macroinvertebrate community remained representative of good flow and habitat availability, although several taxon were identified which are indicators of water quality deterioration.

The riparian vegetation at this site was highly disturbed by flooding, erosion, livestock trampling and grazing and human access and use. Alien plant species were abundant and widespread but were mainly annual weeds. Perennial alien species were scattered and limited.

It is suggested that the REC remain unchanged (category D) (**Table 5-7**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- High flow releases to scour the fine sediment from the pools and channel margins;
- Any future land use activities within upstream catchment should be managed to prevent degradation of the ecological health of the system and deterioration of the water quality (buffer zones to be implemented for future proposed developments); and
- Catchment management (cattle grazing and trampling).

5.8 bKAT01_I: Kat River (Upper)

Sample Date	13 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	KAT01_I	**IUA**	IUA_Q03
River	Kat	**IUA description**	Koonap and Kat
Altitude (m.a.s.l.)	634	**Prioritised RU**	R_RU08_I
Latitude	-32.56964523	**Longitude**	26.72185233
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q94B
Level 2 EcoRegion	18.02	**SQ Reach**	Q94B-07623
Geomorphological zone	D (slope 0.007)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology			

MAP ILLUSTRATION (Figure 5-15) AND SITE PHOTOGRAPHS (Figure 5-16)

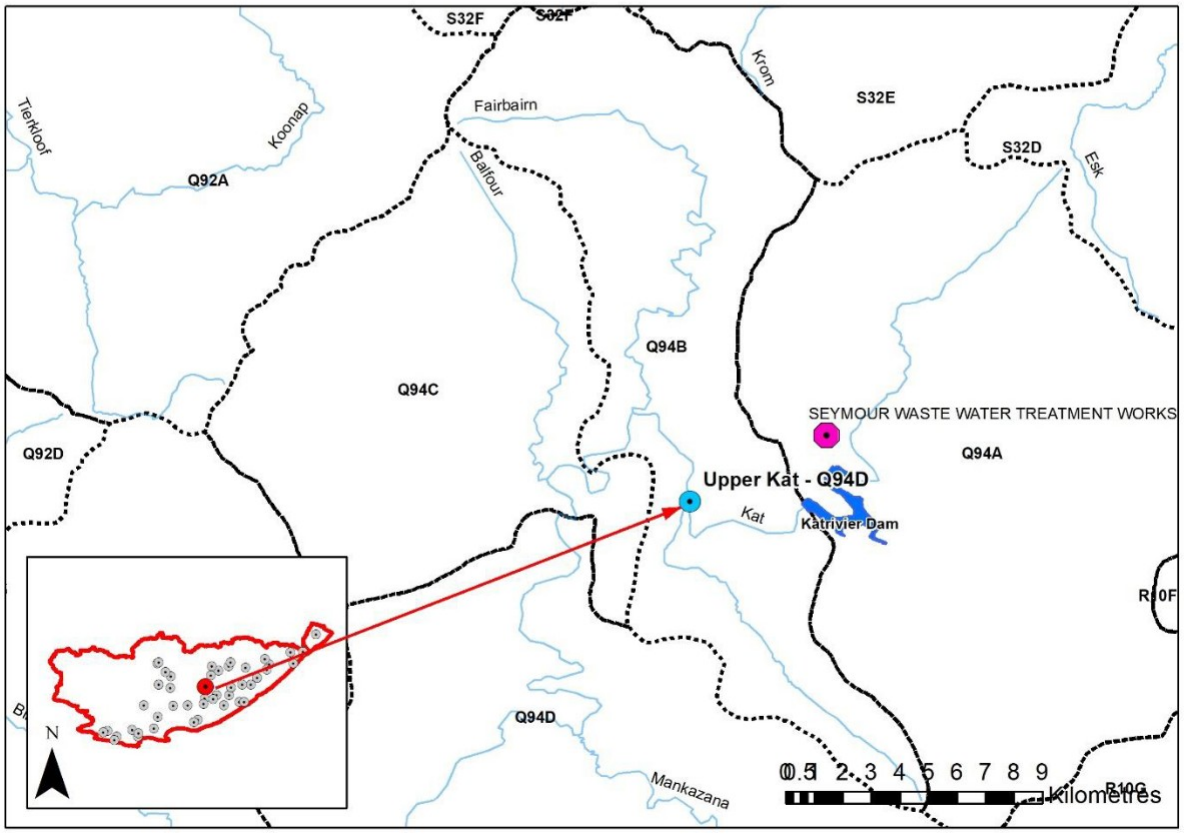


Figure 5-15: Location of site KAT01_I (Upper Kat) in relation to the study area *(pink dot represents an existing WWTW)*

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)

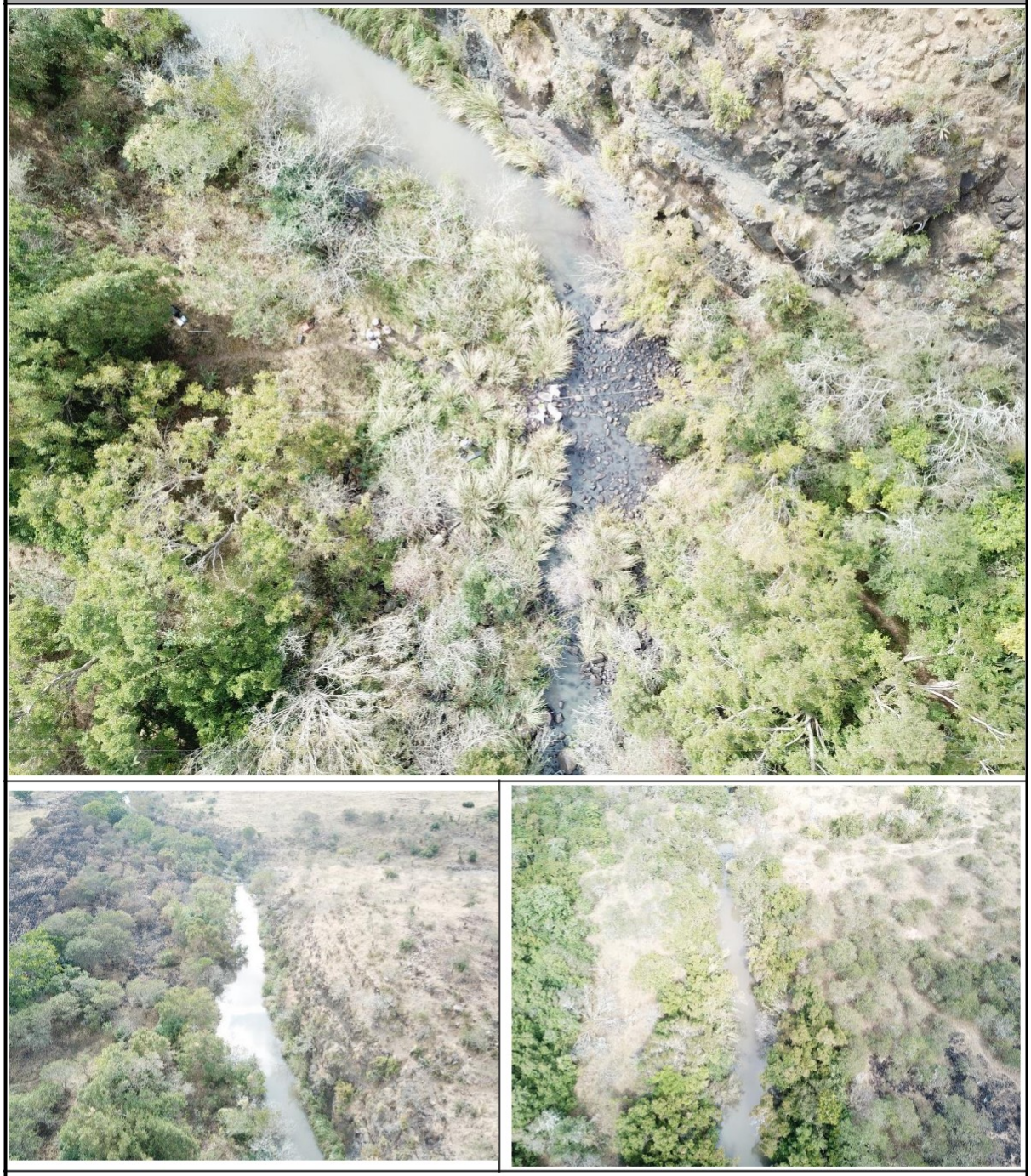


Figure 5-16: Site photographs of the upper Kat EWR site

Site Description:

The site is located near Hertzog, about 1 km (straight distance) from the R67.

The site is located in a confined valley setting with a single channel and narrow flood features within a deeply incised macro channel. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and silt sediment types. The banks and benches are composed of sand and silt, with bedrock cliffs

along the outer bends. The channel has dense tree and grass vegetation with some localised trampling where livestock cross the channel. Bank erosion is localised and the bed along the riffle has a limited gravel and sand deposits, possibly due to sediment starvation. Siltation takes place along the pools with a silt drape covering slow flowing habitats. There are numerous weirs along the river, increasing pool type habitats.

Biota habitats available
A good availability of aquatic macroinvertebrate biotopes. These included SIC, SOOC, some bedrock along the right bank. Marginal vegetation and some in-stream aquatic macrophytes. The GSM biotope was slightly limited. Varying fish habitats comprised FD, FS, SD and SS.

Riparian vegetation
Pool and riffle habitats restricted on the right bank (RB) by cliffs. Pool margins were narrow on the RB, comprised of shrubs (*C. strobilifera*) and grasses (*Miscanthus ecklonii*), while the left bank (LB) had taller trees (*Combretum caffrum*) with overhanging cover. Aquatic vegetation was absent. *Gomphostigma virgatum* was growing in fast flowing water in cobble areas of the riffle, where marginal zone species were dominated by grasses (*M. ecklonii*) and sedges (*C. textilis, Kyllinga elatior*) with scattered *C. caffrum* individuals. Grazing and trampling pressure was evident in the zone. Bank species were dominated by riparian (*C. caffrum*) and terrestrial (*Senegalia caffra*) trees with a shrub layer (*Gymnosporia senegalensis*) and a well-developed understorey. Alien plant species were low in abundance but included some invasive species (*Mellia azedarach, Opuntia ficus-indica*) which have the potential to increased and cause deterioration of the site.

Site impacts:

- Alien invasive plants within riparian zone
- Upstream dam (Kat River Dam)
- Downstream weir
- Cattle trampling, grazing, crossings
- Local villages

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	7.76	8.16
EC (µS/cm)	123.3	123
TDS (g/l)	0.1002	0.097
DO (mg/l)	7.30	8.91
DO% (%)	71.7	89.5
Clarity (cm)	40	Approx. 30cm
Temperature (°C)	14.5	15.52
Salinity (ppt)	0.07	0.07
Discharge (m^3/s)	0.03	0.05

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
September 2022				
29	14.4	B (Good)	4.9	1.5
Dominant Species	(1) *Achnanthidium spp.*			
	(2) *Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preference	(1) Moderate to good quality waters			
	(2) Nutrient and salinity increases (eutrophication)			
May 2023				
19	16.8	B (Good)	3.2	0.75
Dominant Species	*Achnanthidium sp.*			
Preferences	Moderate to good water quality conditions			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	1.5	• Simple channel form • Easy access	• Dense vegetation along margins • Two observations at similar flow rates
Fish	3	• Easily wadable • Slow-shallow, fast-shallow and slow-deep velocity depth classes represented • Substrate and overhanging vegetation cover class well represented	• Limited marginal and aquatic vegetation present
Macroinvertebrates		• SIC, SOOC, marginal vegetation and GSM biotopes available • Highest abundance of Porifera ever observed at this site • DWS REMP Site code: Q9KATR-BRIDG	• Large boulders (bedrock) present – not a suitable habitat for macroinvertebrates • Cattle trampling and grazing (localised bank erosion and disturbances to the marginal vegetation biotope)
Riparian vegetation	3.5	• Both banks accessible • Good diversity of habitat types • Good diversity of riparian obligate species	• AIP • Livestock grazing and trampling pressure
Geomorphology	3	• A reasonable range of morphological features and sediment types	• The river is small and overgrown, making assessments using historical aerial images challenging

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Two observations at similar flow rates
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current two river survey (September 2022 and May 2023) • DWS REMP Site code: Q9KATR-BRIDG
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: Q9KATR-BRIDG
Hydrology						• Monthly hydrology available for natural and present day • Daily data from gauge at Kat River Dam upstream of the site
Geomorphology						• Previous EWR data for site • Historical aerial images, but low resolution and dense vegetation
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1938 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity. • NCMP water quality data site Q9H026Q01 (1972 – 2004, n= 785) • 2022 diatom results • 2023 diatom results

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla mossambica, Enteromius mandelai, Glossogobius callidus, Labeo umbratus, Sandelia bainsii*
Macroinvertebrates	Porifera, Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Atyidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Polymitarcyidae, Telagonodidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Protoneuridae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Empididae, Ephydridae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae.
Riparian vegetation	This site occurs within the Albany Thicket Biome, Albany Thicket Bioregion, and the Fish Valley Thicket vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone, inset and flood benches are expected to be a mixture of woody and non-woody vegetation, but with dominance by non-woody vegetation. Species diversity is expected to be high because habitat diversity is high at the site. An aquatic vegetation component is expected in pools, but this was absent. In keeping with the vegetation unit in which this site occurs, the macro-channel bank is expected to be riverine thicket, dominated by trees and shrubs and with both riparian and terrestrial representation. Alien species are expected to be absent.
Hydrology	Monthly natural flows available for period 1920 to 2009
Geomorphology	In its reference condition, the Kat River site is likely to be a moderately steep boulder and cobble bed channel with pool-riffle or pool-rapid reach types. Pools should be similar in length compared to riffles/rapids. Localised bedrock reaches can be present with anastomosing channels. Sand and gravel bars can be present in pools and along the margins of the riffles, but lower levels

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS		
	of embeddedness and silt cover would be expected. Narrow inset benches and flood benches of sand and gravel could be present as a result of freshets and larger infrequent floods. The channel would be less overgrown with the bed and benches showing recently deposited sediment.		
Physical-chemical	Physical variables	pH	Reference condition data for the site indicated a 95th percentile of 7.6 and a 5th percentile of 6.3 pH units.
		EC	Reference EC data indicates low conductivities with 95th percentile = 27.7 mS/m, which falls with the Natural category for DWS (2008)
		Temperature	No historical temperature records are available. DWA (2008) benchmark tables are used for a low confidence, qualitative assessment of temperature reference conditions.
		Clarity	There are no reference condition records for clarity for the site. The qualitative descriptions in DWS (2008) benchmarks table were used as reference conditions for the site.
		Dissolved Oxygen	No dissolved oxygen records are available for this site. DWA guideline benchmark tables (2008) have been utilised to characterise the site's reference condition.
	Nutrients	PO_4	Site reference data indicated that the 50th percentile was 0.03 mg/l. The Natural (A) category for the site was therefore re-benchmarked such that the PO_4Natural (A) category for the site is <0.03 mg/l
		TIN	Site reference data indicated that the 50th percentile was 0.25 mg/l which is equal to the limit for Natural (0) rating in DWS (2008) benchmarks table.
	Toxins	Fluoride	In terms of the toxics listed within the DWA (2008) rating tables, only fluoride was monitored. The reference data indicated a 95th percentile of 316 ug/L, which fell within the 1500 ug/l limit for a Natural (0) rating.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	C (62.9%)	F/NF	• Water quality impairments. • Significant impedance of upstream migration due to many abstraction weirs located within the system • Presence of non-native *Tilapia sparrmanii* expected
Macroinvertebrates (MIRAI)	C (68.6%)	F/NF	• Nearby upstream Kat River Dam, mostly used for irrigation (flow modification). • Water quality impairments. • Cattle grazing and trampling resulting in bank erosion thus hampering marginal vegetation biotope.
Riparian vegetation (VEGRAI)	C (73.9%)	F	• The Kat River Dam upstream is likely to cause some flow regulation and reduced flood peaks.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
		N/F	• Vegetation removal - Grazing and trampling by livestock, removal for fences and access paths, and selected wood removal. • AIP - annual alien weeds and also *Melia azedarach* and *Opuntia ficus-india.*
Geomorphology (GAI)	C (65 %)	47 % flow related	• Widespread grazing and erosional features in the catchment increase surface erosion. • Kat River Dam ~5 km upstream, trapping large volumes of bedload and high flows. • Trampling by livestock along the banks destabilizes the geomorphic features at the site. • Inset benches are eroded and bed appears armoured. • Silt drape and coarse particles embedded in low-velocity biotopes due to high suspended sediment concentrations.
Hydrology (HAI)	C (65.4%)		Upstream dam impacts on flood peaks and low flows due to releases for downstream users
Diatoms/Physical-chemical	B (15.6)	NF	• Moderate to good quality waters • Nutrient and salinity increases (eutrophication). • Site experiences periodic increases in nutrient loading. • Data was not sufficient to run a PAI model, however the available data did point to periodic spikes in nitrate and orthophosphate in the system. • This stretch of the river is largely a rural setting, dominated by subsistence farming, not likely to have significantly altered the physical-chemical state of the system.
ECOSTATUS (PES)	C (70.1%)		

Component: PES and causes

	Causes Present/Absent
Fish	All expected fish species likely to occur within the reach under reference conditions were still expected under present conditions, with some occurring at a lower-than-expected frequency of occurrence. Of relevance is that the number of weirs located within the system downstream of the reach are impacting the migration of eels in particular, with only a single specimen collected during the September 2022 field survey. These weirs support the citrus industry within the catchment which abstracts water from the system, thus resulting in flow modification in addition to the physical barriers imposed by such weirs. In addition, the expected presence of the non-native *Tilapia sparrmanii* was likely to compete directly with the native *Sandelia bainsii*, although their extent of impact at present seems limited. Nevertheless, the ecological state of the fish assemblage was considered to be moderately modified (Ecological Category C).

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	95.89	97.53
COVER	100.00	100.00
FLOW MODIFICATION	34.27	39.00
PHYSICAL-CHEMICAL	74.51	87.71
MIGRATION		70.35
IMPACT OF INTRODUCED		64.23
FRAI	PRESENT	
FRAI (%)	62.9	
EC: FRAI	C	

Component: PES and causes

The Upper Kat River site was dominated by large boulders, some bedrock with SIC, SOOC and marginal vegetation. The gravel and sand were located between the interstitial zones of the SIC and SOOC biotopes, while the muddy substrate was located further downstream, where signs of anoxic sediments were present.
During the September 2022 and May 2023 surveys, a total of 33 and 30 macroinvertebrates were recorded respectively, overall totalling 41 macroinvertebrate taxa for the last hydrological year (May 2022 – May 2023). The aquatic macroinvertebrate community assemblage collected was determined to be representative of moderately modified conditions (Ecological Category C, 68.6%).

The aquatic macroinvertebrate community recorded at the Upper Kat River site mostly had a preference for low to moderate water quality, standing to moderately fast flowing water, and cobbles. In total, 20 expected taxa were absent from the site during the last hydrological year, of which had high frequencies of occurrence and a range of preferences. Sensitive taxa which were present included Baetidae (>2 spp), Heptageniidae, Trichorythidae (being the dominant taxa in the community), Polymitarcyidae, Chlorocyphidae, Platycnemidae, Psephenidae, and Athericidae. Most of these taxa have a preference for cobbles, with the exception of Polymitarcyidae, which has a preference for GSM. They all preferred a diversity of flows from slow to very fast flowing water, with Baetidae (>2 spp) and Heptageniidae having high requirements for unmodified water quality, and the rest having moderate requirements for unmodified water quality. Conversely, expected sensitive taxa absent from the site included Perlidae, Telagonodidae, Pyralidae, Hydropsychidae (>2 spp), and Helodidae. These taxa mostly had a preference for very fast flowing water, cobbles, and had high requirements for unmodified water quality. Thus, there was an indication of water quality impairment at this site and should flows increase to >0.6 m/s, several additional macroinvertebrates expected for this reach could colonise.
Notably, the high abundance of Simuliidae recorded in September 2022 (C abundance) has since decreased to an abundance of a B during the May 2023 survey. This was likely owing to the system being reset following the floods which occurred in February 2023, scouring the habitat. This may further support the high abundance of Trichorythidaes which have recolonised the SIC and SOOC biotope in high abundances.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	71.7	*0.364*	26.0606	1	100
HABITAT	H	77.8	*0.273*	21.2045	3	75
WATER QUALITY	WQ	57.7	*0.345*	19.9169	2	95
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.45455	3	5
						275
INVERTEBRATE EC				68.6366		
INVERTEBRATE EC CATEGORY				C		

Overall, the community at the Upper Kat River site was primarily driven by water quality (57.7%), then flow (71.7%), and habitat modification (77.8%). The Average Score Per Taxon (ASPT) for the communities identified in September 2022 and May 2023 was 5.2 and 5.6, respectively, indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002).

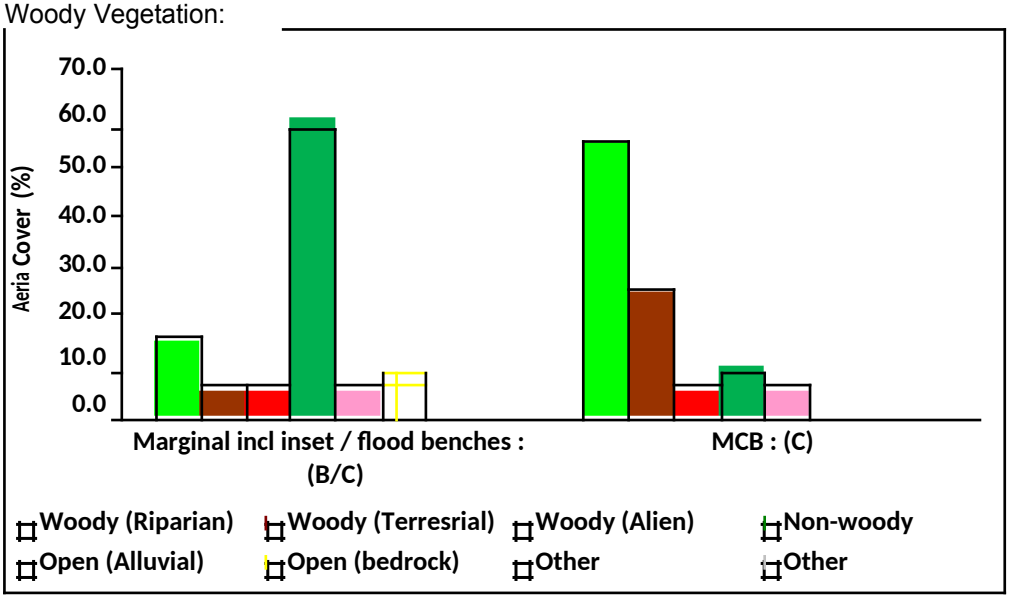
The marginal zone included diverse habitats including alluvial, vegetated deposits, pools, riffle and cobble/boulder, both unvegetated and vegetated. Vegetation was dominated by non-woody vegetation (mainly *Berula thunbergii, Centella asiatica, Cyperus textilis, Persicaria lapathifolia, Kyllinga elatior* and *Miscanthus ecklonii*), but with a scattered woody component comprising *Gomphostigma virgatum* in bedrock / fast-flowing habitats, *Salix mucronata* along alluvial edges of pools or banks and scattered *Senegalia caffra* within the channel on higher consolidated alluvia. Aquatic vegetation was absent. The macro-channel bank was dominated by trees and shrubs of various stature mixed with a well-defined understorey including grasses, forbs and smaller shrubs. Diversity of cohorts was good, and cover was high (>80%). Dominant species included *Celtis africana, Combretum caffrum, Gymnosporia buxifolia, Ziziphus mucronata,* and *Setaria megaphylla* and alien species included annual alien weeds, *Melia azedarach* and *Opuntia ficus-india.*

Overall PES:

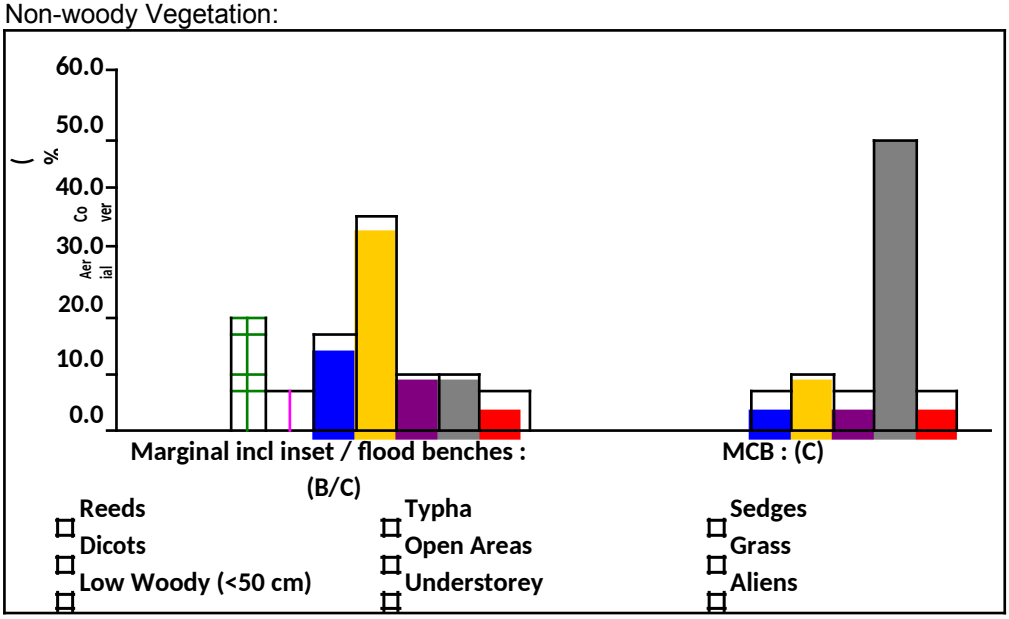
LEVEL 4 ASSESSMENT	**Kat_KAT01_I**					**07 May 2023**
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal incl inset / flood benches	80.0	38.1	3.8		47.6	Weighted according to extent
MCB	68.3	35.8	3.5		52.4	Weighted according to extent
LEVEL 4 VEGRAI (%)						73.9
VEGRAI Category	**Ecological**					**C**
AVERAGE CONFIDENCE						3.6
	Sub-zone					
	Marginal incl inset / flood benches	**MCB**	**0.0**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	80.0	68.3	not assessed	not assessed	not assessed	not assessed
EC (Zone)	**B/C**	**C**				
Confidence (Zone)	3.8	3.5				

Component: PES and causes

Woody Vegetation:



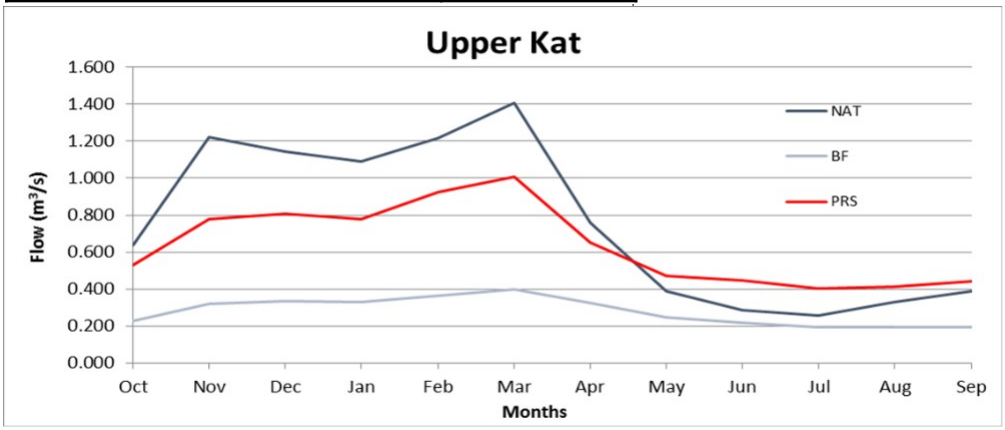
Non-woody Vegetation:



Component: PES and causes

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	**Rank**	**%wt**	**RATING**	**CONFIDENCE**
LOW FLOWS	3.00	80.00	3.00	2.00
ZERO FLOW DURATION	1.00	100.00	0.00	2.00
SEASONALITY	3.00	80.00	2.00	3.00
MODERATE EVENTS	2.00	90.00	3.00	2.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	4.00	75.00	3.50	2.00
HYDROLOGY SCORE	**56.12**			
HYDROLOGY ECOLOGICAL CATEGORY	**D**			
BOUNDARY EC				



Component: PES and causes

The broad geomorphology, as classified by the geomorphic zone, of the Kat River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. The Kat River Dam traps coarse bedload, reducing the extent of coarse sediment habitat along the reach. High flows are less frequent, leading to a contracted channel with dense bank vegetation. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the lower catchment significantly. This results in increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates in lower flow velocity environments, degrading the available coarser habitats.

Erosion associated with the cattle crossing, trampling and frequent grazing by livestock along the banks destabilize and erode the geomorphic features at the site.

FINAL DRIVER STATUS GEOMORPHOLOGY

This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.

SCORING GUIDELINES

GEOMORPHOLOGY DRIVERS

COMPONENTS	RANK	RELATIVE WEIGHTING (%)	RATING	WEIGHT	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
System Connectivity	1.00	100.00	2.40	0.43	1.04	65.81	2.92
Sediment balance	2.00	70.00	1.30	0.30	0.40	13.00	2.80
Bed & bank stability	3.00	60.00	1.23	0.26	0.32	56.82	2.73
TOTALS		230.00		1.00	1.76		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					64.79		
HABITAT DRIVER CATEGORY					C	47.39	2.83

	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
Morphological change	1.28	50.00	2.78
HABITAT CHANGE STATUS	74.44444		
HABITAT CHANGE CATEGORY	C		

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
Macroinvertebrates	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Riparian vegetation	Stable	• Impacts are not too high and alien invasive species occur in low numbers3 • Terrestrialisation has likely equilibrated	

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Hydrology	Stable	• No new water resource developments in recent years	3
Geomorphology	Stable	• The site has adjusted to the reduced bedload input and reductions in flood volume	3.5
Physical-chemical	Stable	• The type and intensity of the Impacts and threats to the Physical-chemical state of the system have remained relatively similar over time. Surroundings are largely rural and sparsely placed dwellings suggesting very low population and subsistence farming practices.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR DEVIATION**
ECOSTATUS	C	C	• Macroinvertebrate community primarily driven by water quality as expected macroinvertebrates with a preference for high water quality were absent from the site, although those absent sensitive biota further have a preference for very fast flow velocities. • Fish – downstream connectivity compromised owing to various weirs within the system resulting in a fish movement barrier • Riparian vegetation – terrestrialisation prominent at this site, suggesting small lower flood events are not coming through or the duration is too short – thus flow and non-flow related.

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, High	Moderate, High

Physical-chemical state of the system
Lower clarity was recorded on both site assessments suggesting sediment loading in the system. Conductivity and TDS were low on both sampling trips. Diatoms indicated that the system experiences period nutrient increases. The system is however in a good physical-chemical state. This is also linked to absence of large-scale activities upstream which may alter the physical-chemical state of the system.

Status (PES)		
C	B/C	• F: Ensure moderate events (freshets) – to be longer and more often for the purpose of the riparian vegetation and colonise the system with those expected sensitive macroinvertebrates to water quality and flow.

OVERALL ASSESSMENT

Table 5-8: Overall EcoStatus assessment for KAT01_I (Upper Kat)

River	Upper Kat
EWR Site Code	KAT01_I
Driver component	PES
HAI	D
Diatoms	
GAI	C
Response component	PES
FRAI	C
MIRAI	C
VEGRAI	C
Ecostatus	C
EI	Moderate
ES	High
REC	B/C

The overall EcoStatus for this EWR site was categorised as a C, thus the system is in a moderately modified condition, with loss and change of natural habitat and biota have occurred in terms of frequencies of occurrence and abundances (**Table 5-8**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats, while the Kat River Dam upstream trap a significant portion of the coarser bedload, reducing the extent of gravel and cobble bars. Flood flows are reduced, leading to a contracted channel with infrequent reset events to renew habitats. At the site, disturbance along the margins, trampling, woody encroachment, are common leading to degradation of the habitat associated with bars, benches and banks.

All fish expected under reference conditions were expected to be present, *albeit* with some at a lower frequency of occurrence than expected. This was largely due to the impact the many weirs within the system, on the movement of fish within the catchment, severely impacting upstream migration. In terms of the macroinvertebrate community, several flow sensitive taxa were recorded, thus the macroinvertebrate community remained representative of good flow and habitat availability, with several taxa being an indicator of water quality deterioration. As with many sites in the catchment area, the outbreak of Simuliidae recorded at this site in September 2022 was of concern, however following the floods in February 2023, the system had reset and the population drastically reduced in May 2032. The riparian vegetation at this site was diverse with moderate removal and grazing. Impacts were mainly associated with alien plant species, although annual species dominated, and terrestrialisation of the flood features, likely a result of reduced flooding disturbance.

It is suggested that the REC be improved to a B/C (close to largely natural most of the time), should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-8**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations; and
- Catchment management (grazing and abstraction for irrigation).

5.9 FISH03_I: Great Fish River (Lower)

Sample Date	20 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	FISH03_I	**IUA**	IUA_Q02
River	Great Fish	**IUA description**	Great Fish
Altitude (m.a.s.l.)	375m	**Prioritised RU**	R_RU06_I
Latitude	-33.08373323	**Longitude**	26.22527359
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q91B
Level 2 EcoRegion	18.02	**SQ Reach**	Q91B-08144
Geomorphological zone	E (slope 0.001)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-17) AND SITE PHOTOGRAPHS (Figure 5-18)

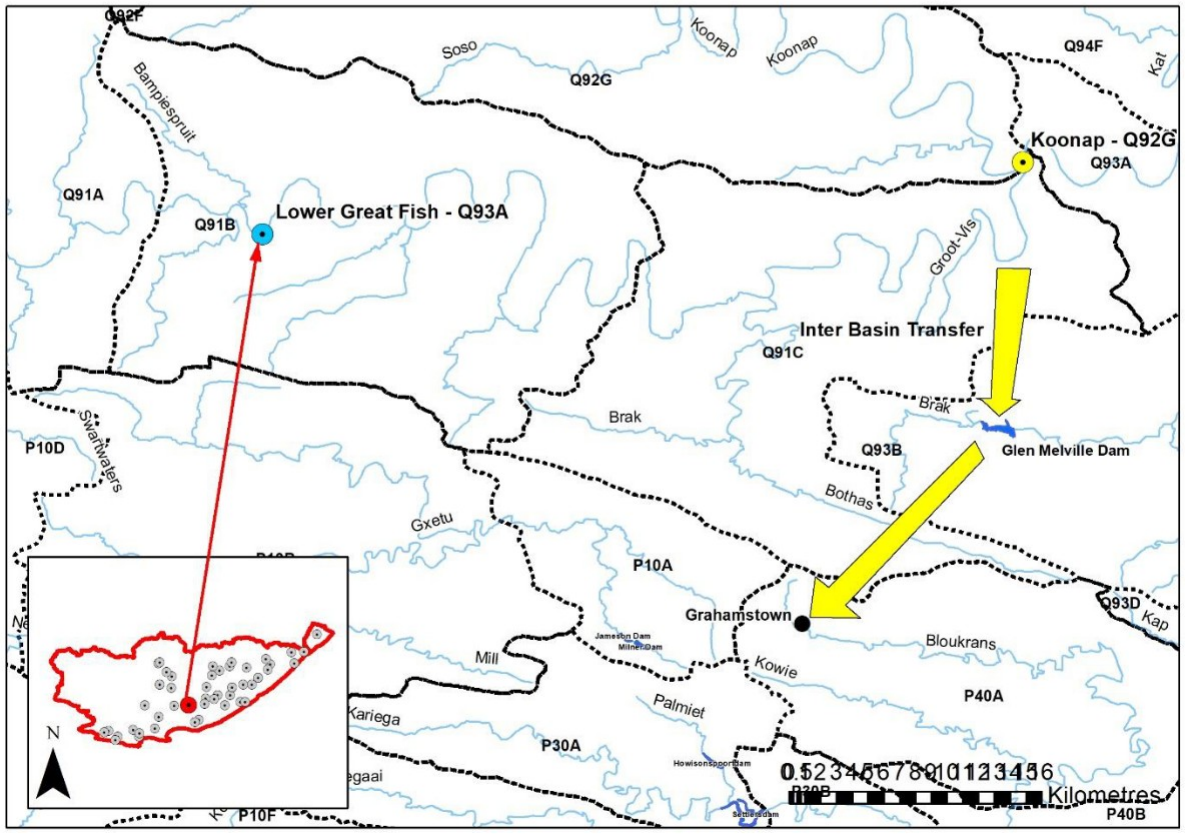


Figure 5-17: Location of site FISH03_I (Lower Great Fish) in relation to the study area *(yellow dot represents a Rapid 3 EWR site. The yellow arrows represents the IBT)*

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)



Figure 5-18: Site photographs of the lower Great Fish EWR site

Site Description:

The site is located at the Carlisle Bridge along the R350.

The site is located in a moderately confined valley setting with a single channel and narrow flood features within a deeply incised macro channel. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and silt sediment types. The banks and benches are composed of fine sand and silt, with bedrock along rapids and along the outer bends. The channel has dense sedge, reed and tree vegetation with some localised trampling where game cross or drink from the channel. Bank erosion is localised and the bed along the riffle has a limited gravel and sand deposits, due to increased flow levels. Siltation takes place along the pools with a silt drape covering slow flowing habitats.
Biota habitats available

Aquatic macroinvertebrate biotopes available were SIC and marginal vegetation, with limited SOOC and GSM. Fish habitats included FD, FS, SD and SS.

Riparian vegetation
The marginal zone appeared scoured with extensive undercutting of reedbeds and an absence of dicotyledonous forbs such as *Persicaria* and *Ludwigia.* The zone was narrow and confined and dominated by *Phragmites australis* and *Cyperus textilis.* The flood bench was also dominated by non-woody vegetation, notably *Phragmites australis, C. textilis, C. sexangularis* and *Paspalum distichum*, but with scattered *Vachellia karroo* saplings and young adults. The macro-channel bank was dominated by dense, tall woody vegetation, mainly *V. karroo*, but also *Searsia lancea.* Alien invasive plant species were minimal and comprised mainly *Opuntia ficus-indica* and *Ricinus communis*, as well as annual weed species such as *Tagetes minuta, Bidens pilosa* and *Conyza bonariensis*.

Site impacts:

- Interbasin Transfer scheme (flow modification)
- Drainage channel
- Cattle trampling and grazing.
- Upstream town (Cradock)
- High sedimentation (highly turbid)

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	8.61	8.26
EC (µS/cm)	891	1205
TDS (g/l)	0.716	0.928
DO (mg/l)	8.25	8.01
DO% (%)	81.9	82.9
Clarity (cm)	11	Approx. 10
Temperature (°C)	15.0	16.83
Salinity (ppt)	0.55	0.72
Discharge (m^3/s)	3.5	5.70

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
September 2022				
34	11.4	C (Moderate)	13.7	0.25

Dominant Species	*Cyclostephanos invisitatus (Hohn & Hellerman) Theriot, Stoermer & Håkansson*			
Preferences	Cosmopolitan, common in summer plankton nutrient-rich streams. These species when in abundance is a good indicator of eutrophication.			
May 2023				
18	6.7	D (Poor)	86.2	1.5
Dominant Species	*(1) Eolimna subminuscula (Manguin) Moser. Lange-Bertalot & Metzeltin*			
	(2) Nitzschia frustulum (Kützing) Grunow			
Preference	(1) A cosmopolitan species common in electrolyte-rich, strongly polluted rivers and flowing waters.			
	(2) A cosmopolitan species found in electrolyte-rich and brackish waters. Tolerant of high conductivity, fluctuations in osmotic pressure and of critical levels of pollution.			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	2	• Simple stable channel form	• No high flow observations
Fish	2	• Fast-deep, fast-shallow and slow-deep velocity depth classes represented	• High flows limit successful sampling
Macroinvertebrates	3	• SIC, SOOC, GSM and marginal vegetation biotopes available • Varying flow velocities	• River access constraints owing to depth and high velocity. • High turbidity
Riparian vegetation	3	• Moderate representation by riparian indicator species	• Elevated flows (transfer scheme) have reduced/ inundated marginal zone habitats with possible scour.
Geomorphology	3	• Reasonable range of morphological features and sediment types	• A possible steeper and more stable section than the reach.

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Two flow observations
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current two river survey (September 2022 and May 2023)
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)
Hydrology						• Monthly hydrology available for natural and present day

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Geomorphology						• Historical aerial images and recent satellite images
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1949 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity. • One 1982 NCMP water quality data entry for site 100776. • 2022 diatom results. • 2023 diatom results.

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Fish	*Anguilla bicolor bicolor, Anguilla bengalensis, Anguilla marmorata, Anguilla mossambica, Enteromius mandelai, Glossogobius callidus, Labeo umbratus Oreochromis mossambicus*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Naucoridae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Physidae, Corbiculidae.
Riparian vegetation	This site occurs within an Azonal Vegetation Biome, Inland Saline Vegetation Bioregion, and the Southern Karoo Riviere vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone is expected to be more defined with a greater presence of alluvial features. The zone is expected to be dominated by non-woody vegetation, mostly reeds, sedges and grasses. As with the marginal zone, the flood benches are expected to be dominated by non-woody vegetation, notable sedges and grasses with lower density reeds. Some overhanging woody vegetation is also expected along the zone's upper limit.
Hydrology	Natural flows available for the period 1920 to 2009
Geomorphology	In its reference condition, the Great Fish River site is likely to be a moderately steep cobble and boulder bed channel with pool-riffle or pool-rapid reach types. Pools would be much longer compared to riffles/rapids. Localised bedrock reaches can be present with anastomosing channels. Sand and gravel bars can be present in pools and along the margins of the riffles, but lower levels of embeddedness and silt cover would be expected. Narrow inset benches and flood benches/flood plain of sand and gravel could be present as a result of freshets and larger infrequent floods. The marginal vegetation would be less dense due to fluctuations in baseflows.
Physical-chemical	Reference data for the site was only n=1 and does not predate the 1977 interbasin water transfer scheme. The diatom results were used to infer the reference conditions at the site. The diatom results indicated that the site experiences period eutrophication and the water quality is in a moderate condition. It is expected that under reference conditions the site would have lower nutrient concentrations and lower turbidity/sedimentation, especially pre the interbasin transfer scheme.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	E (27.6%)	F/NF	• Significant flow modification as a result of inter-basin transfer • Dominance of non-native fish species
Macroinvertebrates (MIRAI)	C (67.0%)	F	• Highly turbid system

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Sustained high flows and high baseflows (Flow modification) • *Upstream interbasin transfer scheme contributing to the flows along this reach (flow modification)* • SIC highly embedded, thus limited scouring of this *biotope*.
Riparian vegetation (VEGRAI)	C (71.5%)	F	• Influenced by the Gariep transfer with elevated and aseasonal flows. The Great Fish River upstream of this site (i.e., no transfer influence) is dry and different. • Terrestrial species occurrence higher than expected, as seen by increased woody cover since 1949 aerial photographs.
Geomorphology (GAI)	C (70 %)	50 % flow related	• Sustained high flows entraining finer bed sediment resulting in reductions in gravel and sand habitats. • Increased bank vegetation due to higher baseflows, leading to increased bank stability despite the steep banks. • Low evidence of trampling and grazing at the site. • Moderate levels of embeddedness along slow biotopes. • Increased surface erosion in the catchment producing high silt loads
Hydrology (HAI)	D (50.8%)		All flow components impacted by Orange-Fish transfer scheme
Physical-chemical/Diatoms	C (9.1)	NF	• Nutrient-rich (eutrophication). • This stretch of the river is largely surrounded by farmland with extensive cultivated land along the length of the river. • Apart from the interbasin transfer upstream and the and cultivated land along this stretch of the river, there were no other potential sources of elevated nutrient loads that could be identified at this river reach.
ECOSTATUS (PES)	C (62.0%)		

Component: PES and causes

	Causes Present/Absent			
Fish	The inter-basin transfer into the Great Fish river has resulted in a significantly modified flow regime within the reach. In addition, the complete dominance of the fish assemblage by non-native fish species from the Orange River catchment, including *Labeobarbus aeneus, Labeo capensis, Clarias gariepinus* and *Tilapia sparrmanii*, as well as the alien *Cyprinus carpio* has significantly impacted the native species, with only a few species still likely to occur. These larger non-native species are likely to out-compete many native fish species. Consequently, the ecological state of the fish assemblage within the reach was considered to be seriously modified (Ecological Category E).			

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	92.31	87.65
COVER	100.00	95.96
FLOW MODIFICATION	35.95	58.03
PHYSICAL-CHEMICAL	36.43	46.24
MIGRATION		66.67
IMPACT OF INTRODUCED		100.00
FRAI	PRESENT	
FRAI (%)	27.6	
EC: FRAI	E	

Macroinvertebrates

The biotopes of the Lower Great Fish River were comprised of SIC, boulders, bedrock, GSM, and marginal vegetation. During the September 2022 and May 2023 surveys, a total of 17 and 20 taxa were recorded respectively, resulting in a community of 25 taxa. The aquatic macroinvertebrate community collected was determined to be representative of moderately modified conditions (Ecological Category C, 67.0%).

Several taxa that were expected to be present with a high frequency of occurrence were not recorded, including Potamonautidae, Hydracarina, Aeshnidae, Gerridae, Heptageniidae, Trichorythidae, Hydropsychidae >2spp, and Psephenidae. The latter four taxa are sensitive to water quality, flow, and habitat. The aquatic macroinvertebrate community representing this site mostly had a preference for standing water, cobbles, and low to very low requirements for unmodified physical-chemical conditions.

Comparing the communities recorded between the two surveys showed that there has been a change in the health and integrity of the system. For example, Baetidae >2spp was recorded in B abundance in September 2022, while May 2023 recorded an A abundance for only Baetidae 2spp. Hydropsychidae 2spp recorded a B abundance in September 2022 but an A abundance for 1 spp in May 2023. Perlidae was only recorded in May 2023 in an A abundance, similar to the reference state.

Upstream of the Lower Great Fish River includes the IBT, resulting in notable flow regulation activities. Therefore, this site is driven mainly by a wide diversity of hydraulic conditions across the system, including fast-flowing rapid-riffle complexes, as well as some slow-flowing and standing pools within the marginal zones. This was supported by the presence of several flow-dependent taxa, including Turbellaria, Baetidae >2spp, Hydropsychidae 2spp, Perlidae, Elmidae, Ceratopogonidae, Chironomidae, Simuliidae, and Ancylidae. However, most of these taxa, except Baetidae >2spp, Hydropsychidae 2spp, Perlidae, and Elmidae, have a preference for low to very low water quality. Therefore, although there are taxa indicative of flows, sensitive water quality taxa are absent from this site.

From a habitat perspective, although most taxa within the community preferred cobbles, only 9 out of an expected 18 taxa were recorded and four out of an expected 9 taxa were recorded with a preference for vegetation. This is likely due to compromised water quality conditions, deterring those flow and habitat-sensitive taxa from colonising these biotopes. Furthermore, majority of the marginal vegetation being woody (*Phragmites australis*) as opposed to non-woody and aquatic macrophytes which is more preferred by macroinvertebrates.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC GROUP	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	73.2	*0.333*	24.4086	2	95
HABITAT	H	69.8	*0.298*	20.8291	3	85
WATER QUALITY	WQ	58.1	*0.351*	20.3947	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.40351	4	5
						285
INVERTEBRATE EC				67.0359		
INVERTEBRATE EC CATEGORY				C		

Overall, the community was primarily driven by water quality (58.1%), then habitat modification (69.8%) and flow modification (73.2%). The ASPT for the communities identified in May 2023, September 2022, and May 2023 was 5.1 and 5.3, respectively, indicating that the community was mostly composed of tolerant taxa (Dickens and Graham, 2002).

Riparian vegetation

The marginal zone was largely flooded with fairly extensive removal of the zone by scouring of sediments due to incresaed flows from transfer schemes. As such, the zone was narrow, either dense inundated reed beds or overhanging shrubs. In places where sediment deposition occurred, substrates were colonised by non-woody vegetation. Dominant species included *Phragmites australis, Cyperus textilis* and *Paspalum distichum*. Dominant habitats along the flood benches were alluvial and dominated by tall, dense reeds (*P. australis*), and some scattered woody individuals (mainly *Vachellia karoo*). Although sedges were also present (*Cyperus textilis, C. sexangularis*), they were uncommon and species diversity was low. The macrochannel bank was steep, confining, well vegetated with no signs of removal, browsing or grazing and was dominated by tall, woody vegetation, mostly closed canopy, dense and near impenetrable. The only area dominated by grasses (*M. ecklonii*) was associated with the bridge.

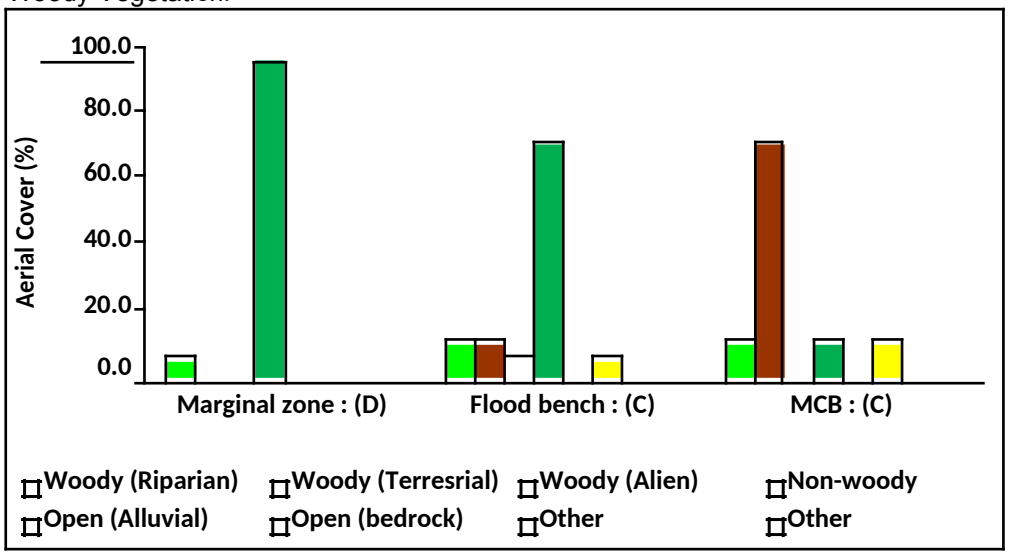
Overall PES:

LEVEL 4 ASSESSMENT	**Great Fish_FISH03_I**					**04 May 2023**
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal zone	52.5	6.1	3.3		11.6	Weighted according to extent
Flood bench	70.3	13.1	3.3		18.6	Weighted according to extent
MCB	75.0	52.3	2.3		69.8	Weighted according to extent
LEVEL 4 VEGRAI (%)						71.5
VEGRAI Category	**Ecological**					**C**
AVERAGE CONFIDENCE						3.0
	Sub-zone					
	Marginal zone	**Flood bench**	**MCB**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	52.5	70.3	75.0	not assessed	not assessed	not assessed
EC (Zone)	**D**	**C**	**C**			
Confidence (Zone)	3.3	3.3	2.3			

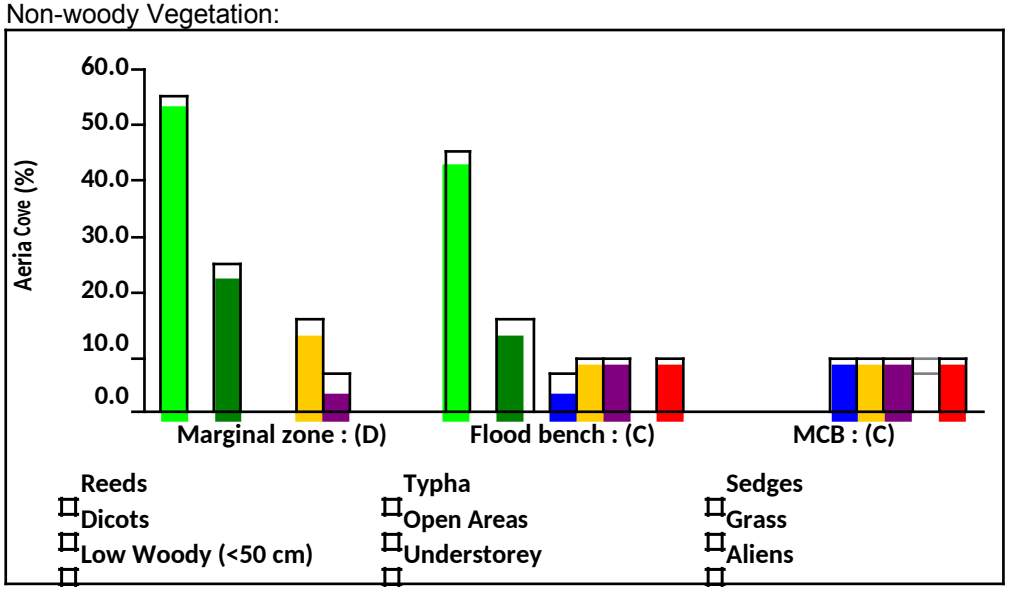
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

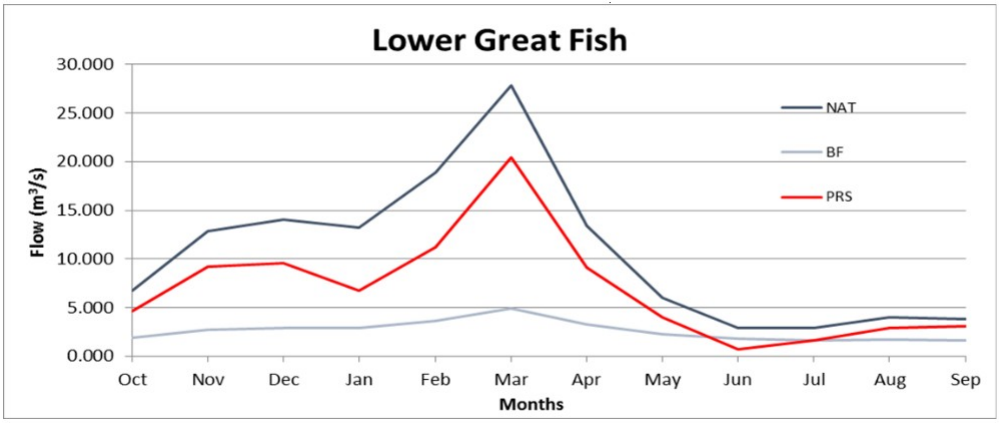


Component: PES and causes

Causes Present/Absent

Hydrology

HYDROLOGY METRICS	Rank	%wt	RATING	CONFIDENCE
LOW FLOWS	2.00	90.00	2.00	3.00
ZERO FLOW DURATION	1.00	100.00	0.00	4.00
SEASONALITY	2.00	90.00	1.00	3.00
MODERATE EVENTS	3.00	80.00	3.50	2.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	4.00	75.00	3.00	2.00
HYDROLOGY SCORE	**64.37**			
HYDROLOGY ECOLOGICAL CATEGORY	**C**			
BOUNDARY EC				



Component: PES and causes	
	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Fish River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment and water from the lower catchment. This results in increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates in lower flow velocity environments, degrading the available coarser habitats. Flow manipulation reduces the variability of flows, resulting in a channel with low geomorphic diversity.

FINAL DRIVER STATUS GEOMORPHOLOGY	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*					
SCORING GUIDELINES						
GEOMORPHOLOGY DRIVERS						
COMPONENTS	**RANK**	**RELATIVE WEIGHTING (%)**	**RATING**	**WEIGHT**	**WEIGHED SCORE**	**FLOW RELATED**	**CONFIDENCE**
System Connectivity	1.00	100.00	1.63	0.43	0.71	62.10	3.00
Sediment balance	2.00	70.00	1.05	0.30	0.32	9.00	2.70
Bed & bank stability	3.00	60.00	1.73	0.26	0.45	78.64	2.89
TOTALS		230.00		1.00	1.48		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					70.43		
HABITAT DRIVER CATEGORY					C	50.25	2.88
					WEIGHED SCORE	**FLOW RELATED**	**CONFIDENCE**
Morphological change					1.56	76.67	2.78
HABITAT CHANGE STATUS					68.88889		
HABITAT CHANGE CATEGORY					C		

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish			
Macroinvertebrates	Stable	• Flow modification owing to upstream IBT scheme continued, of which the system has adapted to.	3
Riparian vegetation	Stable	• The riparian vegetation has likely equilibrated to current impacts. • AIP low to absent	3
Hydrology	Stable	No new water resource developments	3
Geomorphology	Stable	• The system has adjusted to the increased flows and silt input	3

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Physical-chemical	Stable	• In the absence of additional pressures on the system at this reach the physical-chemical state of the system is only affected by the flow dynamics. Some agricultural activities are present upstream; however, no signs of nutrient enrichment were identified during the site visit.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR DEVIATION**
ECOSTATUS	C	C	• Primarily driven by the fish (E category) (non-native fish species- BAEN, LCAP, CGAR, TSPA, CCAR, GAFF). • Artificial flows due to interbasin transfer likely to be impacting migration cues

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
Low clarity/visibility was recorded during the survey, suggesting high sediment loads in the system as a result of sustained flows with the interbasin transfer scheme. Elevated conductivities were also recorded during both site assessments.

C	C	• F: Maintain the EcoStatus as a C, being impacted due to the upstream IBT - which cannot be altered due to the importance of the IBT for socio-economic development; and • NF: Need to continually ensure water quality is managed to not decrease the current category, as a result of the upstream towns and return flows (nutrients).

OVERALL ASSESSMENT

Table 5-9: Overall EcoStatus assessment for FISH03_I (Lower Great Fish)

River	**Lower Great Fish**
EWR Site Code	**FISH03_I**
Driver component	**PES**
HAI	C
Diatoms	D
GAI	C
Response component	**PES**
FRAI	E
MIRAI	C
VEGRAI	C
Ecostatus	**C**
EI	Moderate
ES	Moderate
REC	**C**

The overall EcoStatus for this EWR site was categorised as a C, thus the system is in a moderately modified condition, with loss and change of natural habitat and biota have occurred in terms of frequencies of occurrence and abundances (**Table 5-9**). The degradation of the local catchment and elevated erosion associated with the transfer are elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats. Base flows are elevated, leading to a channel with limited habitat diversity. At the site, disturbance along the margins, such as trampling and woody encroachment are localised leading to degradation of the habitat associated with bars, benches and banks.

The macroinvertebrate community was primarily driven by water quality, likely owing to nutrient enrichment from upstream towns and return flows (supported by the diatom community indicative of moderate to poor water quality). The riparian vegetation at this site is mostly responding to an altered, but fairly stable, hydrological regime, with elevated (transfer) flows reducing and scouring marginal zone habitats, and with reduced floods causing terrestrialisation of flood features and banks.

It is suggested that a REC be maintained at a category C, owing to the upstream IBT - which cannot be altered owing to the importance of the socio-economics component (**Table 5-9**).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations; and
- Increase flow variability to improve the range of geomorphic habitats.

5.10 SWAR01_I: KwaZungu / Swartkops River

Sample Date	24 September 2022	**ReserveLevel Assessment**	Intermediate
Site Name	SWAR01_I	**IUA**	IUA_M01
River	KwaZungu / Swartkops	**IUA description**	M primary catchment
Altitude (m.a.s.l.)	77	**Prioritised RU**	R_RU03_I
Latitude	-33.722183	**Longitude**	25.300816
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	M10C
Level 2 EcoRegion	19.02	**SQ Reach**	M10C-08897
Geomorphological zone	E (slope 0.005)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-19) AND SITE PHOTOGRAPHS (Figure 5-20)

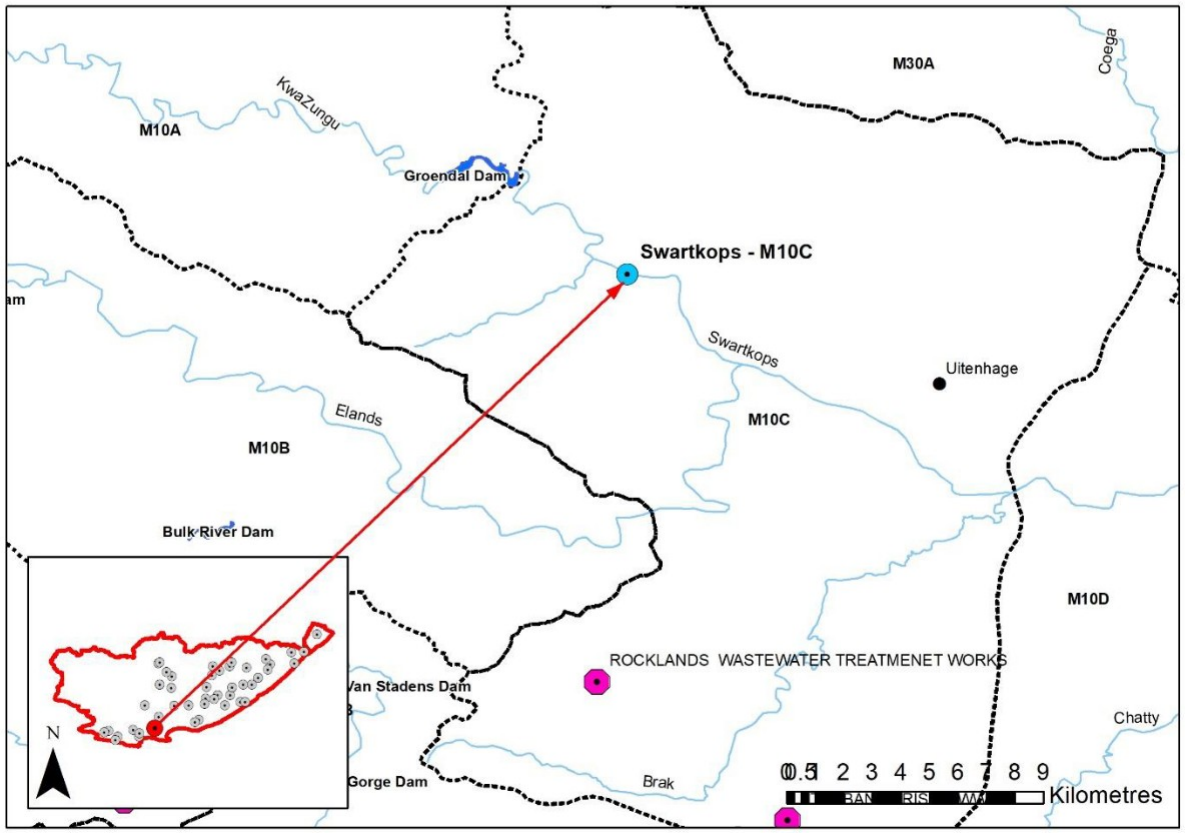


Figure 5-19: Location of site SWAR01_I (Swartkops) in relation to the study area *(pink dot represents an existing WWTW)*

Site Photographs: Survey 1 (September 2022)





Drone access denied owing to conservation area

Site Photographs: Survey 2 (May 2023)





Figure 5-20: Site photographs of the Swartkops EWR site

Site Description:

The site is located in Groendal Nature Reserve, about 5 km (straight distance) downstream of the Groendal Dam.

The site is located in a partly confined valley setting with a single channel and floodplain along the left bank. The active channel has narrow flood benches and is deeply incised into the valley floor. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by boulder, cobble, gravel and sand sediment types. The floodplain, banks and benches are composed of boulder, cobble, gravel and sand, with bedrock cliffs or steep hillslopes along parts of the outer bends. The channel is densely vegetated with shrubs, sedges and tall grasses. There were very limited signs of grazing and trampling along the banks. Undercut banks and bank erosion is fairly common and the bed along the riffle and pools have very low embeddedness, possibly due to sediment starvation caused by the Groendal Dam. Small inset benches are forming and are composed of medium sand.

Biota habitats available
All macroinvertebrate biotopes had good availability. Fish habitats only included FS and SD.

Riparian vegetation
The channel was confined and bedrock controlled with some lateral sediment deposition which supported patches of grass (*Leersia hexandra*) and sedge (*Schoenoplectus decipiens*), but the marginal zone was mostly narrow and limited to sedges and waterfern (*Cyclosorus interruptus*) with overhanging shrubs (*Cliffortia strobilifera*). *Prionium serratum* was also present but only small pockets

here and there. Banks were either non-vegetated loose cobble or vegetated with mainly shrubs (*C. strobilifera*) and tall trees (*Podocarpus falcatus*). A flood terrace dominated by cobble/ boulder was terrestrial, mainly Fynbos species such as *Erica.*

Site impacts:

- Upstream Groendal Dam
- Limited impacts (conservation area – Groendal Nature Reserve)

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	6.65	7.88
EC (µS/cm)	205.8	211
TDS (g/l)	0.1634	0.172
DO (mg/l)	7.63	7.16
DO% (%)	76.7	74.3
Clarity (cm)	>1m	>1m
Temperature (°C)	15.5	17.01
Salinity (ppt)	0.12	0.13
Discharge (m^3/s)	0.069	0.096

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
September 2022				
32	15.8	B (Good)	11.6	1
Dominant Species	*Psammothidium oblongellum (Oestrup) Van de Vijver*			
Preferences	Tolerant of mild pollution only and pollution sensitive. This was the only site with **endemic species**: *Achanthes subaffinis Cholnok*. Its preference is slow flowing water and oligotropic streams			
May 2023				
26	16.1	B (Good)	20.9	3
Dominant Species	*Psammothidium oblongellum (Oestrup) Van de Vijver*			
Preference	Tolerant of mild pollution only and also pollution sensitive. This was the only site with endemic species: *Achanthes subaffinis Cholnok*. Its preference is slow flowing water and oligotrophic streams			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2	• Simple stable channel form	• Observations for low flow only
Fish	4	• Easily wadable • Slow-shallow, fast-shallow and slow-deep velocity depth classes represented. • Substrate, overhanging vegetation and instream vegetation cover classes well represented	• Site is not truly representative of downstream reach
Macroinvertebrates	4	• Relatively pristine site • SIC, SOOC, GSM and both marginal and instream aquatic vegetation biotopes present • Varying flow velocities • High clarity • DWS REMP Site code: M2KWAZ-VYEBO	• Upstream dam (flow modifications) • Major sand mining (although downstream from the site) and outside of the Groendal Nature Reserve
Riparian vegetation	3	• Both banks accessible • Reasonable range of riparian indicators • Largely unimpacted site	• Site does not represent downstream reaches in character
Geomorphology	2.5	• Fairly unimpacted site except for flow modifications	• Small overgrown system so aerial images can't be used to explore the reach and history

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Two observations for low flows
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records • Current two river survey (September 2022 and May 2023) • DWS REMP site
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: M2KWAZ-VYEBO
Hydrology						• Monthly natural and present day hydrology available
Geomorphology						• No aerial images or literature available

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1939 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity, diatom results. • NCMP water quality data- only one data entry from 1997, for site M1H001Q01. • 2022 diatom data • 2023 diatom data

** 0 (no information) to 4 (large amount of data available)*

Reference Conditions	
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla marmorata, Anguilla mossambica, Enteromius pallidus, Glossogobius callidus, Pseudobarbus afer, Sandelia capensis*
Macroinvertebrates	Porifera, Turbellaria, Oligochaeta, Hirudinea, Amphipoda, Potamonautidae, Atyidae, Paleomonidae, Hydracarina, Notonemouridae, Baetidae >2spp,

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
	Caenidae, Heptageniidae, Leptophlebiidae, Telagonodidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Lestidae, Platycnemidae, Protoneuridae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Polycentropodidae, Hydroptilidae, Leptoceridae, Pisuliidae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Ephydridae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Planorbinae, Thiaridae, Corbiculidae, Sphaeridae, Unionidae.
Riparian vegetation	This site occurs within the Albany Thicket Biome, Albany Thicket Bioregion, and the Sundays Mesic Thicket vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. Due to channel confinement, the marginal zone is expected to be narrow, scattered (riffle habitats) or absent (pool edges), dominated by non-woody grasses, sedges and broad-leafed forbs, but with a high level of overhanging woody vegetation resulting in longitudinal fragmentation due to shading. Where flood benches form, they are expected to be dominated by a mix of woody (mainly shrubs) and non-woody (mainly sedges and grasses) vegetation, but habitats along this feature are not expected to be extensive. In keeping with the Sundays Mesic Thicket vegetation type, the macro-channel banks are expected to be dominated by dense, short to tall woody vegetation including riparian, terrestrial and forest species.
Hydrology	Natural flows available for the period 1920 to 2009
Geomorphology	In its reference condition, the KwaZungu/Swartkops River site is likely to be a moderately steep boulder and cobble bed channel with pool-riffle or pool-rapid reach types. Pools should be similar in length or longer compared to riffles/rapids. Localised bedrock reaches can be present with anastomosing channels. Sand and gravel bars can be present in pools and along the margins of the riffles. Low levels of embeddedness would be expected along channel margins and along pools. Narrow inset benches and flood benches of sand and gravel could be present as a result of freshets and larger infrequent floods. The channel would be less overgrown with the bed and benches showing evidence of recently deposited sediment.
Physical-chemical	Historical data for the site was only n = 1. Diatom results were used to infer the reference Physical-chemical conditions at the site. The diatom results indicated good water quality free of organic pollution. Dominant taxa also indicated an oligotrophic system akin to natural conditions. The site has therefore experienced minimal change from reference conditions, especially being in a nature conservation area and with the dam acting as a contaminant sink upstream.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	D/E (41.6%)	F/NF	• Flow modification as a result of upstream impoundments

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Presence of non-native fish species *Clarias gariepinus, Oreochromis mossambicus* and *Tilapia sparrmanii* • Sand mining and urbanisation downstream limiting upstream migration from lower reaches
Macroinvertebrates (MIRAI)	C (73.8%)	F/NF (limited)	• Limited impacts • Some water quality issues owing to upstream developments and stresses. • Upstream Groendal Dam (Flow modification)
Riparian vegetation (VEGRAI)	B (82.4%)	F NF	Limited impacts: • The Groendal Dam upstream is likely to cause some flow regulation, altered flood frequency and duration, and reduced flood peaks. • Very limited AIP
Geomorphology (GAI)	C (74 %)	51 % flow related	• Reductions in freshets and flood flows driving geomorphological processes. • Starvation of bedload reducing the habitat diversity through the loss of inset benches, bank undercutting and bank steepening.
Hydrology (HAI)	D (42.2%)		All flow components impacted due to operation of upstream Groendal Dam to provide Algoa systems with water
Physical-chemical/Diatoms	B (16.0)	NF	• Mild pollution • Only site with endemic species: *Achanthes subaffinis Cholnok*. Its preference is slow flowing water and oligotrophic streams. • Site characterised by good quality waters, owing to its location in a conserved area. Expected impacts to this stretch of the river would arise from developments and the Groendal dam upstream.
ECOSTATUS (PES)	C (69.1%)		

Component: PES and causes	
	Causes Present/Absent
Fish	Habitat for fish within the reach of the Swartkops River within Groendal Nature Reserve was considered good, and supportive of a diverse native fish assemblage. However, significant sand mining within the channel of the river immediately downstream of the nature reserve is impacting upstream migration of fish species (particularly eels) from lower reaches, as is the urban and industrial areas of Uitenhage, thus limiting their occurrence within Groendal Nature Reserve. Several weirs within the system downstream of the nature reserve further contribute to the fragmentation of the system from a fish perspective. Upstream of the EWR site, Groendal Dam has resulted in flow modifications within the reach, while the presence of several non-native fish species including *Clarias gariepinus, Oreochromis mossambicus* and *Tilapia sparrmanii* was likely contributing to the largely to seriously modified state (Ecological Category D/E) of the fish assemblage, with some native species (*Pseudobarbus afer*) now occurring on the tributaries only. Some potential water quality impairment was also suspected based on observations made during the May 2023 field survey.

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	98.82	99.31
COVER	100.00	100.00
FLOW MODIFICATION	66.47	64.40
PHYSICAL-CHEMICAL	68.93	78.75
MIGRATION		67.85
FRAI	PRESENT	
FRAI (%)	41.6	
EC: FRAI	D/E	

Component: PES and causes

	Causes Present/Absent
Macroinvertebrates	At this site along the Swartkops River, a diverse range of biotopes were present, including SIC, SOOC, marginal vegetation, and GSM, although the mud biotope was limited. During the September 2022 and May 2023 surveys, a total of 21 and 18 taxa were recorded respectively. with a total of 40 recorded for the last hydrological year (May 2022 – May 2023). Overall, the aquatic macroinvertebrate community assemblage collected was determined to be representative of moderately modified conditions (Ecological Category C, 73.6%). The aquatic macroinvertebrate community present at this site mostly preferred moderate to low water quality, standing to slow flowing water, and cobbles. The other 30 expected taxa were absent from the site, although mostly with low frequency of occurrences. The exception being Hydropsychidae >2spp, which are sensitive to flow and water quality, and Gomphidae, which had high frequency of occurrences. Most notably, the novel appearance of Calopterygidae which was recorded in May 2023, and not previously observed at the site. This taxon prefers slow flowing water, vegetation, and moderate water quality. Philopotamidae was recorded in every survey since May 2022, except during the survey conducted in May 2023. This taxon prefers fast flowing water, cobbles, and moderate water quality. Chlorocyphidae were recorded during both surveys and have a preference for slow flowing water, cobbles, and moderate water quality. Benthic algae were more noticeable during the May 2023 survey, supporting the moderately modified state of the water quality. Overall, the macroinvertebrate community appear to be indicating some water quality impairments and should flows increase to >0.6m/s, several additional macroinvertebrates expected for this reach could colonise.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	82.4	*0.328*	26.9976	2	95
HABITAT	H	73.3	*0.310*	22.7586	3	90
WATER QUALITY	WQ	65.6	*0.345*	22.6348	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.017*	1.37931	4	5
						290
INVERTEBRATE EC				73.7704		
INVERTEBRATE EC CATEGORY				C		

Overall, the community was primarily driven by water quality (65.6%) (perhaps owing to limited flows flushing the system and algae, compromising the water quality, habitat (73.3%), and flow modification (82.4%). The ASPT for the communities identified in September 2022 and May 2023 was 5.8 and 5.7, respectively, indicating that the community was mostly comprised of tolerant taxa (Dickens and Graham, 2002).

Riparian vegetation

The marginal zone was narrow, confined and bedrock dominated (cobble/ boulder/ bedrock). Narrow and fragmented vegetation was dominated by non-woody vegetation (grasses, sedges and broad-leafed forbs) with extensive overhanging woody vegetation, mostly shrubs (*Cliffortia strobilifera, Searsia lucida*). Pool habitats had little marginal zone vegetation, but with overhanging woody shrubs and an aquatic component (*Nymphaea nouchali*). Scattered clumps of Palmiet (*Prionium serratum*) also occurred in places. The few sediment depositional areas that there were, were well vegetated by non-woody vegetation (*Leersia hexandra,Schoenoplectus decipiens,Cyclosorus interruptus*). Other common species included *Cyperus textilis, Miscanthus ecklonii,* and *Persicaria madagascariensis*. Alien plant species were absent. Flood benches were narrow or absent, with overhanging woody vegetation shading out non-woody vegetation, or open sunspot areas, well covered by grasses and tall sedges. Dominant species included *L.hexandra, S.decipiens, C.textilis, C. strobilifera* and alien species were absent. The channel bank was either a loose cobble/ boulder bank with scattered shrubs or a consolidated alluvial bank with shrubs and tall trees. Banks were dominated by woody vegetation, with extensive overhanging and shading of the flood benches and marginal zone. Dominant species included *Afrocarpus falcatus, Erica caffra var. caffra, Euclea divinorum, Olea europaea subsp. africana, Searsia lancea, Vachellia karroo* and a few alien individuals were found (*Grevillea robusta* and *Rubus fruticosus*). Some localised bank erosion was also prevalent.

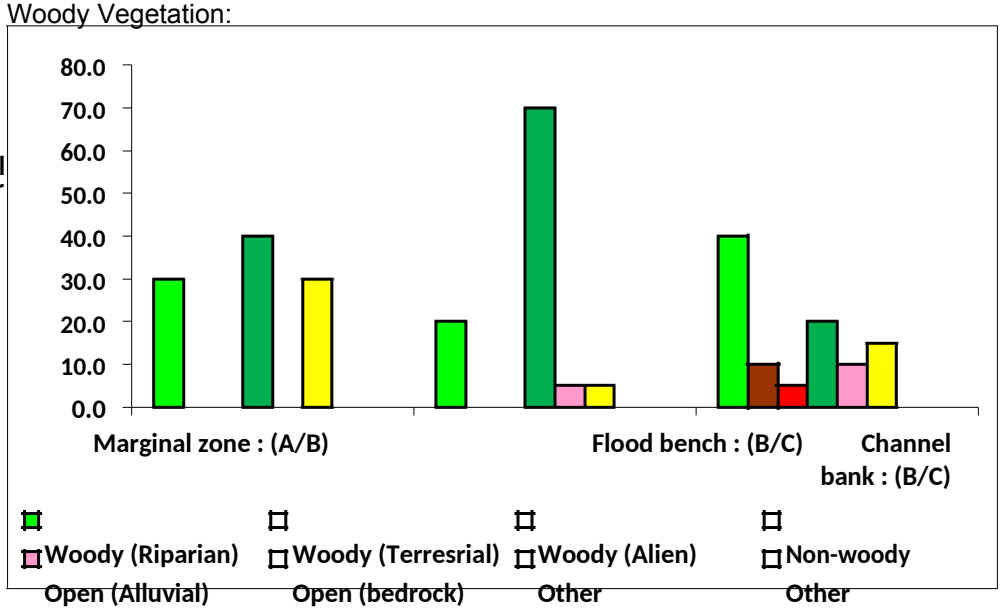
Overall PES:

LEVEL 4 ASSESSMENT	**Swartkops_SWART01_I**					**06 May 2023**
RIPARIAN VEGETATION ECMETRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal zone	87.9	10.1	3.3		11.5	Weighted according to extent
Flood bench	81.1	21.8	3.4		26.9	Weighted according to extent
Channel bank	81.9	50.4	2.3		61.5	Weighted according to extent
LEVEL 4 VEGRAI (%)						82.4
VEGRAI Category	**Ecological**					**B**
AVERAGE CONFIDENCE						3.0
	Sub-zone					
	Marginal zone	**Flood bench**	**Channel bank**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	87.9	81.1	81.9	not assessed	not assessed	not assessed
EC (Zone)	**A/B**	**B/C**	**B/C**			
Confidence (Zone)	3.3	3.4	2.3			

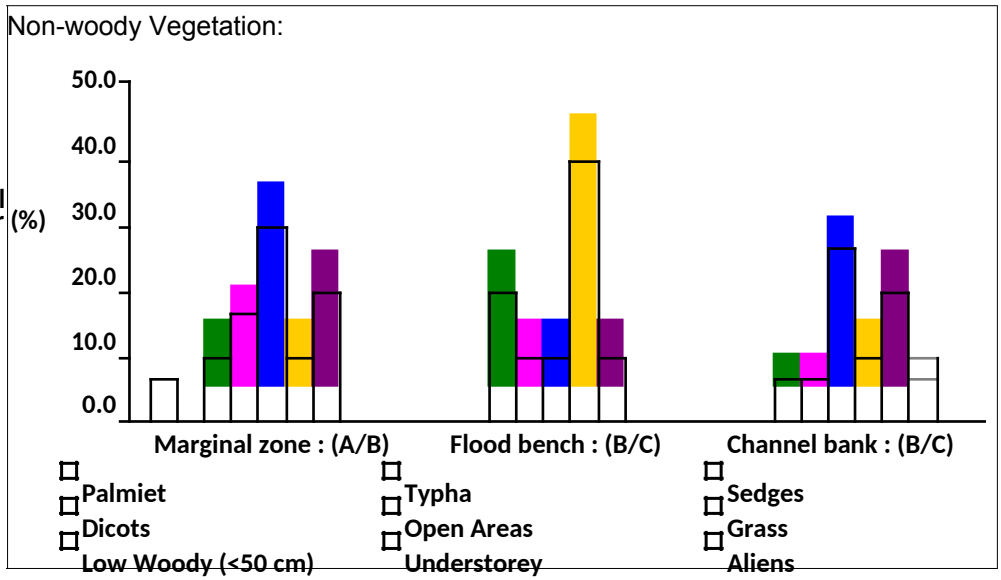
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

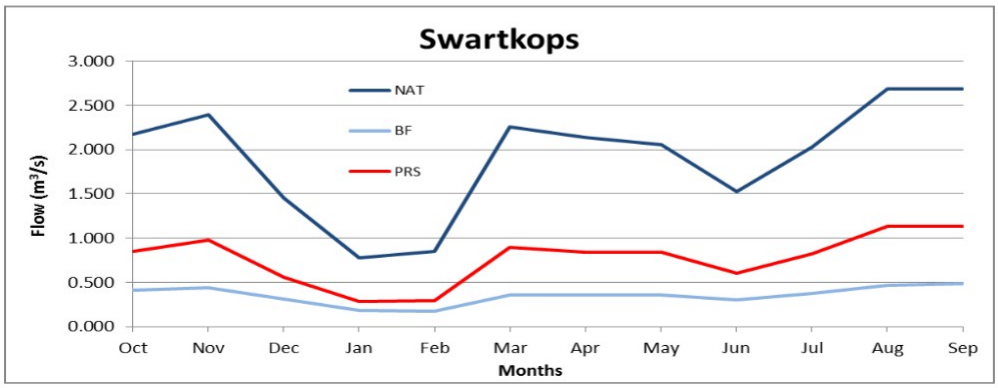


Component: PES and causes

Causes Present/Absent

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	Rank	%wt	RATING	CONFIDENCE
LOW FLOWS	2.00	90.00	4.00	3.00
ZERO FLOW DURATION	1.00	100.00	1.00	3.00
SEASONALITY	2.00	80.00	2.00	3.00
MODERATE EVENTS	2.00	85.00	4.00	4.00
EVENT HYDROLOGY(HIGH FLOWS-FLOODS)	4.00	60.00	4.00	2.00
HYDROLOGY SCORE	42.17			
HYDROLOGY ECOLOGICAL CATEGORY	D			



Component: PES and causes	
	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Swartkops River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment. The floods and freshets have been eliminated by the Groendal Dam and bedload has been trapped, resulting in erosional processes dominating the site. Flow manipulation reduces the variability of flows, resulting in a channel with low geomorphic diversity. Incision is possibly enhanced by downstream gravel mining.

FINAL DRIVER STATUS GEOMORPHOLOGY	*This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.*						
SCORING GUIDELINES							
GEOMORPHOLOGY DRIVERS							
COMPONENTS	**RANK**	**RELATIVE WEIGHTING (%)**	**RATING**	**WEIGHT**	**WEIGHED SCORE**	**FLOW RELATED**	**CONFIDENCE**
System Connectivity	1.00	100.00	2.43	0.43	1.06	65.36	3.21
Sediment balance	2.00	70.00	0.65	0.30	0.20	29.00	3.00
Bed & bank stability	3.00	60.00	0.11	0.26	0.03	54.55	3.00
TOTALS		230.00		1.00	1.28		
System Driver status:							
Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F					74.33		
HABITAT DRIVER CATEGORY					C	51.47	3.09
					WEIGHED SCORE	**FLOW RELATED**	**CONFIDENCE**
Morphological change					1.44	71.11	3.00
HABITAT CHANGE STATUS					71.11111		
HABITAT CHANGE CATEGORY					C		

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Decline/Stable	• Non-native fish species collected during May 2023 represent the first records of non-native fish within the reach according to results obtained during DWS REMP studies	3
Macro-invertebrates	Stable	• Flows, water quality and habitat continue to be relatively intact. • No new developments upstream.	3
Riparian vegetation	Stable	• Few impacts • A single individual of the *alien Rubus fruticosus* was found, could increase in time if unchecked but removal of aliens with the nature reserve seems to be taking place	4

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Hydrology	Stable	• No new water resource developments	3
Geomorphology	Stable	• The site has adapted to the reduced flows and sediment input	3
Physical-chemical	Stable	• Factors influencing the physical-chemical state of the systems at this reach have remained relatively the same over time.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR DEVIATION
ECOSTATUS	D	C	• Driven by the fish component (D/E category): • Downstream sand mining (major channel modification) resulting in a migration barrier for the Eels needing to move upstream. • Non-native fish species presence (CGAR, OMOS, TSPA)

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, High

Physical-chemical state of the system
In situ water quality results suggested good physical-chemical state. DO% concentrations slightly lower, likely as a result of minimal primary productivity/algal activity and reduced flows/less air-water mixing as a result of flow regulation by the dam upstream. High clarity/visibility suggesting low suspended solids. Low nutrient concentrations are also expected to prevail in the system.

Status (PES)		
C	B/C	• Albany Alluvial Vegetation is located downstream of the site near to the sand mining activities taking place. This vegetation type is a threatened ecosystem and is categorised as Endangered. It is further narrowly distributed, placing the ecosystem type at risk of collapse. Protection of this reach is vital for the upkeep of this vegetation type; • F and NF: **A directive should be issued from DWS as a matter of urgency to the polluters responsible for the illegal sand mining within the Swartkops channel just outside of the Groendal Nature Reserve**. Major rehabilitation effort will be required along this reach in order to improve the hydrology (flow), water quality, and overall improving the ecosystem functioning and associated instream biotic health and integrity, to ultimately meet the REC; and • Although this SQR only a small portion of this SQR is located within the Groendal Nature Reserve – the fact that the EWR site is located on this

Status (PES)	
	portion, DWS have a responsibility to ensure the protection of this nature reserve and its associated conservation.

OVERALL ASSESSMENT

Table 5-10: Overall EcoStatus assessment for SWAR01_I (Swartkops)

River	Swartkops
EWR Site Code	**SWAR01_I**
Driver component	**PES**
HAI	D
Diatoms	
GAI	C
Response component	**PES**
FRAI	D/E
MIRAI	C
VEGRAI	B
Ecostatus	**C**
EI	Moderate
ES	High
REC	B/C

The overall EcoStatus for this EWR site was categorised as a C, thus the system is in a moderately modified condition, with loss and change of natural habitat and biota have occurred in terms of frequencies of occurrence and abundances (**Table 5-10**). The catchment is in a fairly natural condition, with localised changes to hillslope-channel connectivity and suspended sediment loads. The Groendal Dam upstream trap a large portion of the coarser bedload, reducing the extent of gravel and cobble bars and driving channel incision. Flood flows are reduced, leading to a stable channel with infrequent reset events to renew habitats. Gravel mining downstream is possibly driving the channel incision and associated bank erosion.

Habitat at this EWR site was regarded as good for both the fish and macroinvertebrates. However, sand mining activities and urban/industrial areas, downstream of Groendal Nature Reserve, flow modification as a result of Groendal Dam as well as the presence of several non-native fish species, is impacting significantly on the native fish diversity within the reach. Owing to the mentioned good biotope availability and hydraulic conditions, the macroinvertebrate community remained representative of good flow and habitat availability (sensitive taxa recorded), with selected taxa being an indicator of water quality deterioration (perhaps owing to limited flows flushing the system and algae). The riparian vegetation at this site is in a near-natural state with few impacts, mainly related to the upstream dam and a few alien plant individuals along flood features.

It is suggested that both the REC can be improved to a category B/C (clos to largely natural most of the time), should the proposed mitigation measures/recommendations be assessed and applied (**Table 5-10**).

RECOMMENDATIONS

- Refer to Chapter 10.1 for general recommendations;
- Any future land use activities within upstream catchment should be managed to prevent degradation of the ecological health of the system and deterioration of the water quality (buffer zones to be implemented for future proposed developments);
- Alien weed infestation eradication implementation programme within the nature reserve; and
- Ensure compliance enforcement is followed through regarding the illegal downstream sand and gravel mining located just downstream of the EWR site. A study of the geomorphological effect of the gravel mining on the incision of the river should be considered by one of the local universities.

5.11 GAMT01_I: Gamtoos River

Sample Date	25 September 2022	**Reserve Level Assessment**	Intermediate
Site Name	GAMT01_I	**IUA**	IUA_KL01
River	Gamtoos	**IUA description**	Kromme from KrommeDam to estuary and Gamtoos
Altitude (m.a.s.l.)	74	**Prioritised RU**	R_RU02_I
Latitude	-33.760983	**Longitude**	24.693677
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L90A
Level 2 EcoRegion	19.02	**SQ Reach**	L90A-08877
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, VEGRAI, *in situ* water quality, diatoms, cross-section, re-measurements of slope and water levels, discharge, geomorphology

MAP ILLUSTRATION (Figure 5-21) AND SITE PHOTOGRAPHS (Figure 5-22)

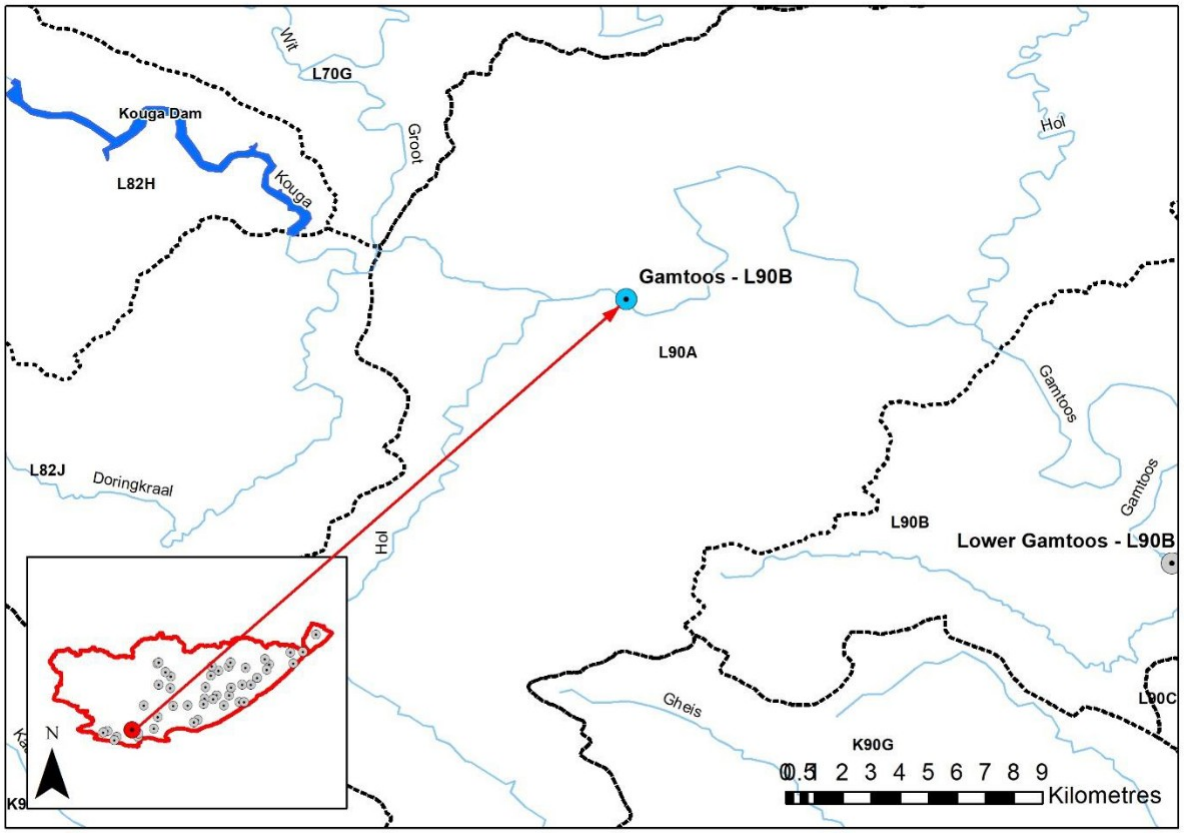


Figure 5-21: Location of site GAMT01_I (Gamtoos) in relation to the study area

Site Photographs: Survey 1 (September 2022)







Site Photographs: Survey 2 (May 2023)







Figure 5-22: Site photographs of the Gamtoos EWR site

Site Description:

The site is located roughly 10 km in an upstream direction from Patensie and 10 km downstream of the Kouga Dam (both straight line distances).

The site is located in an unconfined valley setting with a single channel and floodplain along both banks. The valley floor is composed of cobbles, boulders and gravel with a fairly shallow channel. Inset benches and shallow flood channels are present. Terraces and alluvial fans are common along the valley floor and buffer the channel from the steep hillslopes. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by boulder, cobble, gravel and sand sediment types. The floodplain, banks and benches are composed of boulder, cobble, gravel and sand, with bedrock cliffs or steep hillslopes along parts of the outer bends. The

channel margins and flood features are vegetated with small shrubs and sedges. Grazing and trampling takes place along the banks and floodplain. Undercut banks and bank erosion is fairly uncommon at the site and the bed along the riffle and pools have a moderate level of embeddedness. A silt drape is present across coarser sediment in slow flowing habitats, such as pools.

During the May 2023 survey, flow conditions were zero. The water had pooled upstream of the low water bridge, with zero flow and limited water downstream of the bridge. Consequently, macroinvertebrates were not sampled. The rest of the components were conducted.

Biota habitats available
During the September 2022 survey, all biotopes for aquatic macroinvertebrate habitats were available. In September 2022 and May 2023, fish habitats included FS, SD, SS and SS and SD respectively.

Riparian vegetation
The site has a gentle lateral slope and was dominated by non-woody vegetation across all zones, with high aerial cover. Vegetation comprised mainly sedges (notably *Cyperus* textilis) and grasses (mainly *Ischaemum fasciculatum*) with scattered shrubs. The presence of *Typha capensis* and extensive filamentous green algae suggests elevated nutrients in the system. Flow was almost absent with only a trickle remaining, but an aquatic component persisted (*Potamogeton pusillus*) in pooled areas. *Cyperus textilis* had increased in density and extent since the first visit and had encroached to within the main channel. Alien species cover was moderate to high in other areas, mainly *Sesbanea punicea* and *Senna didymobotrya.*

Site impacts:

- Cattle trampling and grazing
- Low water bridge
- Citrus farming
- Irrigation
- Return flows
- Nutrients (high algae content)
- Alien invasive vegetation within the riparian zone (peanut butter cassia)

SUMMARY RESULTS

WATER QUALITY AND DISCHARGE

In situ water quality:

Parameter	Survey 1 (September 2022)	Survey 2 (May 2023)
pH	7.87	8.25
EC (µS/cm)	939	829
TDS (g/l)	0.707	0.578
DO (mg/l)	8.97	12.09
DO% (%)	94.9	136.4
Clarity (cm)	43	Approx. 10
Temperature (°C)	17.8	21.4
Salinity (ppt)	0.54	0.44
Discharge (m^3/s)	0.06	0.00

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
September 2022				
15	17.6	A (High)	0	1.25
Dominant Species	*Achnanthidium minutissimum (Kützing) Czarnecki*			
Preferences	Found in well-oxygenated, clean, fresh waters. Usually attached to a substratum by a short mucilage stalk.			
May 2023				
34	9.1	C (Moderate)	9.5	0
Dominant Species	*(1) Navicula recens (Lange-Bertalot) Lange-Bertalot*			
	(2) Nitzschia forfica Cholnoky			
Preference	(1) Cosmopolitan species, found in large eutrophic rivers with elevated electrolyte content, also found in brackish waters. Tolerant to critical levels of pollution.			
	(2) Not much known about his species but assumed to be associated with high EC (per comms Dr Jonathan Taylor)			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	1.5	• Simple channel form • Easy access	• Near low water bridge • 1 flow observation
Fish	3	• Easy access • Slow-deep and slow-shallow velocity-depth classes represented	• Reach below deep pool likely dry much of the year
Macroinvertebrates	4	• SIC, SOOC, GSM and both marginal and instream aquatic vegetation biotopes present • Varying flow velocities • DWS REMP Site code: L9GAMT-PATEN	• Low water crossing bridge (flow modifications) • Extensive citrus farming adjacent to the water resource
Riparian vegetation	3	• Reasonable representation by riparian indicators	• Vegetation response to low level crossing high due to upstream pooling and elevated sediments downstream
Geomorphology	3	• Reasonable range of morphological features and sediment types	• Increased impacts at the site due to the low water crossing • Steep section at the site that is less representative of the reach

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• A single flow observation (high flow survey had no flow)
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current two river survey (September 2022 and May 2023)
Macroinvertebrates						• Current two river survey (September 2022 and May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: L9GAMT-PATEN
Hydrology						• Monthly natural and present day hydrology
Geomorphology						• Historical and recent aerial images
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Historical anecdotal information on the vegetation of the area from early (around 1800's or earlier) explorers. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • South African National Biodiversity Institute (SANBI) online distribution data of plant species. • Google Earth © & Bing satellite imagery. • Historical aerial photographs: 1969 • Hydraulic rating curves and lookup tables for each site. • Hydrology: Natural and observed data (various weirs). • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Regional Conservation Plans (Eastern Cape Province Map of Critical Biodiversity Areas and Ecological Support Areas, 2007) • Level 1 and 2 Ecoregions. • NSBA map of alien plant species probability. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area • South Africa Protected Areas Database (SAPAD_OR_2022_Q4)
Diatoms						• Current two river survey (September 2022 and May 2023)

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Physical-chemical						• Current surveys (September 2022 and May 2023) only measured *in situ* water quality and clarity. • 2022 diatom results. • 2023 diatom results.

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Fish	*Anguilla marmorata, Anguilla mossambica, Enteromius pallidus, Gilchristella aestuaria, Glossogobius callidus, Monodactylus falciformis, Mugil cephalus, Pseudomyxus capensis, Labeo umbratus*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Amphipoda, Potamonautidae, Paleomonidae, Hydracarina, Notonemouridae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Telagonodidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Lestidae, Platycnemidae, Protoneuridae, Aeshnidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Corydalidae, Sialidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Polycentropodidae, Psychomyiidae, Barbarochthonidae, Glossosomatidae, Hydroptilidae, Lepidostomatidae, Leptoceridae, Pisuliidae, Sericostomatidae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Empididae, Ephydridae, Muscidae, Psychodidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Physidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae.
Riparian vegetation	This site occurs within an Azonal Vegetation Biome, Alluvial Vegetation Bioregion, and the Albany Alluvial Vegetation type (Mucina & Rutherford, 2018). Two major types of vegetation pattern are observed in these zones, namely riverine thicket and thornveld (*Vachellia natalitia*). The riverine thicket tends to occur in the narrow floodplain zones in regions close to the coast or further inland, whereas the thornveld occurs on the wide floodplains further inland. The reference state along the marginal zone is expected to be dominated by non-woody vegetation as it currently is, perhaps less dense due to natural grazing and shading by woody species, and with less filamentous algae. The reference state along the flood bench is expected to be the same as the marginal zone reference state, but with a woody component, notably *Salix mucronata*, which was absent at the site. The channel bank vegetation is expected to be in keeping with the azonal vegetation unit i.e., dominated by woody riverine thicket.
Hydrology	Natural flows for the period 1920 to 2009 available
Geomorphology	In its reference condition, the Gamtoos River site is likely to be a moderately steep to gentle cobble and boulder bed channel with pool-riffle reach types. Pools would be much longer compared to riffles. Sand and gravel bars can be present in pools and along the margins of the riffles, but lower levels of embeddedness and silt cover would be expected. Narrow inset benches and flood benches/flood plain of sand and gravel could be present as a result of freshets and larger infrequent floods.

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Physical-chemical	No reference data could be obtained for the site. Diatom results were used infer the reference condition at the site. The diatom results indicated water quality in natural conditions. The Physical-chemical conditions recorded during the study are, therefore, expected to be similar to those recorded under reference conditions i.e.,, well oxygenated and low nutrient concentrations.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish (FRAI)	D (45.5%)	F/NF	• Presence of several non-native fish species, including *Oreochromis mossambicus, Tilapia sparrmanii, Pseudocrenilabrus philander, Clarias gariepinus* and *Cyprinus carpio* • Flow modification as a result of the upstream Kouga Dam • Runoff from surrounding and upstream citrus industry likely resulting in some water quality impairment
Macroinvertebrates (MIRAI)	D (42.1%)	F/NF	• Upstream Kouga Dam mostly for irrigation and domestic use (flow modifications) • Extensive citrus farming, irrigation and domestic use all contributing to the water quality issues. • High nutrient input observed filamentous algae coverage over SIC biotope. • High sediment concentrations over SOOC biotope • Low lying water bridge (flow modifications)
Riparian vegetation (VEGRAI)	D (54.4%)	F F/NF NF	• Influenced by the Kouga Dam upstream which is likely to cause some regulation, altered flooding frequency and duration and reduced flood peaks. There are also return flows from citrus irrigation which would elevate low flows. • Nutrients appear elevated due to thick and extensive filamentous green algae. • Removal of vegetation for access roads paths and trampling pressure, also agricultural encroachment quite extensive since 1969 • AIP: *Senna didymobotrya, Sesbanea punicea, Arundo donax* and annual weed species
Geomorphology (GAI)	C (76 %)	35 % flow related	• Low intensity grazing and localised erosional features in the catchment increasing surface erosion. • Kouga Dam ~15 km upstream, trapping significant volumes of bedload and high flows. • Livestock grazing and trampling along the banks destabilize the geomorphic features at the site. • Coarse particles are embedded and a silt drape is present in low velocity biotopes due to high suspended sediment concentrations.
Hydrology (HAI)	D (53.3)		All flow components impacted by operation of dam upstream

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Physical-chemical/ Diatoms	B (13.4)	NF	• Water quality likely impacted on by irrigation return flows. • Diatom suggest eutrophic waters with elevated electrolyte content.
ECOSTATUS (PES)	D (48.6%)		

Component: PES and causes	
	Causes Present/Absent
Fish	The larger system was noted to support several large pool features which are likely to act as a refuge for fish species during drier periods of the year, only of which was noted immediately upstream of the selected cross section. During the September 2022 field survey, water was noted to be flowing within the system, although water levels were considered to be low. During the May 2023 field survey however, flow within the system had ceased, with the pool habitat providing the only available habitat for fish species present. The fish assemblage was however noted to be dominated by non-native fish species, including *Oreochromis mossambicus, Tilapia sparrmanii* and *Pseudocrenilabrus philander*, with *Clarias gariepinus* and *Cyprinus carpio* also likely to be present. Consequently, the fish assemblage was noted to be largely modified (Ecological Category D), with native fish species generally occurring at a lower frequency of occurrence than expected.

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	95.52	88.62
COVER	100.00	91.31
FLOW MODIFICATION	54.58	54.66
PHYSICAL-CHEMICAL	62.08	59.16
MIGRATION		75.00
IMPACT OF INTRODUCED		100.00
FRAI	PRESENT	
FRAI (%)	45.5	
EC: FRAI	D	

Component: PES and causes

	Causes Present/Absent
Macroinvertebrates	A successful Intermediate survey was conducted in September 2022 for the Gamtoos River. However, due to the absence of flow conditions in May 2023, the survey of aquatic macroinvertebrates could not be conducted. This river system is relatively unstable and experiences fluctuating conditions such as flow, no flow, or dry conditions. This is primarily due to extensive abstraction and irrigation for the surrounding Citrus farming. In May 2023, the site was pooled just upstream of the low water bridge, with minimal flow downstream with much overgrown sedges in the channel, and thick algae smothering the muddy substrate. In September 2022, the site was dominated by GSM, SOOC, some SIC, marginal, and in-stream aquatic vegetation. A total of 17 macroinvertebrates were recorded in September 2022, with a total of 18 recorded for the last hydrological year (May 2022 – May 2023). The aquatic macroinvertebrate community assemblage collected was found to be representative of largely modified conditions (Ecological Category D, 42.1%). This indicates a significant change or loss of natural habitat, biota, and basic ecosystem functions along this reach. The aquatic macroinvertebrate community representing this reach have a preference for low to very low water quality, standing water, and cobbles. Only 1 sensitive taxa was recorded at this site which was Baetidae >2spp. The 17 other taxa expected, with a high frequency of occurrence, but which were absent from the site during the last hydrological year had a preference for mostly cobbles, moderate water quality, and fast to very fast flowing water (the 2 former metrics being absent from this reach). The sensitive taxa absent from the site included Chlorocyphidae and Hydropsychidae >2spp, with moderate and high requirements for unmodified water quality, and which prefer slow and very fast flowing water, respectively. Therefore, it appears that the observed macroinvertebrate assemblage is indicative of impaired water quality and slow flow conditions. If these conditions improve, several expected macroinvertebrates for this reach could colonize the area.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	38.0	*0.357*	13.5831	1	100
HABITAT	H	46.4	*0.304*	14.0944	3	85
WATER QUALITY	WQ	40.5	*0.321*	13.0263	2	90
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.42857	3	5
						280
INVERTEBRATE EC				42.1324		
INVERTEBRATE EC CATEGORY				D		

Overall, the community was primarily driven by flow modification (38.0%), water quality (40.5%) and habitat modification (46.4%). The ASPT for the communities identified in September 2022 was 3.8, indicative of the community being mostly very tolerant taxa (Dickens and Graham, 2002).

Riparian vegetation

The marginal zone along this seasonal channel was narrow and overgrown by sedges, this being the dominant vegetation type and species (*Cyperus textilis*), but also with grasses (*Ischaemum fasciculatum*) and a small aquatic (*Stuckenia pectinatus, Potamogeton schweinfurthii*) and bullrush (*Typha capensis*) component upstream due to pool habitats. The zone was bedrock dominated, mainly gravel, cobble and boulder, but with sediment deposition along the edges. Vegetation cover was high, broadleaf marginal zone obligates were represented (*Cotula nigellifolia, Persicaria madagascariensis*) and filamentous algae was abundant and dense. The flood bench was fairly impacted, gentle sloping with woody and non-woody vegetation, high aerial cover, but with a high prevalence of alien species and access disturbance. Dominant habitats along the flood benches were a cobble/boulder bench with trapped fine sediments and a high-flow channel. The zone was dominated by non-woody vegetation, mainly sedges (*C. textilis*), but with some reeds (*Phragmites australis*) and a high degree of alien invasive species (*Pennisetum clandestinum, Ricinus communis, Schkuhria pinnata, Senna didymobotrya,Sesbania punicea, Xanthium strumarium*). The macrochannel bank was predominantly well vegetated, but with low stature, mixed bedrock and upland soil, gently sloping and highly disturbed. Vegetation was dominated by non-woody species (*P. australis, C. textilis*) but also with a low shrub, mainly alien component (*Senna didymobotrya, Sesbanea punicea, Arundo donax* and annual weed species).

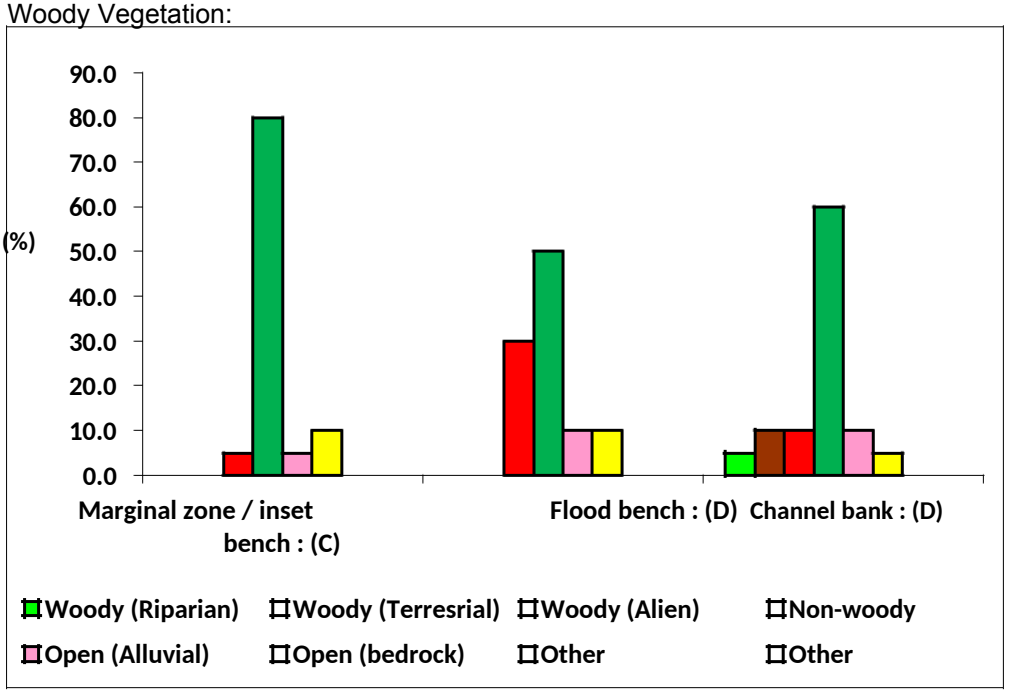
Overall PES:

LEVEL 4 ASSESSMENT	**Gamtoos_GAMT01_I**					**05 May 2023**
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**	**Notes:**
Marginal zone / inset bench	70.2	26.3	3.3		37.5	Weighted according to extent
Flood bench	42.9	10.7	3.2		25.0	Weighted according to extent
Channel bank	46.4	17.4	2.6		37.5	Weighted according to extent
LEVEL 4 VEGRAI (%)						54.4
VEGRAI Category	**Ecological**					**D**
AVERAGE CONFIDENCE						3.0
	Sub-zone					
	Marginal zone/ inset bench	**Flood bench**	**Channel bank**	**0.0**	**0.0**	**0.0**
VEGRAI % (Zone)	70.2	42.9	46.4	not assessed	not assessed	not assessed
EC (Zone)	**C**	**D**	**D**			
Confidence (Zone)	3.3	3.2	2.6			

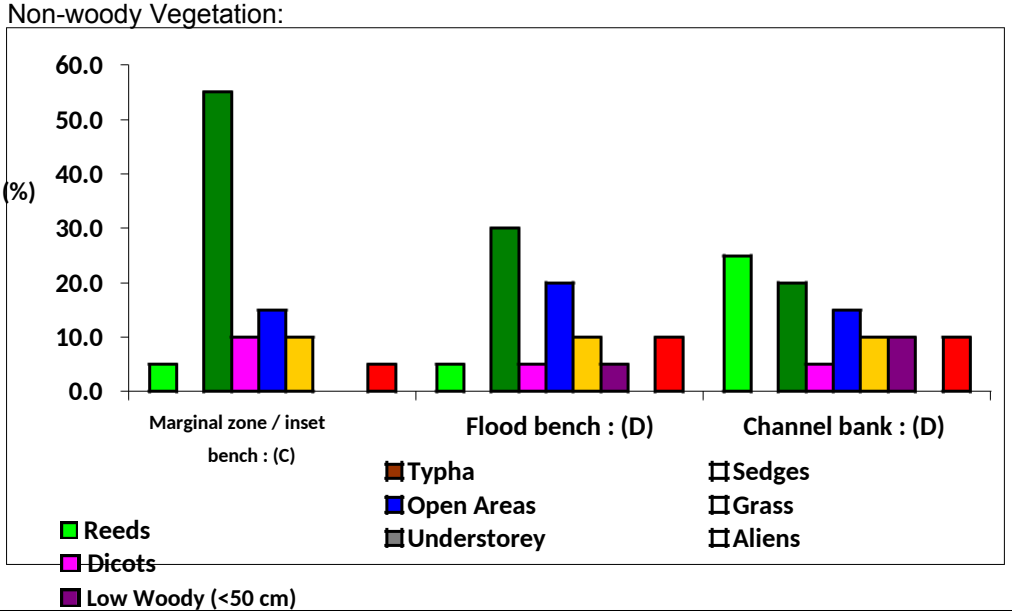
Component: PES and causes

Causes Present/Absent

Woody Vegetation:



Non-woody Vegetation:

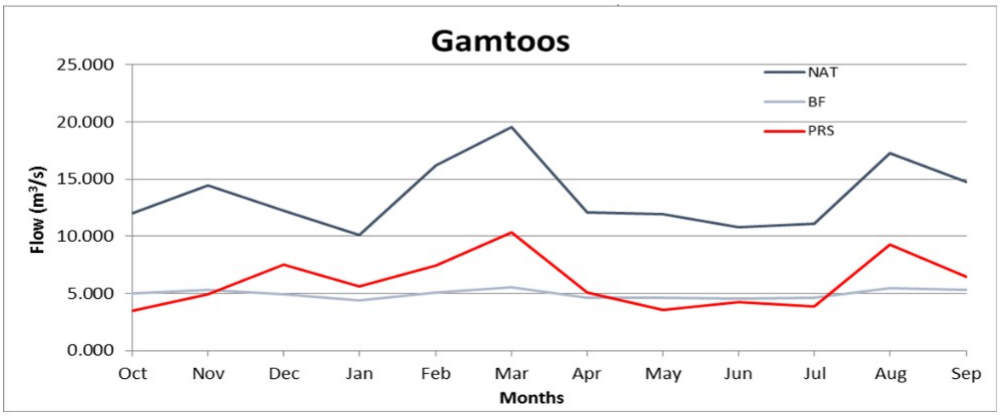


Component: PES and causes

Causes Present/Absent

Hydrology

HYDROLOGY DRIVER ASSESSMENT INDEX				
HYDROLOGY METRICS	**Rank**	**%wt**	**RATING**	**CONFIDENCE**
LOW FLOWS	2.00	90.00	4.00	3.00
ZERO FLOW DURATION	1.00	100.00	1.00	2.00
SEASONALITY	2.00	85.00	0.00	3.00
MODERATE EVENTS	3.00	80.00	4.00	3.00
EVENT HYDROLOGY (HIGH FLOWS-FLOODS)	4.00	75.00	3.00	2.00
HYDROLOGY SCORE	**53.26**			
HYDROLOGY ECOLOGICAL CATEGORY	**D**			
BOUNDARY EC				



Component: PES and causes	
	Causes Present/Absent
Geomorphology	The broad geomorphology, as classified by the geomorphic zone, of the Gamtoos River has not changed due to anthropogenic influence. There have however been changes to the drivers in terms of connectivity, sediment supply from the catchment and pressures at the site. The Kouga Dam traps coarse bedload, reducing the extent of coarse sediment habitat along the reach. High flows are less frequent, leading to a partly contracted channel. Low basal cover and increased hillslope-channel connectivity (gullies, rills and roads, etc.) have increased the erosion of soil and delivery of sediment from the catchment. This results in increased fine bedload and suspended sediment loadings. The increased concentrations lead to fine sediment deposition on coarser substrates, degrading the available coarser habitats. Erosion associated with the low water crossing, trampling and frequent grazing by livestock along the banks destabilize and erode the geomorphic features at the site.

FINAL DRIVER STATUS GEOMORPHOLOGY

This model (GAI level IV) is designed for specialist use by trained, experienced geomorphologists, for the purposes of determining the PES and geomorphic drivers of monitoring sites. Although the data/information driving this model will assist in Reserve studies, additional ESSENTIAL data are required for flow determinations.

SCORING GUIDELINES

GEOMORPHOLOGY DRIVERS

COMPONENTS	RANK	RELATIVE WEIGHTING (%)	RATING	WEIGHT	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
System Connectivity	1.00	100.00	1.37	0.42	0.57	59.33	2.92
Sediment balance	2.00	80.00	1.15	0.33	0.38	16.00	2.90
Bed & bank stability	3.00	60.00	1.00	0.25	0.25	18.64	3.05
TOTALS		240.00		1.00	1.20		

System Driver status:

Driver status:(%): >89=A; 80-89=B; 60-79=C; 40-59=D; 20-39=E; <20=F	75.94		
HABITAT DRIVER CATEGORY	C	34.71	2.94

	WEIGHED SCORE	FLOW RELATED	CONFIDENCE
Morphological change	1.56	28.89	2.50
HABITAT CHANGE STATUS	68.88889		
HABITAT CHANGE CATEGORY	C		

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Stable	• Drivers are expected to have remined unchanged within the system	3
Macroinvertebrates	Stable	• Reduced flows and at times, the system downstream of the low water bridge dries up. • Catchment pressures on water quality (irrigation and return flows)	3
Riparian vegetation	Decline	• Several of the alien plant species at the site are invasive and can increase if left unchecked, such as *Arundo donax, Sesbanea punicea* and *Senna didymobotrya.*	3

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Hydrology	Stable	• No recent water resource developments	2
Geomorphology	Stable	• The system has adapted to the reduced flow, reductions in bedload and high silt loads.	2.5
Physical-chemical	Stable	• Factors influencing the physical-chemical state of the systems at this reach have remained relatively the same over time.	3
ECOSTATUS (PES)			

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR DEVIATION
ECOSTATUS	C	D	• Driven by all components (fish, macroinvertebrates and riparian vegetation): • Cover features and velocity depth classes have all decreased for the fish • Non-native fish species (OMOS, TSPA, PPHI, CCAR, CGAR) • Highlydisturbedsite, high agricultural encroachment • High AIP throughout the riparian zone • Macroinvertebrate community primarily driven by a combination of flow modification and water quality impairment.

Revised Ecological Importance and Ecological Sensitivity	
EIES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
In situ water quality results suggested good physical-chemical state. Diatom results do however suggest that elevated electrolyte and nutrient concentrations in the system, likely as a result of the agricultural irrigation return flows.

D	D	• Maintain the EcoStatus as a D owing to this system being a hard-working river system (socio-economic, irrigation for extensive citrus farming); • F: Possible release for irrigation into the river for abstraction lower downstream. • NF: Need to continually ensure water quality is managed to not decrease the current category, as a result of the return flows (nutrients) – ensure river buffer zones are adhered to; and • NF: Clearing of the AIP within the riparian zone.

OVERALL ASSESSMENT

Table 5-11: Overall EcoStatus assessment for GAMT01_I (Gamtoos)

River	**Gamtoos**
EWR Site Code	**GAMT01_I**
Driver component	**PES**
HAI	D
Diatoms	C
GAI	C
Response component	**PES**
FRAI	D
MIRAI	D
VEGRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

The overall EcoStatus for this EWR site was categorised as a D, thus the system is in a largely modified condition (**Table 5-11**). The degradation of the catchment is elevating suspended sediment loads leading to higher turbidity and silt deposits over coarser habitats, while the Kouga Dam upstream trap a large portion of the coarser bedload, reducing the extent of gravel and cobble bars. Flood flows are reduced, leading to a partly contracted channel with infrequent reset events to renew the habitats. At the site, disturbance along the margins, trampling, removal of biomass, woody encroachment is widespread leading to degradation of the habitat associated with bars, benches and banks.

The macroinvertebrate community was driven by a combination of flow (as at times the reach dries up should abstraction rates be too high), water quality (high algae content) and habitat modification (pooled upstream of the low water bridge and at times dry downstream of the bridge). Overall, the community was largely modified. The riparian vegetation at this site has been highly disturbed with easy access by people and livestock and clear encroachment by agricultural activities. Vegetation clearing and use is widespread, flow have been reduced and invasive alien species occur.

It is suggested that a REC remain unchanged and maintained as a D category (largely modified) (**Table 5-11**). This is owing to this system being a hard-working river system (socio-economic, irrigation for extensive citrus farming).

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Catchment management to improve basal cover and reduce soil erosion;
- Release higher flows to scour fine sediment from pools and coarse sediment habitat;
- Avoid over abstraction, if possible, to avoid the river from drying out downstream.

6. ECO-CATEGORISATION: RAPID LEVEL 3 RESERVE SITES

6.1 MNGA01_R: Mngazi River

Sample Date	7 September 2022	**Reserve Level Assessment**	Rapid 3
Site Code	MNGA01_R	**IUA**	IUA_T04
River	Mngazi	**IUA description**	Pondoland coastal
Altitude (m.a.s.l.)	34m	**Prioritised RU**	R_RU31_R
Latitude	-31.608958	**Longitude**	29.405132
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T70B
Level 2 EcoRegion	31.02	**SQ Reach**	T70B-06498
Geomorphological zone	E (Slope 0.003)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge			
Site Photographs: Survey 1 (September 2022)			
			
Site Description:			
The site is located near Qhaka, about 15 km form Port St Johns and 9km from the coastline. The site is located in a confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by boulder, cobble and gravel sediment types. Large gravel and cobble bars alternate along the active channel. Benches are composed of silt and sand. There is low embeddedness along riffles, runs and pools. All biotopes were present for macroinvertebrates. There was no instream aquatic vegetation, and limited marginal vegetation owing to undercut banks along both banks. Fish habitats included SS, SD and FS.			
Site impacts:			
• Gravel mining • Construction activities (bridges) • Road access • Alien invasive plants (riparian zone) (lantana, peanut cassia, bugweed) • Erosion • Bridge crossing			

In situ water quality and discharge:

- pH: 7.78
- EC: 766.6 µS/cm
- TDS: 0.4195 g/l
- DO: 6.38 mg/l
- DO%: 67.2 %
- Clarity: 81 cm
- Temperature: 18.6 °C
- Salinity: 0.32 ppt
- Discharge: 0.389 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
21	14.1	B (Good)	1	**3.5**
Dominant Species	*Achnanthes thienemannii Hustedt*			
Preferences	Limited research on this diatom species however the specialists feel that it may be indicative of low nutrient/low EC (previously identified in high mountainous streams in SA and Lesotho)			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	3	• Straight single channel with good riffle habitat	• A single observation during low flow.
Fish	2	• SD, SS, FS velocity-depth classes • Some previous fish data from REMP studies (2018)	• A single observation during low flow • No fish data from REMP studies since 2018 • Cover features within velocity-depth classes limited
Macroinvertebrates	3	• SIC, SOOC, GSM • Varying flow conditions • REMP site code: T7MNGA-LOWER (further downstream)	• Limited marginal vegetation and no instream aquatic vegetation • Undercut banks • Localised gravel mining having an effect on in-stream habitats

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• New site with a single observation
Fish						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • GBIF collection records • Single REMP dataset (2018)

Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • REMP site code: T7MNGA-LOWER (further downstream)
Hydrology						• Natural and present day flows • Daily flows from gauging weir
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity, 2022 diatom results.

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Awaous aeneofuscus, Acanthopagrus berda, Anguilla bicolor bicolor, Anguilla bengalensis labiata, Anguilla marmorata, Anguilla mossambica, Gilchristella aestuaria, Glossogobius callidus, Glossogobius giuris, , Monodactylus falciformis, Monodactylus argenteus, Myxus capensis, Mugil cephalusOreochromis mossambicus, Liza macrolepis*
Macroinvertebrates	Porifera, Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Atyidae, Paleomonidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Lestidae, Platycnemidae, Aeshnidae, Gomphidae, Libellulidae, Pyralidae,Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae 2spp,Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae,Elmidae, Gyrinidae, Hydrophilidae, Psephenidae Athericidae, Ceratopogonidae, Chironomidae, Culicidae,Simuliidae,Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae
Physical-chemical/Diatoms	Historical monitoring data begins 2003 and ends 2017, with only n=50 data entries. Therefore, diatom data was used to infer the reference Physical-chemical conditions at the site. The diatom results indicated good water quality, free from organic pollution. % deformed cells, however, indicated a source of inorganic pollution linked to the site. This inorganic source is not expected to be present under reference conditions. Historical data on inorganic substances is not available for the site. It is believed that in the absence of other obvious sources, the elevated inorganic pollutant(s) may be linked to localised gravel mining at the site.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish[a]	C (68.9%)	F/NF	• Mhlangu Dam in upper reaches (flow modification) • Marginal flow modification within immediate reach as a result of catchment modification, although limited – highest impact likely over drier months • Upstream movement from estuary likely compromised (potentially related to offtake from Mngazi to off-channel dam below EWR site)

			• Presence of extralimital fish species (*Tilapia sparrmanii*)
Macroinvertebrates[b]	B (84.73%)	F/NF	• Mhlangu Dam in upper reaches (flow modification) • Loss of seasonal flows during drought/drier months, although limited • Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope • Localised gravel mining (resulting in loss of habitats, flow modifications)
Habitat Integrity: Instream[c]	C/D (60%)	F/NF	• Mhlangu Dam in upper reaches (flow modification) • Localised gravel mining • Cattle trampling and grazing (erosion)
Habitat Integrity: Riparian[c]	C (74%)	NF	• Exotic vegetation encroachment • Cattle trampling and grazing (erosion)
ECOSTATUS (PES)	**C (76.41%)**		

[a]*Refer to Appendix B of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2*
[b]*Refer to Appendix C of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2*
[c]*Refer to Appendix E of Report number WEM/WMA7/00/CON/RDM/1823: Eco-Categorisation Report–Volume 2*
The above applies throughout the report

Component	**Causes Present/Absent**
Fish	Although several velocity-depth classes were present, the cover features from a fish perspective associated with the reach were limited. Although a total of 15 fish species were expected to be present under natural conditions, only a total of 8 indigenous species have been collected within the reach, with a further 4 expected to be present at a low frequency of occurrence. *Tilapia sparrmanii* (Banded Tilapia), a non-native species, was also collected within the reach during previous monitoring studies as well as during the present study. In addition, species with requirements for catchment-scale movement as well as movement between reaches occurred at a lower-than-expected frequency of occurrence. Overall, the ecological state of the fish assemblage reflected a moderately modified state (Ecological Category C, 68.9%), with the velocity-depth metric noted to contribute the most to the overall ecological state obtained during the September 2022 assessment, followed by cover metrics. Other metrics showing a significant contribution (>70%) to the present state included flow and migration metrics. Metrics showing a marked increase in contribution to the overall ecological state of the fish assemblage relative to reference contribution included the Physical-chemical and flow modification metrics, suggesting that water quality impairment and flow modifications are impacting the fish assemblage within the reach.

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	**100.00**	**100.00**
COVER	**87.47**	**93.67**

PES and causes

Component	Causes Present/Absent											
	FLOW MODIFICATION	61.33									75.97	
	PHYSICAL-CHEMICAL	32.31									49.19	
	MIGRATION										71.34	
	IMPACT OF INTRODUCED										46.59	
	FRAI	PRESENT										
	FRAI (%)	68.9										
	EC: FRAI	C										

Macroinvertebrates

INVERTEBRATE EC METRIC GROUP		METRICGROUP CALCULATEDSCORE	CALCULATEDWEIGHT	WEIGHTEDSCOREOFGROUP	RANKOFMETRIC	WEIGHTOFMETRICGROUP
FLOW MODIFICATION	FM	87.7	*0.333*	29.2308	2	95
HABITAT	H	78.5	*0.316*	24.7751	3	90
WATER QUALITY	WQ	82.0	*0.351*	28.7674	1	100
CONNECTIVITY & SEASONALITY	CS	82.6	*0.000*	0	0	0
						285
INVERTEBRATE EC				82.7733		
INVERTEBRATE EC CATEGORY						

A diversity and abundance of biotopes were available to sample at this site, with varying flow conditions, although marginal vegetation was limited due to undercut banks. The aquatic macroinvertebrate assemblage collected was determined to be representative of being largely natural (Ecological Category B, 82.77%). During the current survey, a total of 32 taxa were recorded out of a reference community of 54 taxa (59% of the reference community was present). A number of sensitive taxa were recorded namely Perlidae, Baetidae >2spp and Heptageniidae (sensitivity scores of 12 -13), all with a preference to the stone's biotope and high-water quality conditions. The only sensitive macroinvertebrates absent from the expected community (with a sensitivity score between 12 and 15) was Pyralidae, although with a Froc2. With reference to the water quality conditions, a total of 23 and 13 taxa were expected with a preference to low to very low water quality conditions, of which 16 and 7 were recorded respectively. However, 5 of the expected 6 taxa for high water quality conditions were also recorded.

Overall, the community was primarily driven by habitat (78.5%) (owing to limited marginal vegetation), followed by water quality (82.0%) and then flow modifications (87.7%). The ASPT for the community was 5.9 (87% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), baring several sensitive taxa recorded at this site.

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Macroinvertebrates	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth) • No additional bed modification / erosion (localised) • Habitat availability remains good • Limited monitoring along the Mngazi River • 89% of the reference ASPT	2
Habitat integrity: Instream	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, google earth) • Should the gravel mining continue consistently, this will have a further increased impact on bed medication going forward.	2
Habitat integrity: Riparian	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, google earth)	2
ECOSTATUS (PES)	Stable	• Decreased from a Class a B to a Class C potentially owing to the above	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	B	C	• Fish (Class C) • Non-native fish species (TSPA) • Loss of baseflows, freshets and annual floods

EI/ES, 2014	**Re-assessed, 2022***
High, Moderate	High, High

Physical-chemical state of the system
High clarity/visibility and most parameters also within guidelines. Dissolved oxygen was lower. High conductivity concentrations were also recorded *in situ.*

C	B/C	• NF: Better management of alien invasive vegetation within the riparian zone; • NF: Ensure rehabilitation measures are implemented following gravel mining activities; and • NF: Ecological Sensitivity reassessed to High.

OVERALL ASSESSMENT

Table 6-1: Overall EcoStatus assessment for MNGA01_R (Mngazi)

River	**Mngazi**
EWR Site Code	**MNGA01_R**
Driver component	**PES**
Diatoms	B
IHI (instream)	C/D
IHI (riparian)	C
Response component	**PES**
FRAI	C
MIRAI	B
Ecostatus	**C**
EI	High
ES	High
REC	B/C

The overall EcoStatus was categorised as a Class C, with a REC of a B/C (**Table 6-1**). The fish community was determined to be in a moderately modified state, with several metrics showing a marked increase in contribution to the overall ecological state of the fish assemblage relative to reference, suggesting that water quality impairment and flow modifications are impacting the fish assemblage within the reach. The aquatic macroinvertebrate community was overall still largely natural, with the community primarily being driven by the habitat metric due to limited marginal vegetation owing to undercut banks and erosion. Although several expected sensitive taxa were recorded, majority of the community responded to low to very low water quality, thus on average the community comprising tolerant taxa.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- The extent of sand mining needs to be managed appropriately within the reach to prevent loss of habitat and flow modifications;
- Other current/future land use activities within upstream catchment should be managed to prevent degradation of the ecological health of the system and deterioration of the water quality (buffer zones to be implemented for future proposed developments);
- Alien weed infestation eradication implementation programme;
- Rehabilitation implementation programme for mining (gravel/sand); and
- Catchment management (cattle grazing and trampling).

6.2 NQAB01_R: Nqabarha River

Sample Date	9 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	NQAB01_R	**IUA**	IUA_T04
River	Nqabarha	**IUA description**	Pondoland coastal
Altitude (m.a.s.l.)	711m	**Prioritised RU**	R_RU33_R
Latitude	-32.091927	**Longitude**	28.400234
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T90A
Level 2 EcoRegion	16.06	**SQ Reach**	T90A-07092
Geomorphological zone	E (0.003)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near Idutywa, about 7 km from the N2 in a downstream direction.

The site is located in a partly confined valley setting with a single channel and floodplain along both banks. It has localised islands where the channel has avulsed. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by cobble, gravel and sand sediment types. There are bedrock sections with localised bedrock steps. Benches are composed of silt and sand. There is low embeddedness along riffles and rapids, but significant embeddedness along pools. Bank erosion is widespread.

Good availability of marginal vegetation and GSM biotopes for aquatic macroinvertebrates, with a few seams of SIC and SOOC, although shallow over these areas. Fish habitats included SD, SS and FS.

Site impacts:

- Considerable macroplastics within the riparian zone (due to earlier flood event)
- Cattle grazing and trampling
- Erosion
- Alien invasive plants within the riparian zone

SUMMARY RESULTS

In situ water quality and discharge::

- pH: 8.33
- EC: 1004 µS/cm
- TDS: 0.786 g/l

- DO: 7.98 mg/l
- DO%: 81.3 %
- Clarity: 95 cm
- Temperature: 16.1 °C
- Salinity: 0.61 ppt
- Discharge: 0.024 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
23	10.4	C (Moderate)	29.7	1
Dominant Species	*(1) Achnanthidium spp.*			
	(2) Cocconeis placentula var. euglypta (Ehrenberg) Grunow			
Preferences	(1) Moderate to good quality waters			
	(2) Nutrient and salinity increase (eutrophication)			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2.5	• Relatively straight single channel	• Bank erosion and dense marginal vegetation downstream • Single observation at low flow
Fish	1	• Easy to sample	• Single observation at low flow • Limited velocity-depth classes • Stream reminiscent of incised valley-bottom wetland
Macroinvertebrates	3	• Some SIC, SOOC, GSM • Varying flow conditions	• Very high macroplastics instream and within the marginal vegetation zone • Bedrock dominated

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation at new site
Fish						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • No fish collection records within upper catchment (only a single collection record within lower reach)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)

Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity, 2022 Diatoms results.

** 0 (no information) to 4 (large amount of data available)*

Reference Conditions	
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla mossambica, Enteromius anoplus* sl.
Macroinvertebrates	Turbellaria, Oligochaeta, Potamonautidae, Atyidae, Hydracarina, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Lestidae, Platycnemidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Belostomatidae, Corixidae, Gerridae, Naucoridae, Notonectidae, Pleidae, Veliidae, Hydropsychidae 2spp, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Physidae, Planorbinae, Corbiculidae
Physical-chemical	Historical reference condition data for the site were not available. As such, diatom data was used to infer the reference conditions for the site. The diatom results indicated moderate water quality with some evidence of organic pollution as a result of the Idutywa WWTW. In the absence of this impact, lower nutrient condition are expected to prevail at the site.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	F (17.6%)	NF	• Absence of indigenous fish species • Presence of alien fish species only (MSAL)
Macroinvertebrates	C (69.03%)	F/NF	• Reduced baseflows owing to degradation of wetlands in upper catchment • Impaired waterquality(upstreamWWTW unmaintained) • Recent flood impacts largely due to catchment degradation
Habitat Integrity: Instream	C (73%)	F/NF	• Reduced baseflows owing to degradation of wetlands in upper catchment • Bank erosion, incision • Cattle trampling and grazing
Habitat Integrity: Riparian	C (62%)	F/NF	• Macroplastics • Cattle trampling and grazing (bank erosion) • Recent floods impact largely due to catchment degradation
ECOSTATUS (PES)	**D (58.46%)**		

<table>
<tr><td></td><td></td></tr>
<tr><td>Component</td><td>Causes
Present/Absent</td></tr>
<tr><td>Fish</td><td>From a fish perspective, the reach is reminiscent of an incised valley-bottom wetland system, with the slow-deep velocity-depth class being dominant, as is marginal emergent vegetation also dominant from a cover perspective. Given the perceived nature of the reach under unimpacted state, the presence of fish species is expected to be limited, with only a single species (Enteromius anoplus sl.) likely to be present under reference conditions for much of the time. During the present study, several specimens of a single alien fish species (Micropterus salmoides) were collected, with no indigenous fish collected. Consequently, the ecological state of the system was determined to represent a critically modified state (Ecological Category F, 17.6%), with the primary driver being the presence of alien predatory fish species.

<table>
<tr><th>METRIC GROUP</th><th>REFERENCE WEIGHTS (%)</th><th>PRESENT WEIGHTS (%)</th></tr>
<tr><td>VELOCITY-DEPTH</td><td>96.37</td><td>80.65</td></tr>
<tr><td>COVER</td><td>100.00</td><td>85.43</td></tr>
<tr><td>FLOW MODIFICATION</td><td>34.37</td><td>44.00</td></tr>
<tr><td>PHYSICAL-CHEMICAL</td><td>36.37</td><td>42.55</td></tr>
<tr><td>MIGRATION</td><td></td><td>42.11</td></tr>
<tr><td>IMPACT OF INTRODUCED</td><td></td><td>100.00</td></tr>
<tr><td>FRAI</td><td>PRESENT</td><td></td></tr>
<tr><td>FRAI (%)</td><td>17.6</td><td></td></tr>
<tr><td>EC: FRAI</td><td>F</td><td></td></tr>
</table></td></tr>
<tr><td>Macroinvertebrates</td><td>
<table>
<tr><th>INVERTEBRATE EC METRIC GROUP</th><th></th><th>METRIC GROUP CALCULATED SCORE</th><th>CALCULATED WEIGHT</th><th>WEIGHTED SCORE OF GROUP</th><th>RANK OF METRIC</th><th>%WEIGHT FOR METRIC GROUP</th></tr>
<tr><td>FLOW MODIFICATION</td><td>FM</td><td>65.4</td><td>0.316</td><td>20.6601</td><td>3</td><td>90</td></tr>
<tr><td>HABITAT</td><td>H</td><td>74.4</td><td>0.333</td><td>24.7849</td><td>2</td><td>95</td></tr>
<tr><td>WATER QUALITY</td><td>WQ</td><td>67.2</td><td>0.351</td><td>23.5867</td><td>1</td><td>100</td></tr>
<tr><td>CONNECTIVITY & SEASONALITY</td><td>CS</td><td>80.0</td><td>0.000</td><td>0</td><td>4</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>285</td></tr>
<tr><td>INVERTEBRATE EC</td><td></td><td></td><td></td><td>69.0318</td><td></td><td></td></tr>
<tr><td>INVERTEBRATE EC CATEGORY</td><td></td><td></td><td></td><td>C</td><td></td><td></td></tr>
</table>
The system was dominated by bedrock, with some SIC, SOOC, GSM and good availability of marginal vegetation. However, owing to recent flood events, the riparian zone was scatted with macroplastics, moving instream. The aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately modified (Ecological Category C, 69.03%). During the current survey, a total of 18 taxa were recorded out of a reference community of 45 taxa (40% of the reference community was present). The community appeared to have a preference for low to very low water quality, cobbles and standing water. Only 2 sensitive taxa are expected for this reach namely Baetidae >2spp and Heptageniidae, of which the former was recorded. Furthermore, those taxa expected but not recorded which had a high froc (3-5), were Heptageniidae, Trichorythidae,</td></tr>
</table>

PES and causes	
Component	**Causes Present/Absent**
	Chlorocyphidae, Aeshnidae, Gomphidae, Libellulidae, Belostomatidae, Naucoridae, Notonectidae, Veliidae, Leptoceridae, Dytiscidae, Elmidae, Athericidae, Ceratopogonidae and Corbiculidae. All these absent taxa primarily have a preference for mostly moderate water quality conditions, vegetation and stones biotope in slow to standing water. Overall, the community was primarily driven by flow modification (65.4%) (potentially owing to degraded upstream wetlands within the catchment reducing the baseflows), closely followed by water quality (67.2%) (impaired water quality from upstream WWTW, plastics instream) and then habitat (74.4%). The ASPT for the community was 4.9 (75% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002).

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Lack of indigenous fish species and dominance of non-native predatory fish species unlikely to change	4
Macroinvertebrates	Decline	• Impaired water quality (WWTW) • Reduced baseflows (potentially owing to degradation of wetlands in upper catchment) • Flood events due to poor catchment management • Bank erosion (cattle trampling and grazing) resulting in increased sedimentation and reduced marginal vegetation • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Decline	• Degradation of wetlands in upper catchment – baseflow reduction • Increased bank erosion due to increased cattle roaming	2
Habitat integrity: Riparian	Decline	• Increased bank erosion due to increased cattle roaming • Flood events largely due to catchment degradation	2
ECOSTATUS (PES)	Decline	• Major decrease from a Class a B to a Class D potentially owing to the above	2

** 0 – no confidence to 5 – high confidence*

Overall change and reason for deviation			
COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	B	D	• Lack of indigenous fish species • Presence of alien fish species only (MSAL) • Dominance of alien predatory fish species unlikely to change • Compromised water quality owing to upstream WWTW • Reduced baseflows owing to degradation of wetlands in upper catchment

EI/ES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
In situ water quality suggest high dissolved salts/solids. The Idutywa WWTW discharges into the tributary of the Nqabarha River and is likely the cause of elevated dissolved solids and conductivity due to its poor maintenance. The % change in flow for the WWTW between 2013 and 2021 is -66% suggesting that most of the sewage destined for the sewage works ends up in the river. Information on the WWTW is unavailable in the Green Drop Report.

D	C		• NF: Alien invasive vegetation management and eradication; • NF: Management of upstream WWTW, will ultimately improve the state of the water quality, coupled with an improvement to the overall instream biotic communities, thereafter, leading to a more a functional ecosystem; and • NF: Catchment management and improvement.

OVERALL ASSESSMENT

Table 6-2: Overall EcoStatus assessment for NQAB01_R (Nqabarha)

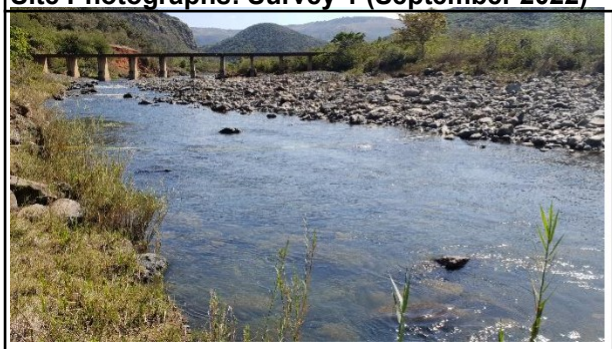
River	**Nqabarha**
EWR Site Code	**NQAB01_R**
Driver component	**PES**
Diatoms	C
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	**F**
MIRAI	C
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**C**

The overall EcoStatus was categorised as a Class D, with a REC of a C (**Table 6-2**). While the fish assemblage within the reach was expected to be naturally limited, the fish assemblage was noted to be devoid of any indigenous species and dominated by a single predatory alien species. Consequently, the ecological state of the fish assemblage was regarded as being critically modified. The aquatic macroinvertebrate community was overall moderately modified, primarily being driven by flow modifications and water quality (reduced baseflows, upstream WWTW, catchment degradation, erosion). On average the community comprising tolerant taxa.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Other current/future land use activities within upstream catchment should be managed to prevent degradation of the ecological health of the system and deterioration of the water quality (buffer zones to be implemented);
- Maintenance and auditing of WWTW upstream;
- Wetland management for upstream wetland system; and
- Catchment management.

6.3 MTEN01_R: Mtentu River

Sample Date	6 September 2022	**Reserve Level Assessment**	Rapid 3
Site Code	MTEN01_R	**IUA**	IUA_T04
River	Mtentu	**IUA description**	Pondoland coastal
Altitude (m.a.s.l.)	274m	**Prioritised RU**	R_RU29_R
Latitude	-31.130483	**Longitude**	29.757179
Level 1 EcoRegion	North Eastern Coastal Belt	**Quaternary catchment**	T60C
Level 2 EcoRegion	17.01	**SQ Reach**	T60C-05942
Geomorphological zone	D (slope 0.005)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge			
Site Photographs: Survey 1 (September 2022)			
			
Site Description:			
The site is located about 10 km form the Holy Cross Hospital and 25km from the coastline. The site is located in a confined valley setting with narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by boulder, cobble and gravel sediment types. Bedrock is locally present. Large gravel and cobble bars alternate along the channel. Benches are composed of silt and sand. There is very low embeddedness along riffles, runs and pools. All biotopes were available for macroinvertebrates, although marginal vegetation was limited owing to undercut banks along the right-hand bank and sand bars along the left bank. Fish habitats included Slow-Shallow (SS), Slow-Deep (SD) and Fast-Shallow (FS).			
Site impacts:			
• Alien invasive plant species within the riparian zone (lantana, peanut cassia) • Localised gravel mining • Erosion • Cattle trampling			
In situ water quality and discharge:: • pH: 8.32 • EC: 252.5 µS/cm			

- TDS: 0.1835 g/l
- DO: 8.56 mg/l
- DO%: 93.3 %
- Clarity: 93 cm
- Temperature: 19.5 °C
- Salinity: 0.14 ppt
- Discharge: 0.954 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
22	14	B (Good)	0.7	0.5
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preference	Nutrient and salinity increase (eutrophication)			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	3	• Stable and straight single channel	• Single observation during low flow
Fish	2	• SD, SS, FS	• Single observation during low flow • Limited cover features
Macroinvertebrates	2	• SIC, SOOC, GSM • Varying flow conditions	• Limited marginal vegetation and no instream aquatic vegetation • Undercut banks • Localised gravel mining (resulting in loss of habitats, flow modifications) • Some bed modification owing to the bridge at the site

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation at new site
Fish						• Current survey (September 2022) • Fish FROC (Kleynhans, 2008) • PESEIS, 2014 • GBIF Collection Records
Macroinvertebrates						• Current survey (September 2022) • 2004 data from Mtentu (Christa Thirion) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)
Hydrology						• Natural and present day flows

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity. • 2022 diatom results • NCMP data site T6H002Q01 – three data entries (1981- 1982)

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Awaous aeneofuscus, Anguilla bicolor bicolor, Anguilla bengalensis labiata, Anguilla marmorata, Anguilla mossambica, Enteromius anoplus, Enteromius viviparus, Gilchristella aestuaria, Glossogobius callidus, Glossogobius giuris, Monodactylus argenteus, Myxus capensis, Monodactylus falciformis, Oreochromis mossambicus*
Macroinvertebrates	Porifera, Turbellaria, Oligochaeta, Potamonautidae, Atyidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Blepharoceridae, Ceratopogonidae, Chironomidae, Culicidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae
Physical-chemical	Historical monitoring data for the site consists of only three data entries between 1981 to 1982. Diatom results were used to infer the reference condition of the site. The diatom results indicated good water quality characterised by periodic episodes of eutrophication. Historical TIN results ranged from 0.29 to 3.22 mg/l. Historical PO_4 results ranged from 0.01 to 0.02. It must be noted that these are obtained from only three data entries. As such, they do not represent reference conditions and are only used to indicate historical nutrient concentrations at the site.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	C (67.0%)	F/NF	• Presence of non-native predatory fish (MSAL) • Possible some flow modification
Macroinvertebrates	B/C (78.10)	F/NF	• Considerable Simuliidae (Blackfly larvae) outbreak, an indication of sustained high flows, limited floods no freshets owing to no upstream dams, potentially loss of seasonal variation) • Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Localised gravel mining (resulting in loss of habitats, flow modifications)
Habitat Integrity: Instream	A/B (90%)	-	• Bed modification (localised gravel mining, bridge and other crossings)
Habitat Integrity: Riparian	C (61%)	NF	• Exotic vegetation encroachment
ECOSTATUS (PES)	**C (69.02%)**		

Component	**Causes Present/Absent**
Fish	Species expected to occur within the reach under natural conditions supported a variety of preferences, with a marked dominance of species with a preference for slow-flowing water, substrate as a cover feature, tolerant to moderately tolerant of no-flow conditions, and moderately tolerant to tolerant of modified water qualities. During the September 2022 assessment, only three of the 14 expected fish species were sampled within the reach, with many being present within sheltered slow-flowing water with accumulated debris and marginal vegetation. Of relevance was the presence of non-native predatory MSAL which is considered to have a marked impact on the native species likely to be present. Nevertheless, the ecological state of the fish assemblage during September 2022 was determined to be moderately modified (Ecological Category C, 67.0%), with a notable reduction in FROC of species with a preference for substrate as a cover feature, as well as those species with a tolerance to no-flow conditions. Velocity-depth and cover metrics were however determined to remain the greatest contributors to the ecological state obtained, although present state community metrics do suggest elevated contribution of flow modification to the ecological state.

METRIC GROUP	**REFERENCE WEIGHTS (%)**	**PRESENT WEIGHTS (%)**
VELOCITY-DEPTH	**100.00**	**97.74**
COVER	**94.00**	**100.00**
FLOW MODIFICATION	**58.38**	**77.15**
PHYSICAL-CHEMICAL	**33.26**	**51.88**
MIGRATION		**67.19**
IMPACT OF INTRODUCED		**64.13**
FRAI	**PRESENT**	
FRAI (%)	**65.9**	
EC: FRAI	**C**	

PES and causes	
Component	**Causes Present/Absent**
Macroinvertebrates	

INVERTEBRATE EC METRIC GROUP			CALCULATEDWEIGHT	WEIGHTEDSCORECOVERAGE	RANKOFMETRIC	VWEIGHTFORMETRIC
FLOW MODIFICATION	**FM**	72.9	*0.357*	26.0302	1	100
HABITAT	**H**	82.5	*0.304*	25.058	3	85
WATER QUALITY	**WQ**	79.6	*0.321*	25.5719	2	90
CONNECTIVITY & SEASONALITY	**CS**	80.0	*0.018*	1.42857	4	5
INVERTEBRATE EC				78.0886		280
INVERTEBRATE EC CATEGORY						

A diversity of biotopes and varying flow velocities was present at this site, although marginal vegetation was limited owing to undercut banks and bank erosion. The aquatic macroinvertebrate assemblage collected was determined to be representative of being largely natural to moderately modified (Ecological Category B/C, 78.10%). During the current survey, a total of 27 taxa were recorded out of a reference community of 52 taxa (52% of the reference community was present). The community appeared to have a preference for low water quality, cobbles and standing water. Although limited surrounding impacts, there was an outbreak of Simuliidae (Blackfly larva) at the time of the September 2022 survey recording an abundance of a C, compared to its A abundance reference state. As this is a free-flowing river, this outbreak may be cognisant to a loss of seasonal variation within this system (per comms Nick Rivers-Moore). Furthermore, a potential lack of floods resulting in the constant and stagnant flows, and/or the system not drying out resulting in a system reset, are causing these outbreaks. Lastly, although other taxa can co-exist on the SIC biotope during these outbreaks, in accordance with Rivers-Moore *et al.,* (2007), it can have an impact on the abundance of other taxa owing to the overwhelming abundance of the Simuliidae. Biota expected but not recorded with these preferences included Hydropsychidae >2spp, Turbellaria and Aeshnidae. Although, sensitive taxa namely Heptageniidae, Leptophlebiidae and 1 individual of Trichorythidae were recorded.

Overall, the community was primarily driven by flow modification (72.9%) (resulting in the outbreak of Simuliidae), followed by water quality (79.6%) and then habitat (82.5%). The ASPT for the community was 6.5 (93% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), and which was dominated by Simuliidae and its associated outbreak.

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Stable	• Drivers unchanged due to impacts remainingunchanged (no new developments and since PES, 2014, google earth)	2

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Macroinvertebrates	Decline	• Outbreak of Simuliidae and dominating the macroinvertebrate assemblage (changes in natural flow regimes. • The study conducted in November 2004, recorded Simuliidae in abundance of an A. • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, google earth)	2
Habitat integrity: Riparian	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, google earth)	2
ECOSTATUS (PES)	Decline	• Decrease from a Class B to a C potentially owing to the above	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	B	C	• Loss of seasonal flows • Presence of alien fish species (MSAL) • Exotic vegetation encroachment within the riparian zone

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2023***
High, Moderate	High, High

Physical-chemical state of the system
In situ water quality parameters were within acceptable limits. DO and clarity were high, reflective of good water quality, and with the absence of potential impacts upstream.

C	B/C	• Ecological Sensitivity reassessed to be High; • F: Flagship river; • F/NF: The presence of flow sensitive macroinvertebrates (as well as water quality sensitive macroinvertebrates); • F/NF: Part of a surface water Strategic Water Source Area (SWSA); • NF: Downstream Provincial Nature Reserve; and

		• NF: Maputaland-Pondoland Region of plant endemism (including the Dwarf Palm (Endangered) - which only occurs along this reach of the Mtentu thus system requires protection).

OVERALL ASSESSMENT

Table 6-3: Overall EcoStatus assessment for MTEN01_R (Mntentu)

River	**Mtentu**
EWR Site Code	**MTEN01_R**
Driver component	**PES**
Diatoms	B
IHI (instream)	A/B
IHI (riparian)	C
Response component	**PES**
FRAI	C
MIRAI	B/C
Ecostatus	**C**
EI	High
ES	High
REC	B/C

The overall EcoStatus was categorised as a Class C, with a REC of a B/C ad TEC a B with the aim of overall catchment management and improvement **(Table 6-3**). The fish community was determined to be in a moderately modified state with a decrease in FROC of many species expected under natural conditions. The aquatic macroinvertebrate community was overall in a largely to moderately modified state primarily comprising tolerant taxa. However, during the current survey, a major outbreak of Simuliidae (Blackfly larvae) was taking place. Thus, the community was driven mostly from flow modifications, followed by water quality and then habitat.

RECOMMENDATIONS

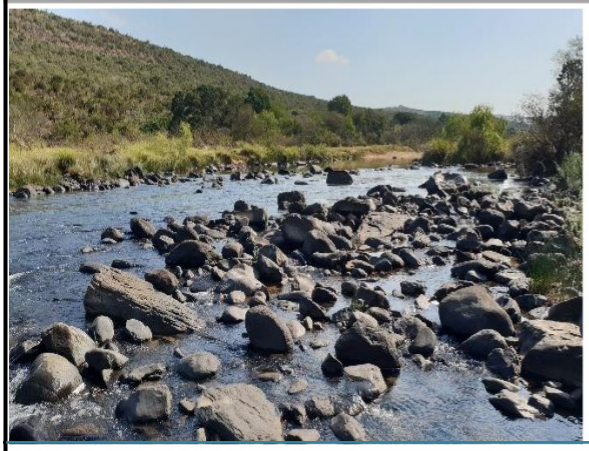
- Refer to Chapter 11 for general recommendations
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach.
- Protection status for reach owing to this reach of the Mtentu having Maputaland-Pondoland Region of plant endemism (including the Dwarf Palm (Endangered) - which only occurs along this reach of the Mtentu thus system requires protection)

6.4 MBHA02_R: Mbhashe River (Upper)

Sample Date	9 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	MBHA02_R	**IUA**	IUA_T01
River	Mbhashe	**IUA description**	Upper Mbhashe, Upper Mthatha
Altitude (m.a.s.l.)	555	**Prioritised RU**	R_RU27_R
Latitude	-31.807857	**Longitude**	28.346994
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	T11H
Level 2 EcoRegion	16.06	**SQ Reach**	T11H-06654
Geomorphological zone	E (slope 0.004)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near eSixhotyeni, about halfway between the N2 and the R61.

The site is located in a confined valley setting with a single channel and narrow flood features. It has localised islands where bedrock or large boulders form obstructions. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble and sand sediment types. There are significant bedrock sections with localised bedrock steps. Benches are composed of silt and sand. There is low embeddedness along riffles and rapids, but significant embeddedness along pools.

Bedrock was the most dominant biotope for the aquatic macroinvertebrates, with some scattered SIC and SOOC. GSM was available in pockets along both banks, mainly within the interstitial spaces of the SOOC. No instream aquatic vegetation was present and limited marginal vegetation primarily owing to undercut banks. Varying flow velocity and depth classes were available for fish, namely SD, SS, FS and FD.

Site impacts:

- Alien invasive plants within the riparian zone (Wattle sp.)
- Cattle grazing and trampling
- Erosion

- Sand mining
- Upstream weir (although with 2 fish ways – positive impact)

SUMMARY RESULTS

In situ water quality and discharge:

- pH: 8.75
- EC: 210.3 µS/cm
- TDS: 0.1458 g/l
- DO: 7.68 mg/l
- DO%: 87.1 %
- Clarity: >95 cm
- Temperature: 21.9°C
- Salinity: 0.11ppt
- Discharge: Q=1.822 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
15	15.7	B (Good)	0.8	0
Dominant Species	*Achnanthes thienemannii Hustedt*			
Preference	Limited research on this diatom species however the specialists feel that it may be indicative of low nutrient/low EC (previously identified in high mountainous streams in SA and Lesotho).			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	3	• Simple and straight channel with stable planform	• A single observation at this new site
Fish	3	• Varying flow conditions • Presence of all velocity depth classes • Availability of REMP monitoring data	• Limited cover features present, with substrate dominant
Macroinvertebrates	3	• Varying flow conditions • Reference data used from REMP site: T1XUKA-CONFL (same ecoregion 2 and geoclass)	• Bedrock dominated, large cobbles and boulders • Limited SIC, SOOC, • Limited GSM – only within interstitial spaces between the stones substrate Limited marginal vegetation and no instream aquatic vegetation • Undercut banks • Large upstream weir

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*				DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• A single observation at a new site

Fish						• Current survey (September 2022) • Fish FROC (Kleynhans, 2008) • PES-EI-ES Assessment (DWS, 2014) • Some REMP monitoring data • Limited GBIF collection records
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • Reference data used from REMP site: T1XUKA-CONFL (same ecoregion 2 and geoclass)
Hydrology						• Natural and present day flows • Daily flows from gauging weir
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity. • 2022 diatom results

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla bicolor bicolor, Anguilla marmorata, Anguilla mossambica, Enteromius anoplus sl., Glossogobius callidus*
Macroinvertebrates	Turbellaria, Oligochaeta, AmphipodaPotamonautidae, Atyidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Prosopistomatidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Lestidae, Platycnemidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Lepidostomatidae, Leptoceridae, Pisuliidae, Sericostomatidae, Dytiscida, Elmidae, Gyrinidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae
Physical-chemical	Earliest monitoring data at the site are from 2006 to 2018, with n = 131 data entries. These data do not represent the reference conditions of the site. Diatoms were used to infer the reference condition of the site. Diatom results indicated good water quality with low nutrient (TIN and PO_4) and low electric conductivities (EC). The available historical data indicated EC ranging between 4.79 – 33.9 mS/m, TIN at 0.03 – 1.175 and pH at 6.99 to 8.47.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	C (63.5%)	NF	• Presence of several extralimital (BAEN, TSPA) and alien (CCAR) fish species likely as a result of water transfer from Tsomo catchment • Upstream migration impedance due to hydropower weir below lower Mbhashe River intermediate site (Collywobbles weir)

Macroinvertebrates	B/C (78.14%)	F/NF	• Considerable Simuliidae (Blackfly larvae) outbreak, an indication of changes in natural flows • Habitat limitations (bedrock, boulders dominated) • Water transfer from Tsomo (flow modifications) • Localised gravel mining (resulting in loss of habitats, flow modifications)
Habitat Integrity: Instream	B (87%)	-	• N/A
Habitat Integrity: Riparian	A/B (89%)	-	• N/A
ECOSTATUS (PES)	**B/C (79.87%)**		

Component	**Causes Present/Absent**
Fish	Although a limited number of species were expected to occur within the reach under reference conditions with only two species expected at a moderate FROC, species expected to occur within the reach under natural conditions supported a variety of preferences and be dominated by a preference for slow-deep habitat, substrate cover features and tolerances to no-flow conditions and modified water quality. During September 2022, a total of one of the 5 expected species were sampled, although REMP monitoring has confirmed the presence of an additional two expected species. Although only expected at low frequencies of occurrence, *Anguilla bicolor* and *Anguilla marmorata* have yet to be sampled within the general area during routine monitoring studies, with their absence likely a result of upstream migration barriers such as the Collywobbles weir. Overall, the fish community present was considered to be in a moderately modified state (Ecological Category C, 63.5%), with velocity-depth and cover metrics still contributing the most to the ecological state obtained. However, the FROC of species requiring catchment-scale migrations as well as the presence of several non-native fish species (and dominance of one extralimital species in particular, *Labeobarbus aeneus*) within the reach has resulted in these metrics significantly contributing to the ecological state obtained.

METRIC GROUP	**REFERENCE WEIGHTS (%)**	**PRESENT WEIGHTS (%)**
VELOCITY-DEPTH	**99.98**	**100.00**
COVER	**100.00**	**96.89**
FLOW MODIFICATION	**39.96**	**58.76**
PHYSICAL-CHEMICAL	**33.42**	**51.14**
MIGRATION		**81.39**
IMPACT OF INTRODUCED		**81.39**
FRAI	**PRESENT**	
FRAI (%)	**63.5**	

PES and causes	
Component	**Causes Present/Absent**
	EC: FRAI | **C**

Macroinvertebrates

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	77.5	*0.316*	24.4612	3	90
HABITAT	H	77.6	*0.333*	25.8743	2	95
WATER QUALITY	WQ	79.2	*0.351*	27.8019	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.000*	0	4	0
						285
INVERTEBRATE EC				78.1373		
INVERTEBRATE EC CATEGORY				C/B		

The dominant biotope at this site was bedrock, large cobbles and boulders. Limited marginal vegetation owing to undercut banks and limited GSM, except for some mud and sand within the interstitial spaces of the boulders. The aquatic macroinvertebrate assemblage collected was determined to be representative of being largely natural to moderately modified (Ecological Category B/C, 78.14%). During the current survey, a total of 23 taxa were recorded out of a reference community of 60 taxa (38% of the reference community was present). The community appeared to have a preference for low to moderate water quality, cobbles and standing water. At the time of the survey in September 2022, there was an outbreak of Simuliidae (Blackfly larva) recorded in a D abundance. This may likely be owing to changes in natural flows, potentially associated with the water transfer from Tsomo, coupled with potential temperature changes associated with this (Rivers-Moore & de Moor, 2020). The critical periods for controlling population sizes of Simuliidae are July–August (winter months) when most of the population is present in the larval or pupal phase (O'Keeffe and de Moor, 1988). Thus, reduced flows, and lower water levels, during these months is critical to expose the substrate to dry out blackfly larvae and pupae in these months (de Moor, 1982b, 1997; O'Keeffe and de Moor, 1988). This is what should be aimed for in these systems dealing with outbreaks, thus avoiding the typical spring outbreaks of blackfly's during the end of winter/spring seasonal period (i.e., September), as what was observed on the Indwe in September 2023.

In addition, although low embeddedness at the site, a lack of floods/freshets coming through, may also be the cause of the occurrence of the Simuliidae outbreak. Although this outbreak may not smother the SIC/bedrock biotopes, they do have the potential to impact on the abundance of other taxa owing to the overwhelming abundance of the Simuliidae (Rivers-Moore et al., 2007).
Biota expected but not recorded with these preferences included Trichorythidae, Hydropsychidae >2spp and Psephenidae (froc ranging from 3-4). However, other sensitive taxa which were expected and recorded include Baetidae >2spp, Heptageniidae and two individuals of Prosopistomatidae (scoring the highest sensitivity of 15). However, owing to the outbreak of the Simuliidae population, ultimately affected the overall current state of the macroinvertebrate assemblage.

PES and causes	
Component	**Causes Present/Absent**
	Overall, the community was primarily driven by both flow modification (77.5%) (resulting in the outbreak of Simuliidae) and the habitat metric (77.6) (dominance of the bedrock opposed to SIC biotope) and then water quality (79.2%). The ASPT for the community was 6.3 (90% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), and which was dominated by Simuliidae and its associated outbreak.

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Macroinvertebrates	Decline	• Outbreak of Simuliidae and dominating the macroinvertebrate assemblage (changes in natural flow regimes. • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Stable	• Remains close to natural conditions	2
Habitat integrity: Riparian	Stable	• Remains close to natural conditions	2
ECOSTATUS (PES)	Improvement	• Slight improvement from a Class C to a B/C potentially owing to the above	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR CHANGE
ECOSTATUS	C	B/C	• Slight improvement • Riparian habitat integrity (A) • Good biotope availability remains

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2022***
Moderate, Moderate	High, Moderate

Physical-chemical state of the system
No major anthropogenic impacts upstream. Largely a rural setting with sparse dwellings. Some evidence of erosion upstream, likely as a result of sandmining. This can result in elevated dissolved as well as suspended solids, which is not reflected in the *in-situ* water quality results i.e, high clarity/visibility. The scale of sandmining and its impacts may be minimal in the water quality/physical-chemical perspective. Diatom results also suggest low conductivities in the system.

B/C	B/C	• Ecological Importance reassessed to High; • F/NF: Flow and water quality sensitive aquatic macroinvertebrates should remain within the system; • F: Hydropower station upstream; • F: Higher flows owing to the upstream transfer; • F: Priority wetland identified within the same primary catchment area was W_RU22 (T11A) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of vital wetlands within this pimary catchment area, affected by the aforementioned influences. The restoration of this wetland (and others) ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas; and • NF: Maputaland-Pondoland Region of plant endemism.

OVERALL ASSESSMENT

Table 6-4: Overall EcoStatus assessment for MBHA02_R (Mbhashe)

River	**Upper Mbhashe**
EWR Site Code	**MBHA02_R**
Driver component	**PES**
Diatoms	B
IHI (instream)	B
IHI (riparian)	A/B
Response component	**PES**
FRAI	C
MIRAI	B/C
Ecostatus	**B/C**
EI	High
ES	Moderate
REC	**B/C**

The overall EcoStatus was categorised as a Class B/C, with an unchanged REC (**Table 6-4**). The fish community was noted to be in a moderately modified state with a decrease in the frequency of occurrence of most species. Of relevance however was the dominance of non-native fish species within the reach, most notably *Labeobarbus aeneus*. The aquatic macroinvertebrate community was overall in a largely natural to moderately modified state primarily comprising tolerant taxa. However, during the current survey, a major outbreak of Simuliidae (Blackfly larvae) was taking place. Thus, the community was driven mostly from flow modifications and habitat, followed by water quality.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach;
- Installation of fish ladders at Collywobbles weir required to facilitate upstream movement of catadromous eel species;
- Ensure the fish ladders at the upstream weir are maintained every 5 years, or immediately following a major flood event; and
- Conduct annual monitoring of installed fish ladders to determine species utilising structures and suitability of design for intended species.

6.5 GCUW01_R: Gcuwa River

Sample Date	11 May 2023	**Reserve Level Assessment**	Rapid 3 *(higher confidence, including VEGRAI)*
Site Name	GCUW01_R	**IUA**	IUA_S03
River	Gcuwa	**IUA description**	Lower Great Kei
Altitude (m.a.s.l.)	536	**Prioritised RU**	R_RU26_R
Latitude	-32.319770°	**Longitude**	28.136094°
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S70D
Level 2 EcoRegion	16.06	**SQ Reach**	S70D-07307
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: Fish, aquatic macroinvertebrates, VEGRAI (to increase confidence), *in situ* water quality, diatoms, cross-section, discharge			
Site Photographs (May 2023)			





Site Description:

This highly turbid reach of the Gcuwa River is located just upstream of Butterworth town, downstream of the Gcuwa Dam wall. This was the only suitable site upstream owing to significant impacts from raw sewage entering into the Gcuwa River downstream of Butterworth.

The single channel is within a deeply incised channel with extensive bank erosion particularly along the left bank. Upstream of the bridge is a pool receiving the overflow from the Gcuwa Dam, while downstream of the bridge is narrowed and follows a pool-riffle and pool-rapid reach type and is dominated by embedded boulder, cobble, gravel and silt sediment types.

Biota habitats available
The aquatic macroinvertebrate biotopes were dominated by bedrock and boulders, including SIC, SOOC and GSM. Marginal vegetation was limited. Fish habitats only included FS, FD, SS and SD.

Site impacts:

- Upstream Gcuwa dam and being located just downstream of the dam wall
- Cattle trampling and grazing
- Low water bridge
- Nutrients (high algae content)
- Moderate alien invasive vegetation within the riparian zone
- Extensive bank erosion

SUMMARY RESULTS
In situ water quality and discharge (May 2023 only): • pH: 8.41 • EC: 533 µS/cm • TDS: 0.380 g/l • DO: 8.91 mg/l • DO%: 97.3 % • Clarity: 11 cm • Temperature: 19.6 °C • Salinity: 0.29 • Discharge: 0.043 m^3/s

No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
May 2023				
15	**16.6**	B (Good)	**0.3**	**0**
Dominant Species	*(1) Achnanthidium sp.*			
	(2) *Fragilaria capucina Desmazieres*			
Preferences	(1) Moderate to good water quality conditions			
	(2) Cosmopolitan taxon is found in circumneutral, oligo- to mesotrophic waters with moderate electrolyte content, may have some resistance to heavy metals			

Component	**Confidence Score***	**Advantages**	**Disadvantages**
Hydraulics	2.5	• Straight simple channel form	• Single observation
Fish	2	• Site not located within polluted reach • Easy access	• Site located immediately below Gcuwa dam within scour zone • Velocity-depth classes limited • Cover features limited
Macroinvertebrates	2	• Ease of access • Some biotopes for macroinvertebrates	• Bedrock driven • Flows compromised as site is located directly from the Gcuwa Dam wall • Limited marginal vegetation due to cattle trampling
Riparian vegetation	3	• Ease of access to site, both banks and features	• Extensive scour from upstream dam has reduced riparian indicator representation substantially

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Single observation for this new site
Fish						• PES-EI-ES Assessment (DWS, 2014) • Current survey (May 2023)
Macroinvertebrates						• Current survey (May 2023) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)
Hydrology						• Natural and present day flows • Daily flows from gauging weir
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • Google Earth © & Bing satellite imagery. • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Level 1 and 2 Ecoregions. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data Spatial distribution of dams in the study area
Diatoms						• Current survey (May 2023)
Physical-chemical						• Current survey (May 2023) only measured *in situ* water quality and clarity • Green Drop Report, 2011, 2013 and 2021 • 2023 diatom data

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla marmorata, Anguilla mossambica, Enteromius anoplus s.l., Glossogobius callidus,*
Macroinvertebrates	Turbellaria; Oligochaeta; Hirudinea; Potamonautidae; Atyidae; Hydracarina; Perlidae; Baetidae >2spp; Caenidae; Heptageniidae; Leptophlebiidae; Prosopistomatidae; Trichorythidae; Chlorocyphidae; Coenagrionidae; Aeshnidae; Corduliidae; Gomphidae; Libellulidae; Belostomatidae; Corixidae; Gerridae; Hydrometridae; Naucoridae; Nepidae; Notonectidae; Pleidae; Veliidae; Hydropsychidae >2spp; Philopotamidae; Hydroptilidae; Leptoceridae; Dytiscidae; Elmidae; inidae; Hydrophilidae; Psephenidae; Athericidae; Ceratopogonidae; Chironomidae; Culicidae; Dixidae; Muscidae; Simuliidae; Tabanidae; Tipulidae; Ancylidae; Lymnaeidae; Planorbinae; Corbiculidae; and Sphaeridae
Physical-chemical	Historical NCMP data for the site begins in 2007, which does not reflect reference condition of the site. Diatom results were used to infer the reference conditions. The diatom results indicate moderate to good water

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
	quality characterised by moderate electrolyte and nutrient concentrations. These are expected to be the prevailing conditions in the system under reference conditions and before the construction of the Gcuwa Dam just upstream of the site.
Riparian vegetation	This site occurs within the Savanna Biome, Sub-Escarpment Savanna Bioregion, and the Bisho Thornveld vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone and active channel features are expected to be dominated by non-woody riparian species, grasses, sedges and broad-leaf emergent macrophytes, while the banks are expected to be dominated by dense woody vegetation comprising both riparian and terrestrial tree and shrub species.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish	D (51.5%)	F/NF	• Downstream water quality impairment deterring upstream migration of catadromous eels • Significant flow modification (site located immediately below Gcuwa dam wall) • Velocity-depth classes and cover features limited
Macroinvertebrates	D (47.3%)	F/NF	• Site located directly downstream of the Gcuwa dam wall • Inundation upstream of the low water bridge • Habitat dominated by bedrock and limited marginal vegetation
Riparian vegetation	C/D (59.5%)	F NF	• Extensive scour of marginal zone and banks due to proximity of the Gcuwa dam • AIP – Wattle, *Lantana camara* • Vegetation clearing for agriculture
ECOSTATUS (PES)	D (54.50%)		

Component	Causes Present/Absent
Fish	The presence of Gcuwa Dam immediately upstream of the EWR site has resulted in significant flow modification within the downstream system, with limited flow noted during the May 2023 field survey. In addition, given the location of the EWR site immediately below the Gcuwa Dam within the scour zone, cover features as well as velocity-depth classes were regarding as being limited, with no marginal vegetation present and an incised channel noted. Furthermore, the alien *Cyprinus carpio* was noted to dominate the fish assemblage during the May 2023 field survey, and was expected to thrive in the highly turbid waters.

Component	Causes Present/Absent
	Downstream of the EWR site, significant sewage pollution was observed to be entering the system as was significant solid waste from the town of Butterworth and the surrounding residential areas. As a result, upstream migration by eels in particular is impacted, with physical-chemical alterations acting as a deterrent. Consequently, the fish assemblage was determined to be in a largely modified state (Ecological Category D).

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	96.80	98.04
COVER	100.00	100.00
FLOW MODIFICATION	46.55	64.52
PHYSICAL-CHEMICAL	28.57	45.21
MIGRATION		66.55
IMPACT OF INTRODUCED		41.59
FRAI	PRESENT	
FRAI (%)	51.5	
EC: FRAI	D	

Macroinvertebrates

This reach of the Gcuwa River is primarily dominated by bedrock, boulders, SIC and SOOC and adequate availability of GSM. The limited presence of marginal vegetation at this site can be attributed to the dominance of bedrock and its location just downstream of the Gcuwa dam wall, forming a plunge pool.

The recorded macroinvertebrate assemblage within the Gcuwa River exhibited a preference for low to very low water quality and cobbles. Some taxa showed a preference for very fast flowing velocities, while others preferred standing water. No taxa were recorded with a preference for moderately fast flowing water. The only sensitive taxon observed within the community was Perlidae.
A significant portion of the expected community for this site was absent. These missing taxa typically favour cobbles, vegetation, a range of flow velocities, and some have a preference for moderate water quality.

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	46.1	*0.357*	16.4747	1	100
HABITAT	H	52.5	*0.321*	16.8614	2	90
WATER QUALITY	WQ	41.2	*0.304*	12.4958	2	85
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.42857	4	5
						280
INVERTEBRATE EC				47.2605		
INVERTEBRATE EC CATEGORY				D		

<table>
<tr><th colspan="2">PES and causes</th></tr>
<tr><th>Component</th><th>Causes
Present/Absent</th></tr>
<tr><td></td><td>Thus overall, the composition of the macroinvertebrate assemblage was primarily influenced by water quality (41.2%), followed by flow (46.1%) (likely due to the proximity to the dam wall and the dependence on overflow), and then habitat modifications (52.5%). Consequently, the aquatic macroinvertebrate community in the Gcuwa River was deemed to represent largely modified conditions (Ecological Category D, 47.3%). This indicates a substantial change or loss of natural habitat, biota, and essential ecosystem functions within the river.</td></tr>
<tr><td>Riparian vegetation</td><td>Overall, the riparian vegetation VEGRAI score was 59.5%, which is a C/D category. The most notable impacts resulting in the ecoststus score, as observed at site, were close proximity to the upstream Gcuwa Dam with resultant sever scouring of the marginal zone and erosion of banks. Alien invasive plant species and removal of vegetation for agriculture were also a cause. The marginal zone and within-channel active features were dominated by non-woody vegetation, mainly grasses (Miscanthus ecklonii) and sedges (Cyperus textilis), but these were scattered, in low number and density and heavily impacted by flooding and scour disturbance. The zone was bedrock controlled, mainly cobble / boulder / gravel and turbidity was notably high. Overall, the zone was in a D category. The macro channel banks was dominated by dense woody vegetation. There was a mixture of riparian (Combretum caffrum) and terrestrial species (Senegalia caffra), but invasive alien tree species also occurred in high numbers (Acacia mearnsii, A. dealbata, Lantana camara). Disturbance by humans and livestock was high and vegetation clearing for agriculture had taken place in some areas. Overall, the zone was in a C category with AIP being the main reason.
<table>
<tr><th colspan="2">LEVEL 3 ASSESSMENT</th><th colspan="2">Gcuwa</th><th colspan="2">11 May 2023</th></tr>
<tr><th>RIPARIAN VEGETATION EC METRIC GROUP</th><th>CALCULATED RATING</th><th>WEIGHTED RATING</th><th>CONFIDENCE</th><th>RANK</th><th>WEIGHT</th></tr>
<tr><td>Macro channel valley</td><td>52.9</td><td>19.8</td><td>3.0</td><td>1.0</td><td>37.5</td></tr>
<tr><td>Macro channel bank</td><td>63.5</td><td>39.7</td><td>3.0</td><td>2.0</td><td>62.5</td></tr>
<tr><td>LEVEL 3 VEGRAI (%)</td><td></td><td></td><td></td><td>59.5</td><td></td></tr>
<tr><td>VEGRAI EC</td><td></td><td></td><td></td><td>C/D</td><td></td></tr>
<tr><td>AVERAGE CONFIDENCE</td><td></td><td></td><td></td><td>3.0</td><td></td></tr>
<tr><td></td><td>Sub-zone</td><td></td><td></td><td></td><td></td></tr>
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Component	Causes Present/Absent		
		Macro channel valley	Macro channel bank
	VEGRAI % (Zone)	52.9	63.5
	EC (Zone)	D	C
	Confidence (Zone)	3.0	3.0

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Stable	• Current impacts have stabilised and unlikely to impact further. • Although potential decline trend, once the Gcuwa dam wall is raised.	2
Macroinvertebrates	Stable	• Although potential decline trend, once the Gcuwa dam wall is raised.	2
Riparian vegetation	Negative	• Impacts from the dam (scour) have likely stabilised, but invasive alien plant species occur and have the potential to increase if unchecked	3
ECOSTATUS (PES)	Stable		

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR CHANGE
ECOSTATUS	D	D	Aim to retain as EWR site is located just downstream of the Gcuwa Dam wall.

EI/ES, 2014	Re-assessed, 2023*
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system

Site was assessed upstream of Butterworth town. The physical-chemical status at this stretch of the river appears to be in a moderate state, characterised by oligo- to mesotrophic waters with moderate electrolyte content. However, further downstream, the Butterworth WWTW is discharging effluent with a sludge and effluent compliance of 6%. Additionally, the % change in flow of -90% between 2013 and 2021, most of the untreated sewage ends up in the river. The Trankei Quarries is also located upstream, and is likely to impact on the TDS, conductivity and suspended solids of the system downstream. The physical-chemical state downstream of the assessment is, therefore, in a critical condition.

D	D	• F: Operational rules of the dam should be developed and implemented (this will be undertaken during the scenarios and consequences phase of the study); and • F: Gcuwa dam wall proposed to be extended primarily for human consumption.

OVERALL ASSESSMENT

Table 6-5: Overall EcoStatus assessment for GCUW01_R (Gcuwa)

River	**Gcuwa**
EWR Site Code	**GCUW01_R**
Driver component	**PES**
Diatoms	
Response component	**PES**
FRAI	D
MIRAI	D
Riparian vegetation	D
Ecostatus	D
EI	Moderate
ES	Moderate
REC	D

The overall EcoStatus was categorised as a Class D, thus the system in a largely modified state, with an unchanged REC (**Table 6-5**). The fish, macroinvertebrates and the riparian vegetation, all were largely modified owing to the system being dominated by non-native fish species, mostly tolerant macroinvertebrates and invasive alien plant species. The REC and TEC will be managed and maintained as per the PES. This is owing to the Gcuwa dam wall proposed to be extended primarily for basic human needs in the surrounding area.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations; and
- Obtain better understanding of the proposed operational rules of the Gcuwa dam.
- Manage waste disposal along the riparian zone.

6.6 INDW01_R: Indwe River

Sample Date	10 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	INDW01_R	**IUA**	IUA_S01
River	Indwe	**IUA description**	Upper Great Kei
Altitude (m.a.s.l.)	838m	**Prioritised RU**	R_RU21_R
Latitude	-31.897077	**Longitude**	27.409825
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	S20D
Level 2 EcoRegion	18.02	**SQ Reach**	S20D-06813
Geomorphological zone	D (slope 0.006)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near eSingeni, about 9 km from the R61.

The site is located in a confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble and sand sediment types. There are significant bedrock sections with localised bedrock steps. Benches are composed of sand. There is high embeddedness along riffles and rapids with sand.

Aquatic Macroinvertebrate biotopes were driven by bedrock and boulder habitats, with pockets of SIC and SOOC, vast GSM areas but limited marginal vegetation. Varying fish habitats comprised FD, FS, SD and SS.

Site impacts:

- Local villages
- Cattle trampling and grazing
- Low water bridge
- Erosion
- Upstream Lubisi Dam on the Indwe River
- Sand mining

In situ water quality and discharge:

- pH: 8.52
- EC: 305.5 µS/cm

- TDS: 0.2110 g/l
- DO: 8.34 mg/l
- DO%: 95.3 %
- Clarity: 61 cm
- Temperature: 21.9 °C
- Salinity: 0.16
- Discharge: 0.134 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
16	16.6	B (Good)	6.3	0
Dominant Species	(1) *Achnanthes thienemannii Hustedt*			
	(2) *Achnanthidium spp.*			
Preference	(1) Limited research on this diatom species however the specialists feel that it may be indicative of low nutrient/low EC (previously identified in high mountainous streams in SA and Lesotho)			
	(2) Moderate to good quality waters			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2.5	• Simple and straight single channel	• Single observation for a new site • Mobile sands on bed, thus the bed geometry is likely to change during higher flows
Fish	1	• Various cover features	• Single observation for a new site
Macroinvertebrates	2	• Varying flow velocities	• Habitat dominated by bedrock and boulders • Limited marginal vegetation

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation for this new site
Fish						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • No REMP data • GBIF collection data largely limited to Lubisi Dam
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)
Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity • 2022 diatom results • NCMP data site S2H002Q01, 1980 to 2007 (n = 11)

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REpERENCE CONDITIONS**
Fish	*Anguilla mossambica, Enteromius anoplus sl.*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Notonectidae, Veliidae, Hydropsychidae 2spp, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Physidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae
Physical-chemical	Historical data for the site is from 1980 to 2007 with only n = 11 data entries, not enough for a low confidence assessment. Diatoms were used to infer the reference conditions of the site. The diatom results indicated good water quality, free from organic pollution and with low electric conductivities. The available earliest historical data (1980 -1984, n = 9) indicated a range for EC of 21.7 to 43.6 mS/m, TIN 0.06 – 1.36 mg/l and pH at 7.10 – 7.98 pH units.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	F (16.3)	F/NF	• Upstream Indwe Dam resulting in flow modification within the reach assessed • Complete assemblage dominance of non-native species
Macroinvertebrates	C/D (59.03%)	F	• Considerable Simuliidae (Blackfly larvae) outbreak, an indication of changes in natural flows • No bed armouring/high embeddedness – indication of a lack of floods/freshets coming through, supplementing the potential occurrence of the Simuliidae outbreak • Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope • Upstream Indwe Dam (flow modification) • Localised gravel mining (resulting in loss of habitats, flow modifications)
Habitat Integrity: Instream	C (75%)	F/NF	• Indwe Dam upstream • Sand mining

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Bank erosion
Habitat Integrity: Riparian	C (71%)	F/NF	• Loss of baseflows, freshets and annual floods due to dam upstream
ECOSTATUS (PES)	**C/D (60.37%)**		

Component	**Causes Present/Absent**
Fish	Despite the limited diversity of fish species expected under reference conditions, no indigenous fish species were collected during September 2022, with only one species likely to be present under present conditions at a significantly reduced frequency of occurrence, if any. To some extent, this was attributed to the modification of flow by Lubisi Dam located upstream of the reach. However, a complete dominance of non-native species was noted, with one species in particular, *Labeobarbus aeneus*, noted to dominate the catch assemblage. This species is expected to out-compete the smaller indigenous species present. Consequently, the fish assemblage was considered to be critically modified (Ecological Category F).

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	96.37	91.83
COVER	100.00	100.00
FLOW MODIFICATION	34.37	48.52
PHYSICAL-CHEMICAL	36.37	52.72
MIGRATION		55.13
IMPACT OF INTRODUCED		87.05
FRAI	PRESENT	
FRAI (%)	16.3	
EC: FRAI	F	

Macroinvertebrates

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	51.0	*0.296*	15.1213	3	80
HABITAT	H	60.7	*0.370*	22.4868	1	100
WATER QUALITY	WQ	64.3	*0.333*	21.4228	2	90
CONNECTIVITY & SEASONALITY	CS	80.0	*0.000*	0	4	0
						270
INVERTEBRATE EC				59.0309		
INVERTEBRATE EC CATEGORY				C/D		

PES and causes	
Component	**Causes Present/Absent**
	The dominant biotope at this site was bedrock, large cobbles and boulders. Limited marginal vegetation owing to undercut banks. The aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately to largely modified (Ecological Category C/D, 59.03%). During the current survey, a total of 12 taxa were recorded out of a reference community of 48 taxa (25% of the reference community was present). There were a number of taxa absent for some of the velocity metrices. No taxa were recorded that have a preference for moderately or slow flowing, only taxa with a preference for very fast flowing water and only 4 out of an expected 17 taxa were recorded for standing water. This is a clear indication of changes in natural flows. Also indicative of the considerable abundance of Simuliidae (Blackfly larva) recorded at the time of the September 2022 survey (Rivers-Moore & de Moor, 2020). Assessing the flow data from the upstream weir, no flow variability was observed during July and August 2022, thus these constant flows of approximately 1cumec recorded over this time, may have been the reason to the resulting outbreak of Simuliidae during September 2022. The critical periods for controlling population sizes of Simuliidae are July–August (winter months) when most of the population is present in the larval or pupal phase (O'Keeffe and de Moor, 1988). Thus, reduced flows, and lower water levels, during these months is critical to expose the substrate to dry out blackfly larvae and pupae in these months (de Moor, 1982b, 1997; O'Keeffe and de Moor, 1988). This is what should be aimed for in these systems dealing with outbreaks, thus avoiding the typical spring outbreaks of blackfly's during the end of winter/spring seasonal period (i.e., September), as what was observed on the Indwe in September 2023. In addition, owing to no bed armouring/high embeddedness, may also be an indication of a lack of floods/freshets coming through, supplementing the potential occurrence of the Simuliidae outbreak. Although this outbreak may not smother the SIC/bedrock biotopes, they do have the potential to impact on the abundance of other taxa owing to the overwhelming abundance of the Simuliidae (Rivers-Moore et al., 2007). Biota expected but not recorded with these preferences included Turbellaria, Perlidae (sensitive), Heptageniidae (sensitive), Leptophlebiidae, Aeshnidae, Libellulidae and Hydroptilidae (all with a froc ranging from 3-5). Furthermore, owing to undercut banks and limited vegetation to sample, no taxa were recorded out of an expected 10 taxa. Therefore overall, the community was primarily driven by flow modification (51.0%) (resulting in the outbreak of Simuliidae), then habitat metric (60.7%) (dominance of the bedrock opposed to SIC biotope and limited marginal vegetation) and then water quality (64.3%). The ASPT for the community was 5.3 (37% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), and which was dominated by Simuliidae and its associated outbreak.

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Lack of indigenous fish species and dominance of non-native predatory fish species unlikely to change	4
Macroinvertebrates	Decline	• Outbreak of Simuliidae and dominating the macroinvertebrate assemblage (changes in natural flow regime). • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Stable	• drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Riparian	Decline	• Loss of baseflows, freshets and annual floods due to dam upstream	2
ECOSTATUS (PES)	Improvement	• Improvement from a Class D to a C potentially owing to the above	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	D	C/D	• Riparian habitat integrity (C) • Macroinvertebrates (C/D) • Fish category (F) - although only 2 fish species expected • Non-native fish species (CGAR, BAEN)

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2022***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
In situ water parameters were within limits. This is largely due to the lack of major impacts upstream, with no WWTW, major town centres, industries etc. The physical-chemical state of the river at this reach is, to a greater extent, expected to be influenced by the dynamics of the system itself, which are also limited by the Indwe Dam upstream. The impacts of sandmining are likely to be minimal and were not reflected in the *in-situ* water quality results. Diatom result also indicated moderate to good water quality.

C/D	C/D	• Maintain as per the PES; and • F: Indwe reach is a stressed area – high water use for domestic purposes.

OVERALL ASSESSMENT

Table 6-6: Overall EcoStatus assessment for INDW01_R (Indwe)

River	**Indwe**
EWR Site Code	**INDW01_R**
Driver component	**PES**
Diatoms	B
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	F
MIRAI	C/D
Ecostatus	**C/D**
EI	Moderate
ES	Moderate
REC	**C/D**

The overall EcoStatus was categorised as a Class C/D, with an unchanged REC (**Table 6-6**). The fish community was largely devoid of indigenous species during September 2022, with a complete dominance of non-native species resulting in a critically modified ecological state. The aquatic macroinvertebrate community was overall in a moderately to largely modified state primarily comprising tolerant taxa. However, during the current survey, a major outbreak of Simuliidae (Blackfly larvae) was taking place. Thus, the community was driven mostly from flow modifications and habitat (bedrock and boulder dominated), followed by water quality.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations.
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach.
- Flow restrictions (to be assessed during the EWR stage) for a selected period of time (up to a full month), in order to reduce the winter population of the family Simuliidae within the system and to avoid the typical spring outbreaks of the blackfly (Rivers-Moore et al., 2008).

6.7 WKEI01_R: White Kei River

Sample Date	10 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	WKEI01_R	**IUA**	IUA_S01
River	White Kei	**IUA description**	Upper Great Kei
Altitude (m.a.s.l.)	787m	**Prioritised RU**	R_RU20_R
Latitude	-32.003057	**Longitude**	27.351052
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	S10J
Level 2 EcoRegion	18.02	**SQ Reach**	S10J-06985
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, cross-section, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near Saint Marks, about 1 km upstream of the R61.

The site is located in a moderately confined valley setting with a single channel. The river is incised into the surrounding landscape with narrow flood features along the left bank. It has localised islands where bedrock or large boulders form obstructions. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble and sand sediment types. There are localised bedrock sections with localised bedrock steps. Benches are composed of silt and sand. There is low embeddedness along riffles and rapids, but significant embeddedness along pools. Large sand bars form along pool sections.

Aquatic Macroinvertebrate biotopes were dominated by bedrock, with some SIC, SOOC. SIC were heavily embedded compromising this biotope. Good availability of the GSM biotope. No marginal vegetation was present at this site owing to exposed banks and sand mining along the left bank. Varying fish habitats comprised FD, FS, SD and SS.

Site impacts:

- Sand mining
- Erosion and exposed banks
- Cattle trampling and grazing
- Nutrient enrichment (algae)
- Macroplastics (instream and riparian zone)
- Indwe River bringing in high nutrient water (irrigation)

SUMMARY RESULTS

In situ water quality and discharge:

- pH: 8.76
- EC: 644 µS/cm
- TDS: 0.4096 g/l
- DO: 8.29 mg/l
- DO%: 103.5 %
- Clarity: 80 cm
- Temperature: 26.2 °C
- Salinity: 0.31
- Discharge: 0.931 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
28	14.3	B (Good)	11.6	0.7
Dominant Species	*(1) Achnanthidium eutrophilum (Lange-Bertalot) Lange-Bertalot*			
	(2) Achnanthidium spp.			
	(3) Encyonopsis minuta Krammer & Reichardt			
Preference	(1) Found in well-oxygenated eutrophic fresh water. Tolerant only to slight or moderate pollution			
	(2) Moderate to good quality waters			
	(3) Moderately motile, common in circumneutral water (low nutrient concentration)			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2.5	• Stable bad and single channel	• A single observation for this new site • Thesite islocated downstream of a bend, so high-flow hydraulics could be less accurate
Fish	4	• Variety of velocity-depth classes (SD, SS, FS) • REMP monitoring data	• Limited cover features
Macroinvertebrates	4	• Varying flow velocities • Some availability of biotopes (SIC, SOOC) • DWS REMP Site code: S1WKEI-STMAR	• Limited marginal vegetation • High embeddedness along riffles to kick around • Habitats dominated by bedrock

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation for this new site
Fish						• Current survey (September 2022) • Fish FROC (Kleynhans, 2008) • PES-EI-ES Assessment (DWS, 2014)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• REMP monitoring data • GBIF collection records (although limited)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP Site code: S1WKEI-STMAR
Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity • NCMP data site S1H002Q01 1980 to 1996 (n=10) • 2022 diatom results

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla mossambica, Enteromius anoplus sl.*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Prosopistomatidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Protoneuridae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Empididae, Ephydridae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae
Physical-chemical	Historical monitoring dataset for the site consists of 1980 to 1996 data, with only n=10 data entries during this monitoring period. These data were not enough to perform a low confidence assessment. Therefore, diatom results were used to infer the reference conditions of the site. Diatom results indicated good water quality - well oxygenated and free from organic pollution. The earliest historical monitoring data (1980-1982, n=8) indicated an EC range of 36 - 116 mS/m, a TIN range of 0.21 - 2.04 mg/l and a pH range of 6.8 - 8.3 pH units.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	E (25.1%)	F/NF	• Upstream Indwe and Xonxa Dams resulting in flow modification within the reach

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Complete assemblage dominance of non-native species
Macroinvertebrates	C (64.36%)	F	• Considerable Simuliidae (Blackfly larvae) outbreak, an indication of sustained high flows and turbidity • No bed armouring/high embeddedness – indication of a lack of floods/freshets coming through, supplementing the potential occurrence of the Simuliidae outbreak • Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope • Upstream Indwe and Xonxa Dams resulting in flow modification within the reach • Localised sand mining (resulting in loss of habitats, flow modifications)
Habitat Integrity: Instream	C (74%)	F/NF	• Indwe and Xonxa Dams upstream • Sand mining • Cattle trampling and grazing (bank erosion)
Habitat Integrity: Riparian	C (68%)	F/NF	• Loss of baseflows, freshets and annual floods due to dams upstream • Cattle trampling and grazing (bank erosion)
ECOSTATUS (PES)	**C/D (58.22%)**		

Component	**Causes Present/Absent**
Fish	Despite the limited diversity of fish species expected under reference conditions, no indigenous fish species were collected during September 2022. Although these indigenous species cannot be ruled out from occurring within the reach, they may be present at a significantly reduced frequency of occurrence, if any. To some extent, this was attributed to the modification of flow by Indwe and Xonxa Dams located upstream of the reach. Of interest was that previous REMP monitoring within the reach identified the presence of *Glossogobius callidus* which was not expected to occur under reference conditions, and no other collection records for the species occurs within the larger catchment. Nevertheless, a complete dominance of non-native species was noted, with one species in particular, *Labeobarbus aeneus*, noted to dominate the catch assemblage. This species is expected to out-compete the smaller indigenous species expected to be present. Consequently, the fish assemblage was considered to be seriously modified (Ecological Category E, 25.1%).

METRIC GROUP	**REFERENCE WEIGHTS (%)**	**PRESENT WEIGHTS (%)**
VELOCITY-DEPTH	**96.65**	**87.46**
COVER	**100.00**	**89.67**
FLOW MODIFICATION	**34.58**	**43.46**

PES and causes

Component	Causes Present/Absent

PHYSICAL-CHEMICAL	35.57		50.00
MIGRATION			70.59
IMPACT OF INTRODUCED			100.00
FRAI		PRESENT	
FRAI (%)		25.1	
EC: FRAI		E	

Macroinvertebrates

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	68.9	*0.345*	23.7422	1	100
HABITAT	H	55.3	*0.328*	18.1264	2	95
WATER QUALITY	WQ	67.3	*0.293*	19.7309	3	85
CONNECTIVITY & SEASONALITY	CS	80.0	*0.034*	2.75862	4	10
						290
INVERTEBRATE EC				64.3582		
INVERTEBRATE EC CATEGORY				C		

The dominant biotope at this site was bedrock, with some highly embedded SIC, SOOC and limited marginal vegetation owing to undercut banks. The aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately modified (Ecological Category C, 64.36%). During the current survey, a total of 27 taxa were recorded out of a reference community of 59 taxa (46% of the reference community was present). Taxa recorded during the survey mostly had a preference for low to very low water quality, cobbles and standing water. Similarly, the most dominant taxa recorded was Simuliidae, clearly in their outbreak densities primarily owing to sustained high flows downstream of the Indwe and Xonxa Dams, coupled with high turbidity in this system (Rivers-Moore & de Moor, 2020). The critical periods for controlling population sizes of Simuliidae are July–August (winter months) when most of the population is present in the larval or pupal phase (O'Keeffe and de Moor, 1988). Thus, reduced flows, and lower water levels, during these months is critical to expose the substrate to dry out blackfly larvae and pupae in these months (de Moor, 1982b, 1997; O'Keeffe and de Moor, 1988). This is what should be aimed for in these systems dealing with outbreaks, thus avoiding the typical spring outbreaks of blackfly's during the end of winter/spring seasonal period (i.e., September), as what was observed on the Indwe in September 2023.

Furthermore, owing to no bed armouring/high embeddedness, may also be an indication of a lack of floods/freshets coming through, supplementing the potential occurrence of the Simuliidae outbreak. Although this outbreak may not smother the SIC/bedrock biotopes, they do have the potential to impact on the abundance of other taxa owing to the overwhelming abundance of the Simuliidae (Rivers-Moore et al., 2007). Biota expected but not recorded with these preferences included Turbellaria and Hydropsychidae >2spp, the rest of the absent taxa had low froc's.

PES and causes	
Component	**Causes Present/Absent**
	Therefore overall, the community was primarily driven by habitat (55.3%) (bedrock dominated, Simuliidae outbreak and high embeddedness thus limitations with colonising the biotope), followed by water quality (67.3%) (majority of the recorded taxa responded to low to very low water quality), closely followed by flow modification (68.9%) indicative of the Simuliidae population. The ASPT for the community was 5.5 (78% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), and which was dominated by Simuliidae and its associated outbreak.

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Lack of or limited presence of indigenous fish species and dominance of non-native predatory fish species unlikely to change	4
Macroinvertebrates	Decline	• Outbreak of Simuliidae and dominating the macroinvertebrate assemblage (changes in natural flow regimes) • Erosion increasing which may have future impacts on the community. • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Decline	• Loss of baseflows, freshets and annual floods due to dams upstream • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Riparian	Decline	• Loss of baseflows, freshets and annual floods due to dams upstream • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
ECOSTATUS (PES)	Decline	• Slight decline from a Class C to a Class C/D potentially owing to the above	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR CHANGE
ECOSTATUS	C	C/D	• Loss of baseflows, freshets and annual floods • Dominance of non-native fish species

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
In situ water parameters tested were within limits. Satellite imagery does, however, indicate erosion in the area, which will lead to high sediment loading in the system, not reflected in the *in-situ* water quality results, possibly as a result of the location of the monitoring point downstream where the flow velocity has reduced and suspended solids settled. Diatom results indicated moderate to good quality waters.

C/D	C	• F: Irrigation schemes aid in social economic upliftment; and • F: Some flow sensitive aquatic macroinvertebrate taxa present within the system, which should remain.

OVERALL ASSESSMENT

Table 6-7: Overall EcoStatus assessment for WKEI01_R (White Kei)

River	**White Kei**
EWR Site Code	**WKEI01_R**
Driver component	**PES**
Diatoms	
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	E
MIRAI	C
Ecostatus	C/D
EI	Moderate
ES	Moderate
REC	**C**

The overall EcoStatus was categorised as a Class C/D, with a REC of a C (**Table 6-7**). The fish community was largely devoid of indigenous species during September 2022, with a complete dominance of non-native species resulting in a critically modified ecological state. The aquatic macroinvertebrate community was overall in a moderately modified state primarily comprising tolerant taxa. However, during the current survey, a major outbreak of Simuliidae (Blackfly larvae) was taking place. Thus, the community was driven mostly from habitat, closely followed by water quality and flow modifications.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach.
- Flow restrictions (to be assessed during the EWR stage) for a selected period of time (up to a full month), in order to reduce the winter population of the family Simuliidae within the system and to avoid the typical spring outbreaks of the blackfly (Rivers-Moore et al., 2008)
- Implementation of riverine buffers from the outer edge of the riparian zone with concomitant grazing management within the buffer areas

6.8 KUBU03_R: Kubusi River (Lower)

Sample Date	10 May 2023	**Reserve Level Assessment**	Rapid 3 *(higher confidence, including VEGRAI)*
Site Name	KUBU01_I	**IUA**	IUA_S03
River	Kubusi	**IUA description**	Lower Great Kei
Altitude (m.a.s.l.)	641m	**Prioritised RU**	R_RU0_12
Latitude	-32.50722	**Longitude**	27.731348
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S60B
Level 2 EcoRegion	16.06	**SQ Reach**	S60E-07531
Geomorphological zone	D (slope 0.012)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Components sampled: Fish, aquatic macroinvertebrates, VEGRAI (high confidence), *in situ* water quality, diatoms, cross-section, discharge			
Site Photographs: Survey 2 (May 2023)			
			
Site Description:			
The site is located off the N6, near Mokalo Private Game Reserve at the DWS REMP site. The site is located in a confined valley setting with a braided channel and narrow flood features. It has localised islands where bedrock or large boulders form obstructions. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by cobbles, boulder and sand sediment types. There are several riffle steps down the reach. Benches are composed of silt and sand. There is low embeddedness along riffles and rapids. *Biota habitats available* Boulders and cobbles were the most dominant biotope for the aquatic macroinvertebrates, with SOOC and GSM available in pockets along both banks and within the interstitial spaces of the SIC and SOOC. Abundance of both in-stream aquatic vegetation and marginal vegetation. Varying flow velocity and depth classes were available for fish, namely SD, SS, FS and FD.			
Site impacts:			
• Bridge • Agriculture and irrigation			

- Alien invasive plants within the riparian zone
- Upstream Tois River contributing to the sediment loads
- Upstream Wriggleswade Dam

SUMMARY RESULTS

In situ water quality and discharge (May 2023 only):

- pH: 8.23
- EC: 342 µS/cm
- TDS: 0.259 g/l
- DO: 7.91 mg/l
- DO%: 82.6 %
- Clarity: 72 cm
- Temperature: 17.52 °C
- Salinity: 0.19
- Discharge: 0.291 m^3/s

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
May 2023				
31	5.2	B (Good)	4.8	0
Dominant Species	*Achnanthidium sp.*			
Preferences	Moderate to good water quality conditions			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2.5	• Simple singe channel with stable perimeter	• Single observation
Fish	4	• Easy access • Slow-deep,slow-shallow and fast-shallow velocity-depth classes represented • Varity of cover features present, with substrate as a cover feature well represented	• Limited marginal vegetation
Macroinvertebrates	4	• A diversity of macroinvertebrate biotopes • Varying flow velocities • DWS REMP Site code: S6KUBU-BRIDG	• No instream aquatic vegetation
Riparian vegetation	3	• Ease of access to both banks and all features • Reasonable representation of riparian plant species	Proximity to low level bridge and weir

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Hydraulics						• Single observation at a new site
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current river survey (May 2023) • DWS REMP site
Macroinvertebrates						• Current survey (May 2023) • PES-EI-ES Assessment (DWS, 2014) • DWS REMP Site code: S6KUBU-BRIDG
Hydrology						• Natural and present day flows
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • Google Earth © & Bing satellite imagery. • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Level 1 and 2 Ecoregions. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data • Spatial distribution of dams in the study area
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (May 2023) only measured *in situ* water quality and clarity • May 2023 diatom data.

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla marmorata, Anguilla mossambica, Enteromius anoplus s.l., Enteromius amatolicus, Glossogobius callidus,*
Macroinvertebrates	Porifera; Turbellaria; Oligochaeta; Hirudinea; Potamonautidae; Atyidae; Hydracarina; Perlidae; Baetidae >2spp; Caenidae; Heptageniidae; Leptophlebiidae; Oligoneuridae; Polymitarcyidae; Prosopistomatidae; Trichorythidae; Chlorocyphidae; Chlorolestidae; Coenagrionidae; Lestidae; Platycnemidae; Aeshnidae; Corduliidae ;Gomphidae; Libellulidae; Pyralidae; Belostomatidae; Corixidae; Gerridae; Hydrometridae; Naucoridae; Nepidae; Notonectidae; Pleidae; Veliidae; Ecnomidae; Hydropsychidae >2spp; Philopotamidae; Hydroptilidae; Lepidostomatidae; Leptoceridae; Pisuliidae; Sericostomatidae; Dytiscidae; Elmidae; Gyrinidae; Helodidae; Hydraenidae; Hydrophilidae; Psephenidae; Athericidae; Ceratopogonidae; Chironomidae;

Reference Conditions			
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**		
	Culicidae; Dixidae; Muscidae; ;Simuliidae; Tabanidae; Tipulidae; Ancylidae; Lymnaeidae; Planorbinae; Thiaridae; Corbiculidae; Sphaeridae; and Unionidae		
Riparian vegetation	This site occurs within the Savanna Biome, Sub-Escarpment Savanna Bioregion, and the Bisho Thornveld vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone and active channel features are expected to be dominated by non-woody riparian species, grasses, sedges and broad-leaf emergent macrophytes, while the banks are expected to be dominated by dense woody vegetation comprising both riparian and terrestrial tree and shrub species.		
Physical-chemical	Historical data used was from DWS NCMP monitoring site S6H002Q01 (1971-1983, n = 446) i.e., predates the Wriggleswade dam upstream.		
	Physical-variable	pH	Reference condition data indicates a 5th percentile of 6.57 and 95th percentile of 8.13 pH units. The Natural (0) rating was recalibrated such that ≥ 6.57 ≤ 8.13 pH units.
		EC	Reference condition indicates 95th percentile of 37 mS/m. The Natural (0) rating for the site was therefore rebenchmarked such that ≤ 37 mS/m
		Temperature	No historical temperature records are available for this RC site. DWA (2008) benchmark tables are used for a low confidence, qualitative assessment of temperature reference conditions.
		Clarity	There are no clarity/turbidity records available for referenceconditionassessment. Reference condition is taken as that qualitatively described in the DWA (2008) benchmark tables.
		Oxygen	No dissolved oxygen records are available for this site. DWA guideline benchmark tables (2008) have been utilised to characterise the site's reference condition.
	Nutrients	PO_4	Reference data indicated a 50th percentile of 0.017 mg/l. The Natural (0) rating was therefore rebenchmarked such that <0.017 mg/l.
		TIN	Reference data indicated a 50th percentile of 0.2 mg/l, which within the DWA (2008) benchmark for TIN.
	Toxins	Aluminium, Fluoride, Ammonia	In terms of the toxics listed within the DWA (2008) rating tables, only fluoride was monitored. Reference data indicated that the 95th percentile for fluoride was within the DWA (2008) benchmark.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	D/E (39.4%)	F/NF	• Flow modification as a result of Wrigglesway Dam • Dominance of larger non-native fish species
Macroinvertebrates	B/C (78.0%)	NF	• Water quality driven owing to some sediment loads coming down the Tois River (tributary of the Kubusi River located upstream)
Riparian vegetation	C (66.4%)	F NF	• Flow modification as a result of Wrigglesway Dam • AIP – mainly Wattles (*Acacia maernsii, A. dealbata*) and *Lantana camara*
ECOSTATUS (PES)	C (65.95%)		

Component	**Causes Present/Absent**
Fish	The reach of the Kubusi River associated with the EWR is immediately below confluence with the Gqolonci (Toise) River. At the time of the May 2023 assessment, little water was flowing over the Wrigglesway Dam, significantly impacting the hydrology of the system. A local landowner confirmed that eels are still present within the system, albeit in far less abundances. Given the flow modification of the Kubusi River immediately downstream of Wriggelsway Dam, it is expected that eels migrating up the system would be routing along the Gqolonci (Toise) River as they move upstream within the catchment. However, by far the biggest driver of the largely to seriously modified state (Ecological Category D/E) is the dominance of the fish assemblage by non-native fish species, including the translocated *Labeobarbus aeneus, Clarias gariepinus* and *Tilapia sparrmanii*, as well as the alien *Micropterus salmoides* and *Micropterus dolomieu* within the system which are expected so significantly impact the presence of the smaller barb (*Enteromius*) species expected within the system.
Macroinvertebrates	This reach of the Kubusi River was driven largely by the wide diversity of hydraulic conditions across the system, including fast-flowing rapid-riffle complexes, as well as some slow-flowing and standing pools within the marginal zones. An abundance of in-stream aquatic vegetation, marginal vegetation, boulders, SIC, SOOC, some bedrock and GSM between the interstitial spaces were all sampled. The macroinvertebrate assemblage mostly comprised of taxa with a preference

METRIC GROUP	**REFERENCE WEIGHTS (%)**	**PRESENT WEIGHTS (%)**
VELOCITY-DEPTH	**100.00**	**97.15**
COVER	**99.68**	**100.00**
FLOW MODIFICATION	**47.89**	**62.50**
PHYSICAL-CHEMICAL	**28.95**	**43.77**
MIGRATION		**64.36**
IMPACT OF INTRODUCED		**91.94**
FRAI	**PRESENT**	
FRAI (%)	**39.4**	
EC: FRAI	**D/E**	

PES and causes	
Component	**Causes Present/Absent**
	for moderately fast flowing water, cobbles and those taxa with a low requirement for unmodified physical-chemical conditions. Overall, the aquatic macroinvertebrate community assemblage collected was determined to be representative of largely natural to moderately modified conditions (Ecological Category B/C, 70.0%). Consequently, there has been a slight change in the attributes of natural habitats and biota that have occurred in terms of frequencies of occurrence and abundance. Basic ecosystem functions and resilience are still predominantly unchanged. The resilience of the system to recover from human impacts has not been lost and it is ability to recover to a moderately modified condition following disturbance has been maintained. The vast cobbles biotope availability and diversity of hydraulic conditions at the site was supported by the presence of Perlidae, Baetidae >2spp, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Psephenidae and Athericidae. All these taxa have a moderate and high preference for unmodified physical-chemical conditions. However, a number of taxa within the community with low to very low preferences for unmodified physical-chemical conditions were also recorded, thus suggestive of impaired water quality along this reach. This may likely be attributed to the upstream tributary, the Gqolonci River, contributing to sediment loads and further impaired water quality to the lower reaches of the Kubusi River. Those taxa expected, with high frequency of occurrences, but which were absent from the community included Hydracarina, Naucoridae, Hydropsychidae >2spp, Hydroptilidae, Dytiscidae, Hydrophilidae, Ceratopogonidae and Tipulidae. None of which are sensitive taxon, and which prefer the vegetation biotope, a range of velocity conditions and low water quality, with the exception of Hydropsychidae >2spp, being sensitive to water quality and preferring cobbles, although 2spp Hydropsychidae were recorded. **INVERTEBRATE EC METRIC GROUP** |		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
---	---	---	---	---	---	---
FLOW MODIFICATION	FM	82.5	*0.317*	26.1124	2	95
HABITAT	H	72.1	*0.333*	24.0351	1	100
WATER QUALITY	WQ	64.3	*0.200*	12.8642	3	60
CONNECTIVITY & SEASONALITY	CS	100.0	*0.150*	15	4	45
						300
INVERTEBRATE EC				78.0117		
INVERTEBRATE EC CATEGORY				C/B			 Overall, the community was driven by water quality (64.3%), followed by habitat (72.1%), which may be owing to some of the marginal vegetation not being sampled owing to undercut banks and then flow modification (82.5% of the drivers). The ASPT for the community identified in May 2023 was 6.6, indicating the community mostly comprising tolerant taxa (Dickens and Graham, 2002), despite several sensitive taxa making up the community overall.

PES and causes	
Component	**Causes Present/Absent**
Riparian vegetation	Overall, the riparian vegetation VEGRAI score was 66.4%, which is a C category. The most notable impacts resulting in the ecoststus score, as observed at site, were close proximity to upstream weir, and invasive alien perennial and annual species in high densities on flood features and banks. The marginal zone and within-channel active features were dominated by non-woody vegetation, mainly grasses (*Miscanthus ecklonii*) and sedges (Cyperus textilis) with some broadleaf emergent macrophytes (*Persicaria* sp) and scattered alien tree species (*Sesbanea punicea*). The zone was bedrock controlled, mainly cobble / boulder / gravel and water quality was such that it supported extensive algal biofilms cover all wetted bedrock. The main impacts affecting the zone was water quality and quantity, with dams in the catchment but more influential was the close upstream weir. Overall, the zone was in a B/C category. The macro channel banks was dominated by dense woody vegetation. There was a mixture of riparian (*Combretum caffrum*) and terrestrial species (*Senegalia caffra*), but invasive alien tree species also occurred in high numbers (*Acacia mearnsii, A. dealbata, Lantana camara*). Overall, the zone was in a C/D category with AIP being the main reason.

LEVEL 3 ASSESSMENT		**Kubusi**		**10 May 2023**	
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**
Macro channel valley	78.6	29.5	3.0	1.0	37.5
Macro channel bank	59.2	37.0	3.0	2.0	62.5
LEVEL 3 VEGRAI (%)				66.4	
VEGRAI EC				**C**	
AVERAGE CONFIDENCE				3.0	
	Sub-zone				
VEGRAI % (Zone) **EC (Zone)** Confidence (Zone)		Macro channel valley 78.6 B/C 3.0		Macro channel bank 59.2 C/D 3.0	

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers are stable unlikely to change in the near future (e.g. non-native fish species have been present within the system for >50 years and are well established)	4
Macroinvertebrates	Stable	• Biotopes remain plentiful • Good range of flow velocities • However, water quality and sediment loads are compromising the Kubusi, coming in from the Tois River upstream confluence	4
Riparian vegetation	Negative	• Alien invasive tree species (Wattles)	3
ECOSTATUS (PES)	Stable	•	

** 0 – no confidence to 5 – high confidence*

Overall change and reason for deviation			
COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	D	C	• Fish was a category E owing to dominance of non-native fish species (BAEN, CGAR and MSAL)

EI/ES, 2014	**Re-assessed, 2023***
High, High	High, High

Physical-chemical state of the system
Site visit notes indicated nutrient enrichment at this site from the surrounding agricultural land. The high DO levels observed in the *in situ* results are likely a result of the increased algal activity during the day. All other *in situ* parameters were within limits. Diatom results also suggest moderate to good quality water.

C B/C	• F: Wriggleswade – if they can release, and will release the required operational rules, this will ultimately improve flows and buffer the impaired water quality with the aim to reach this REC; • F/NF: Part of a SWSA that requires priority protection measures and a formal hydrological flow gauge preferably in the form of real flow measurements; and • NF: Improvement of water quality (high sedimentation) entering the Kubusi from the small upstream tributary Tois River.

OVERALL ASSESSMENT

Table 6-8: Overall EcoStatus assessment for KUBU03_R (Kubusi)

River	**Lower Kubusi**
EWR Site Code	**KUBU03_R**
Driver component	**PES**
Diatoms	B
Response component	**PES**
FRAI	E
MIRAI	B/C
Riparian vegetation	C
Ecostatus	C
EI	**High**
ES	High
REC	B/C

The overall EcoStatus was categorised as a Class C, thus the system being moderately modified (**Table 6-8**). This was driven primarily by the fish component, with the community being dominated by non-native fish species and the flow being modified by Wriggleswade Dam. The aquatic macroinvertebrate community comprised water quality and flow sensitive taxa, although several tolerant taxa with a low requirement for unmodified physical-chemical conditions were also required, thus responding to water quality modification. Both the REC and TEC can be improved to a B/C, should additional releases from the upstream Wriggleswade Dam can be done, with the aim to improve flows and buffer the impaired water quality along this reach.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations; and
- Improvement of water quality (high sedimentation) entering the Kubusi from the small upstream tributary Tois River should be managed.

6.9 KEIS02_R: Keiskamma River (Lower)

Sample Date	19 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	KEIS02_R	**IUA**	IUA_R01
River	Keiskamma	**IUA description**	Keiskamma
Altitude (m.a.s.l.)	118m	**Prioritised RU**	R_RU18_R
Latitude	-33.075316	**Longitude**	27.218534
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	R10L
Level 2 EcoRegion	31.01	**SQ Reach**	R10L-08173
Geomorphological zone	E (slope 0.003)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, cross-section, discharge			

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near Kalana, about 1.5 km from the N2 in a downstream direction.

The lower Keiskamma reach is located in a confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel, sand and silt sediment types. The banks and benches are composed of sand and silt.

Biotopes available for the aquatic macroinvertebrates included SIC, SOOC and marginal vegetation. GSM was available in pockets along both banks, mainly within the interstitial spaces of the SIC. Sand was limited and there was no instream aquatic vegetation present. Fish habitats included FD, FS and SS.

Site impacts:

- 2 x dams in the upstream catchments of Upper Keiskamma (Sandile) and Tyume (Tyume/ Binfield)
- Cattle trampling and grazing
- Some bank erosion
- Irrigation
- Low water bridge
- Nutrients (high fibrous algae)

In situ water quality and discharge:

- pH: 8.15
- EC: 362.6 µS/cm

- TDS: 0.2734 g/l
- DO: 7.45 mg/l
- DO%: 79.00 %
- Clarity: 13 cm
- Temperature: 17.8 °C
- Salinity: 0.20 ppt
- Discharge: 0.568 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
33	8.3	D (Poor)	16	0
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preferences	Nutrient and salinity increases, so meso- or eutrophic conditions and is often related to standing water.			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2.5	• Simple single channel with stable bed	• One observation for this new site • Close to downstream bridge, could influence high flow hydraulics
Fish	3	• Easy access and wadable • Slow-deep, slow-shallow and fast-shallow velocity-depth classes represented • Substrate, overhanging vegetation and water column as cover features present	• Highly turbid
Macroinvertebrates	3	• Good availability of biotopes • Varying flow velocities • DWS REMP site further upstream: R1KEIS-GCINI (within same Ecoregion Level 2 and geoclass)	• High filamentous algae content smothering SIC biotopes • Highly turbid • Some bed modification owing to the bridge at the site

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• A single observation for this new site
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current river survey (May 2023)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• DWS REMP site further upstream: R1KEIS-GCINI (within same Ecoregion Level 2 and geoclass)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP site further upstream: R1KEIS-GCINI (within same Ecoregion Level 2 and geoclass)
Hydrology						• Natural and present day flows • Daily flows from gauging weir
Diatoms						• Re-con survey (April 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity. • 2022 diatom data. • NCMP data site 1-11019 (2005 – 2009, n=107)

** 0 (no information) to 4 (large amount of data available)*

Reference Conditions	
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla bengalensis, Anguilla marmorata, Anguilla mossambica, Awaous aeneofuscus, Enteromius mandelai, Gilchristella aestuaria, Glossogobius callidus, Monodactylus falciformis, Pseudomyxus capensis, Oreochromis mossambicus, Redigobius dewaali, Sandelia bainsii*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Amphipoda, Potamonautidae, Atyidae, Paleomonidae, Hydracarina, Notonemouridae, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Oligoneuridae, Polymitarcyidae, Prosopistomatidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Platycnemidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Pisuliidae, Dytiscidae, Elmidae, Gyrinidae, Helodidae ,Hydrophilidae ,Psephenidae, Athericidae, Blepharoceridae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Simuliidae, Syrphidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Physidae, Corbiculidae, Sphaeridae
Physical-chemical	The earliest monitoring data for the site is from 2005 up to 2019 (n=107). These data do not reflect the reference conditions at the site. Diatoms were used to infer the reference conditions of the site. The diatom results indicated poor water quality characterised by periodic nutrient and salinity increases. Under reference conditions, the site is expected to have low organic pollutants.

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	E (36.4%)	F/NF	• Flow modification as a result of upstream impoundments (Sandile Dam and Tyume Dam) • Presence of non-native fish species, including translocated *Clarias gariepinus, Labeo umbratus* and *Tilapia sparrmanii*, and alien *Cyprinus carpio*
Macroinvertebrates	C (77.06%)	F/NF	• Water quality (nutrients, high fibrous algae) • Considerable Simuliidae (Blackfly larvae) outbreak, an indication of sustained high flows and loss of floods due to upstream impoundments • Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope • Upstream Sandile and Tyume Dams (loss of some floods, flow modification)
Habitat Integrity: Instream	C (76%)	F	• Upstream dams (Sandile, Tyume) resulting in a loss of floods
Habitat Integrity: Riparian	B (87%)	-	• N/A
ECOSTATUS (PES)	**C (72.35%)**		

Component	**Causes Present/Absent**
Fish	Based on data collected during the May 2023 field survey and taking results obtained during recent REMP monitoring activities into consideration, only 4 of the expected 12 expected native fish species were present or considered likely to be present under current conditions. The reach of the Keiskamma River is subject to flow modification as a result of the presence of two main dams, notably Sandile Dam and Tyume Dam. This has resulted in a decrease in the migratory cues due to loss of larger flood events in recent years (possibility of drought influence). In addition, the presence of several non-native fish species, including translocated *Clarias gariepinus, Labeo umbratus* and *Tilapia sparrmanii*, and alien *Cyprinus carpio* were expected to be negatively impacting the native fish assemblage. Consequently, the fish assemblage within the reach was determined to be in a seriously modified state (Ecological Category E).

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	95.27	86.98
COVER	100.00	100.00
FLOW MODIFICATION	52.94	66.91
PHYSICAL-CHEMICAL	69.14	73.80
MIGRATION		90.28
IMPACT OF INTRODUCED		83.59

PES and causes

Component	Causes Present/Absent

FRAI	**PRESENT**
FRAI (%)	**36.4**
EC: FRAI	**E**

Macroinvertebrates

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	77.2	*0.345*	26.6164	1	100
HABITAT	H	85.6	*0.328*	28.0562	2	95
WATER QUALITY	WQ	67.7	*0.310*	21.008	3	90
CONNECTIVITY & SEASONALITY	CS	80.0	*0.017*	1.37931	4	5
						290
INVERTEBRATE EC				77.0598		
INVERTEBRATE EC CATEGORY				C		

A diversity of biotopes and varying flow velocities was present at this site. The aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately modified (Ecological Category C, 77.06%). During the last hydrological year (September 2021 – September 2022), a total of 35 taxa were recorded out of a reference community of 61 taxa (57% of the reference community was present). The community appeared to respond mostly to the cobble's biotope, moderate fast flowing velocities (0.3-0.6 m/s) and low to very low water quality. Although, a number of sensitive taxa was recorded, indicative of good flow velocity and water quality. These included Perlidae, Baetidae >2spp, Heptageniidae, Pyralidae and Hydropsychidae >2spp. Those taxa expected but not recorded mostly had low frocs, with the exception of Atyidae and Corixidae (froc 3), both of which are driven by standing water and vegetation and moderate to high water quality.

Overall, the community was primarily driven by water quality (67.7%) (high nutrient input resulting in considerable filamentous algae and loss of floods), flow modification (77.2%) (outbreak of Simuliidae), and then habitat (85.6%). The ASPT for the community was 6.4 (78% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), and which was dominated by Simuliidae and its associated outbreak.

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
Macroinvertebrates	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	4

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
		• Erosion increasing which may have future impacts on the community • Habitat availability remains • Average ASPT for the hydrological year: ranged from 5.9 – 6.8 • Although outbreak of Simuliidae and dominating the macroinvertebrate assemblage (changes in natural flow regimes) – these abundances were not recorded during previous surveys at the upstream REMP site	
Habitat integrity: Instream	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
Habitat integrity: Riparian	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
ECOSTATUS (PES)	Stable	• Remains a Class C	3

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	C	C	• Remains unchanged • Presence of several non-native fish species (CCAR, CGAR, TSPA, LUMB) • Indigenous fish species at low frequency of occurrence • Aquatic biotopes availability remains good for aquatic macroinvertebrates

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2023***
High, High	High, High

Physical-chemical state of the system
Very low visibility/clarity was recorded suggesting sediment loading from bank erosion and possibly poor farmland management. High algae cover also suggested nutrient loading from the agricultural activities on the eastern bank of the river. Diatoms also indicated poor water quality characterised by nutrient and salinity increases.

Status (PES)		
	C B/C	• F/NF: Presence of both flow and water quality sensitive aquatic macroinvertebrates present and should remain within the system; • NF: Water quality improvement required, although more prominent further upstream near the upper Keiskamma (rural areas); and • F: Linkage to Keiskamma Estuary.

OVERALL ASSESSMENT

Table 6-9: Overall EcoStatus assessment for KEIS02_R (Lower Keiskamma)

River	Lower Keiskamma
EWR Site Code	**KEIS02_R**
Driver component	**PES**
Diatoms	D
IHI (instream)	C
IHI (riparian)	
Response component	**PES**
FRAI	E
MIRAI	C
Ecostatus	**C**
EI	High
ES	High
REC	B/C

The overall EcoStatus was categorised as a Class C, with a REC of a B/C (**Table 6-9**). The fish community was dominated by non-native fish species. The aquatic macroinvertebrate community was overall in a moderately modified state primarily comprising tolerant taxa. However, during September 2022, a major outbreak of Simuliidae (Blackfly larvae) was taking place (had not occurred during previous surveys). Overall, the community was driven mostly from water quality, flow modification and then habitat metric.

RECOMMENDATIONS

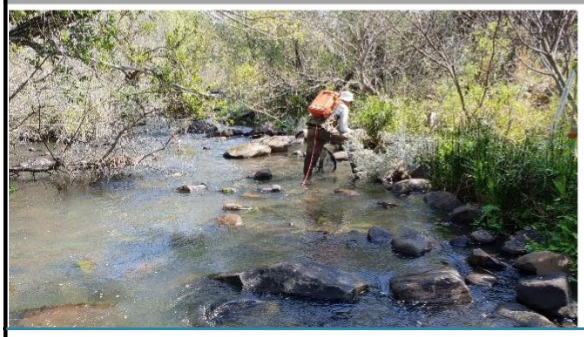
- Refer to Chapter 11 for general recommendations;
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach; and
- Flow restrictions (to be assessed during the EWR stage) for a selected period of time (up to a full month), in order to reduce the winter population of the family Simuliidae within the system and to avoid the typical spring outbreaks of the blackfly (Rivers-Moore *et al.,* 2008).

6.10 TYUM01_R: Tyume River

Sample Date	14 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	TYUM01_R	**IUA**	IUA_R01
River	Tyume	**IUA description**	Keiskamma
Altitude (m.a.s.l.)	347m	**Prioritised RU**	R_RU17_R
Latitude	-32.910291	**Longitude**	26.932242
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	R10H
Level 2 EcoRegion	18.02	**SQ Reach**	R10H-07938
Geomorphological zone	D (slope 0.008)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	High

Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, cross-section, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near Macibini, about 600m upstream of the confluence with the Keiskamma River.

The site is located in a confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and silt sediment types. The banks and benches are composed of sand and silt.

All aquatic macroinvertebrate biotopes had good availability and varying fish habitats comprised FS, SD and SS.

Site impacts:

- Sand mining
- Erosion
- Vegetation clearing upstream
- Nutrient enrichment (algae)
- Alien plant species within the riparian zone (Salix sp.)
- Domestic use
- Irrigation
- Upstream dam (Tyume Dam)
- Cattle grazing and trampling
- Upstream WWTW

SUMMARY RESULTS

In situ water quality and discharge:

- pH: 8.43
- EC: 387.0 µS/cm
- TDS: 0.3014 g/l
- DO: 8.23 mg/l
- DO%: 84.1 %
- Clarity: 68 cm
- Temperature: 16.4 °C
- Salinity: 0.23
- Discharge: 0.198 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
32	11.4	C (Moderate)	14.4	4
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preferences	Nutrient and salinity increases (eutrophication)			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	3	• Simple and stable site along a straight channel	• A single observation for this new site
Fish	3	• Easy access and wadeable • Slow-deep,slow-shallow and fast-shallow velocity-depth classes represented • Various cover features present	• Single observation • Seasonal limitations
Macroinvertebrates	4	• Good availability of biotopes • Varying flow velocities • DWS REMP site directly upstream: R1TYUM-BECON	• High filamentous algae content smothering SIC biotopes • Some bed modification owing to low water bridge/crossing

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• A new site with one observation
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current river survey (September 2022) • DWS REMP site directly upstream: R1TYUM-BECON
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• DWS REMP site directly upstream: R1TYUM-BECON
Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity. • 2022 diatom data. • NCMP data site 1-11018 (2005 – 2019, n=107)

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla marmorata, Anguilla mossambica, Awaous aeneofuscus, Enteromius mandelai, Enteromius trevelyani, Glossogobius callidus, Oreochromis mossambicus, Sandelia bainsii*
Macroinvertebrates	Porifera, Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Oligoneuridae, Telagonodidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Veliidae, Hydropsychidae 2spp, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Physidae, Planorbinae, Corbiculidae
Physical-chemical	Earliest monitoring data for the site is from 2001 up to 2019. These data do not reflect the reflect the reference conditions at the site. As such, the diatom data were used to infer the reference conditions at the site. The diatom results indicated moderate water quality linked to periodic nutrient and salinity increases. Under reference conditions, it is expected that the nutrient concentrations would remain low.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	D/E (41.0%)	F/NF	• Flow modification due to presence of upstream dams • Water quality impairment due to upstream WWTW, irrigation, etc. • Non-native fish species, including translocated *Clarias gariepinus, Tilapia sparrmanii* and *Labeo umbratus*, as well as possibly alien L*epomis macrochirus*
Macroinvertebrates	B/C (79.34%)	F/NF	• Water quality (nutrients from WWTW, irrigation, high fibrous algae)

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
			• Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope • Upstream Tyume Dams (loss of some floods, flow modification)
Habitat Integrity: Instream	C (74%)	NF	• Water quality (nutrients from irrigation and WWTW)
Habitat Integrity: Riparian	B (86%)	F	• Reduced floods due to dam upstream
ECOSTATUS (PES)	**C (75.26%)**		

Component	Causes Present/Absent
Fish	Of the 7 fish species expected under reference conditions, 6 species were confirmed to be present or likely presence under present conditions, albeit with reduced frequencies of occurrence. However, flow modification as a result of Tyme Dam (resulting in loss of migratory cues) as well as the strong presence of non-native fish species (including translocated *Clarias gariepinus, Tilapia sparrmanii* and *Labeo umbratus*, as well as possibly alien L*epomis macrochirus*) within the reach is significantly impacting the ecological state of the fish assemblage within the reach. Additional contributing factors include water quality impairment as a result of WWTW discharges and agriculture within the catchment.

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	99.61	100.00
COVER	100.00	97.07
FLOW MODIFICATION	36.26	47.91
PHYSICAL-CHEMICAL	69.84	71.97
MIGRATION		60.22
IMPACT OF INTRODUCED		98.26
FRAI	PRESENT	
FRAI (%)	41.0	
EC: FRAI	D/E	

PES and causes	
Component	**Causes Present/Absent**
Macroinvertebrates	

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	82.0	*0.333*	27.3333	2	95
HABITAT	H	86.8	*0.281*	24.372	3	80
WATER QUALITY	WQ	70.8	*0.351*	24.8313	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.035*	2.80702	4	10
						285
INVERTEBRATE EC				79.3437		
INVERTEBRATE EC CATEGORY				C/B		

A diversity of biotopes and varying flow velocities was present at this site. The aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately to largely natural (Ecological Category B/C, 79.34%). During the last hydrological year (September 2021 – September 2022), a total of 35 taxa were recorded out of a reference community of 51 taxa (67% of the reference community was present).

From a sensitivity perspectivity (QV>8), of the 16 expected sensitive and very sensitive taxa (QV>8), 10 were recorded namely Baetidae >2spp, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Lestidae, Aeshnidae, Corduliidae, Elmidae and Psephenidae, all of which also have a preference for cobbles. The only taxa absent with a froc 3 was Hydracarina, the rest of the absent taxa had froc 1. However, in terms of water quality references, 71% of the taxa with low or very low water quality requirements were present. Interesting, an abundance of large Porifera (Sponge) was recorded at this site during the September 2022 survey (Figure 6-1).

PES and causes	
Component	**Causes Present/Absent**
	 **Figure 6-1:** Porifera recorded at site TYUM01_R on the Tyume River in September 2022 Overall, the community was primarily driven by water quality (70.8%) (high nutrient input resulting in considerable filamentous algae), flow modification (82.0%) (loss of floods due to upstream Tyume Dam), and then habitat (86.8%). The ASPT for the community was 5.6 (84% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002).

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	
Macroinvertebrates	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth) • Erosion increasing which may have future impacts on the community • Habitat availability remains • Average ASPT for the hydrological year: ranged from 5.6 – 6.0	4

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Habitat integrity: Instream	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
Habitat integrity: Riparian	Stable	• Drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
ECOSTATUS (PES)	Stable	• Remains a Class C	3

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	C	C	• Remains unchanged • Presence of non-native fish species (CGAR, LUMB, TSPA) • Indigenous fish species at low frequency of occurrence • Aquatic biotopes availability remains good for aquatic macroinvertebrates

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2023***
Moderate, High	High, High

Physical-chemical state of the system
Nutrient enrichment noted during site visit, likely resulting from the Fort Hare Alice WWTW approximately 33 km upstream. No information on the WWTW could be found in the Green Drop Report. All the *In situ* water quality parameters were within guidelines. Diatom results indicated moderate water quality characterised by nutrient and salinity increases.

C	B/C	• F: Flow sensitive aquatic macroinvertebrates present and which should remain within the system; • F: This reach is a Fish Support Area (FSA) (*Amatolacypris trevelyani*, - Border Barb - IUCN Status Endangered), *Sandelia bainsii*, - Eastern Province Rock - IUCN Status Endangered); • Ecological Importance reassessed to a High; and • NF: Aim for water quality improvements.

OVERALL ASSESSMENT

Table 6-10: Overall EcoStatus assessment for TYUM01_R (Tyume)

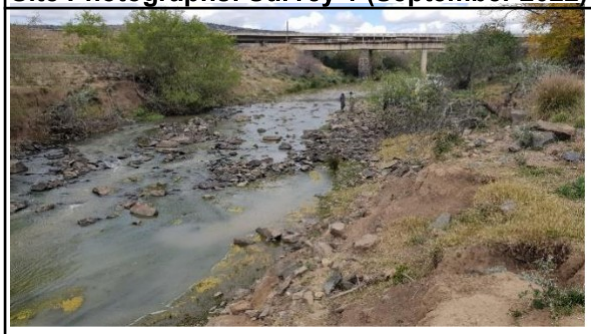
River	Tyume
EWR Site Code	**TYUM01_R**
Driver component	**PES**
Diatoms	C
IHI (instream)	C
IHI (riparian)	B
Response component	**PES**
FRAI	D/E
MIRAI	B/C
Ecostatus	**C**
EI	High
ES	High
REC	B/C

The overall EcoStatus was categorised as a Class C, with a REC of a B/C (**Table 6-10**). The fish community dominated by non-native fish species. The aquatic macroinvertebrate community was overall in a moderately to largely natural state primarily comprising tolerant taxa. Overall, the community was driven mostly from water quality, flow modification and then habitat metric.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Enforcement of riverine buffers, especially around agricultural elements; and
- Maintenance of sewage-related infrastructure (including WWTW).

6.11 KOON01_R: Koonap River

Sample Date	12 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	KOON01_R	**IUA**	IUA_Q03
River	Koonap	**IUA description**	Koonap and Kat
Altitude (m.a.s.l.)	229m	**Prioritised RU**	R_RU16_R
Latitude	-33.042856	**Longitude**	26.658506
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q92G
Level 2 EcoRegion	18.02	**SQ Reach**	Q92G-08203
Geomorphological zone	E (slope 0.003)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, cross-section, discharge			
Site Photographs: Survey 1 (September 2022)			
			
Site Description:			
The site is located just downstream of the R67. The site is located in a partly confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and silt sediment types. The banks and benches are composed of sand and silt. There is high embeddedness along riffles and rapids with silt. Biotopes available for aquatic macroinvertebrates included SIC, SOOC and GSM. Marginal vegetation was limited, however some instream aquatic vegetation was available. Fish habitats included SD, SS, FS and FD.			
Site impacts:			
• Nutrient enrichment (algae) • Erosion • Upstream weir • Upstream town (WWTW) • Abstraction and irrigation • Cattle trampling and grazing • High silt loads			
In situ water quality and discharge: • pH: 8.52			

- EC: 297.7 µS/cm
- TDS: 0.2188 g/l
- DO: 9.58 mg/l
- DO%: 104.5 %
- Clarity: 14 cm
- Temperature: 19 °C
- Salinity: 0.16
- Discharge: 0.23 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
19	8.4	D (Poor)	8.4	7
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preferences	Nutrient and salinity increases (eutrophication)			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	3	• Simple and stable cross section along a straight channel	• A single observation for this new site
Fish	3	• Easy access and wadable • Slow-deep,slow-shallow and fast shallow velocity-depth classes represented • Substrate and water column as cover features present	• High degree of algal growth present of substrate • Potential presence of hippos • Single observation • Seasonal limitations
Macroinvertebrates	3	• Adequate habitat availability for SIC, SOOC and GSM • Varying flow velocities • DWS REMP site: Q9KATR-BRIDG (same ecoregion Level 2 and geoclass)	• High filamentous algae content smothering SIC biotopes • Limited marginal vegetation • High embeddedness along riffles to kick around

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• One observation for this new site
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current river survey (September 2022)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• DWS REMP site: Q9KATR-BRIDG (same ecoregion Level 2 and geoclass)
Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity • 2022 Diatom data • REMP data site 190064 (2006 – 2015, n=25)

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla bicolor bicolor, Anguilla marmorata, Anguilla mossambica, Enteromius mandelai, Glossogobius callidus, Labeo umbratus, Sandelia bainsii*
Macroinvertebrates	Coelenterata, Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Protoneuridae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae
Physical-chemical	Earliest historical data for the site were from 2006 up to 2015, with only n= 25 data entries during this monitoring period. The diatom results were used to infer the reference conditions of the site. Diatom results indicated poor water quality linked to inorganic pollution, expected to be absent under reference conditions. Toxic substances data were not recorded in the historical dataset.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	E (27.5%)	F/NF	• Dominance of non-native fish species, including translocated *Labeobarbus aeneus, Labeo capensis,* and *Clarias gariepinus* and alien *Cyprinus carpio* • Flow modification • Water quality impairment
Macroinvertebrates	D (55.24%)	F/NF	• Water quality (nutrients, irrigation, high fibrous algae) • Considerable Simuliidae (Blackfly larvae) outbreak, an indication of sustained high flows and loss of floods due to upstream impoundments

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Cattle trampling and grazing (erosion) – hampering marginal vegetation aquatic biotope
Habitat Integrity: Instream	C (72%)	NF	• Water quality (extensive algae) • Irrigation
Habitat Integrity: Riparian	C (70%)	F/NF	• Cattle trampling and grazing (causing bank collapse) • Vegetation removal • Several weirs
ECOSTATUS (PES)	**D (54.08%)**		

Component	**Causes Present/Absent**
Fish	The fish assemblage within the reach was considered to be seriously modified, with a dominance of non-native fish species present including translocated *Labeobarbus aeneus, Labeo capensis,* and *Clarias gariepinus* and alien *Cyprinus carpio.* Of relevance is that the landowner has noted that the presence of *Clarias gariepinus* continues to increase, while the abundance of eels within the reach has decreased, suggesting a continued decline of the ecological state of the fish assemblage. In addition, flow modification as a result of water use within the catchment and as well as nutrient enrichment has contributed to the poor state of the fish assemblage present.

METRIC GROUP	**REFERENCE WEIGHTS (%)**	**PRESENT WEIGHTS (%)**
VELOCITY-DEPTH	**100.00**	**79.08**
COVER	**97.35**	**80.45**
FLOW MODIFICATION	**33.09**	**42.89**
PHYSICAL-CHEMICAL	**74.47**	**61.87**
MIGRATION		**64.29**
IMPACT OF INTRODUCED		**100.00**
FRAI	**PRESENT**	
FRAI (%)	**27.5**	
EC: FRAI	**E**	

PES and causes	
Component	**Causes Present/Absent**
Macroinvertebrates	

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	55.7	*0.321*	17.9082	2	90
HABITAT	H	60.5	*0.286*	17.2886	3	80
WATER QUALITY	WQ	48.1	*0.357*	17.1875	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.036*	2.85714	4	10
						280
INVERTEBRATE EC				55.2414		
INVERTEBRATE EC CATEGORY				D		

Although a diversity of biotopes and varying flow velocities were present at this site, a considerable amount of algae was present and smothering the SIC biotope. The aquatic macroinvertebrate assemblage collected was determined to be representative of being largely modified (Ecological Category D, 55.24%). A total of 20 taxa were recorded out of a reference community of 54 taxa (37% of the reference community was present).
A total of 18 sensitive and very sensitive taxa were expected for this site however, only 2 taxa were recorded namely Baetidae>2spp and Leptophlebiidae. A clear indication that this site is highly impacted, mainly from a water quality perspective as majority of the taxa recorded responded to low to very low water quality (52%). Again, the most dominant taxa recorded was Simuliidae, clearly in their outbreak densities primarily owing to sustained high flows, coupled with high turbidity in this system (Rivers-Moore & de Moor, 2020). Furthermore, owing to no bed armouring/high embeddedness, may also be an indication of a lack of floods/freshets coming through, supplementing the potential occurrence of the Simuliidae outbreak. Although this outbreak may not smother the SIC/bedrock biotopes, they do have the potential to impact on the abundance of other taxa owing to the overwhelming abundance of the Simuliidae (Rivers-Moore et al., 2007). Biota expected but not recorded with these preferences included Potamonautidae, Perlidae, Heptageniidae, Trichorythidae, Chlorocyphidae, Aeshnidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Elmidae, Haliplidae, Hydraenidae, Psephenidae, Athericidae, Tabanidae, and Ancylidae. All with froc's of 3-5.

Overall, the community was primarily driven by water quality (48.1%) (high nutrient input resulting in considerable filamentous algae), flow modification (55.7%) (loss of floods), and then habitat (60.5%). The ASPT for the community was 3.9 (52% of the reference ASPT), indicative of the community being mostly very tolerant taxa (Dickens and Graham, 2002), and of which was dominated by an outbreak of Simuliidae.

Ecological trends for the EWR site (include components that were assessed)

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Fish	Decline/Stable	• Drivers unchanged due to impacts remainingunchanged (no new developments and since PES, 2014, Google Earth)	3

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
		• Increased presence of non-native fish species with a decline in eels noted by the landowner	
Macroinvertebrates	Decline	• Outbreak of Simuliidae and dominating the macroinvertebrate assemblage (changes in natural flow regimes) • Erosion increasing which may have future impacts on the community • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Decline	• Water quality impairment owing to upstream WWTW and continued filamentous algae blooms • Although a potential decline trend, drivers unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Riparian	Stable	• Drivers unchanged due to impacts remaining unchanged(no new developments and since PES, 2014, Google Earth)	2
ECOSTATUS (PES)	Decline	• Decline from a Class B to a Class D potentially owing to the above	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	B	D	• Water quality issues (nutrients, irrigation, high fibrous algae) • System dominated by non-native fish species (CCAR, CGAR, BAEN, LCAP, TSPA) • Indigenous fish species at low frequency of occurrence • Smothering ofinstream SICbiotopefor macroinvertebrates

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2023***
Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system
Very low clarity, owing to high silt loads in the system. pH elevated but still within limits. Diatom results indicated poor water quality characterised by nutrient and salinity increases.

	REC	
D	D	• Maintain the PES.

OVERALL ASSESSMENT

Table 6-11: Overall EcoStatus assessment for KOON01_R (Koonap)

River	Koonap
EWR Site Code	**KOON01_R**
Driver component	**PES**
Diatoms	D
IHI (instream)	C
IHI (riparian)	C
Response component	**PES**
FRAI	E
MIRAI	D
Ecostatus	**D**
EI	Moderate
ES	Moderate
REC	**D**

The overall EcoStatus was categorised as a Class D with an unchanged REC (**Table 6-11**). The fish community was considered seriously modified with the dominance of non-native fish significantly driving the state. The aquatic macroinvertebrate community was overall in a largely modified state primarily comprising very tolerant taxa. During September 2022, a major outbreak of Simuliidae (Blackfly larvae) was taking place. Overall, the community was driven mostly by water quality, flow modification and then the habitat metric.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach.
- Flow restrictions (to be assessed during the EWR stage) for a selected period of time (up to a full month), in order to reduce the winter population of the family Simuliidae within the system and to avoid the typical spring outbreaks of the blackfly (Rivers-Moore et al., 2008).

6.12 KAT02_R: Kat River (Lower)

Sample Date	12 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	KAT02_R	**IUA**	IUA_Q03
River	Kat	**IUA description**	Koonap and Kat
Altitude (m.a.s.l.)	325	**Prioritised RU**	R_RU15_R
Latitude	-32.890965	**Longitude**	26.68407
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q94F
Level 2 EcoRegion	18.02	**SQ Reach**	Q94F-07911
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, cross-section, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near Calderwood, about 15 km downstream (straight distance) from Fort Beaufort and a few kilometres upstream of the Great Fish confluence.

The site is located in a partly confined valley setting with a single channel and narrow flood features. The channel is incised into the surrounding landscape. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel and silt sediment types. The banks and benches are composed of sand and silt.

All biotopes were available for macroinvertebrates (SIC, SOOC, marginal vegetation and GSM). Fish habitats included SS, SD, and FS.

Site impacts:

- Upstream weir
- Abstraction
- Extensive irrigation
- Primarily citrus farming
- Alien invasive plants (*Salix* and *Eucalyptus* sp.)
- Alien instream aquatic macrophytes

SUMMARY RESULTS

In situ water quality nd discharge:

- pH: 9.11
- EC: 568 µS/cm

- TDS: 0.4301 g/l
- DO: 9.75 mg/l
- DO%: 102.6 %
- Clarity: Not measured
- Temperature: 17.7 °C
- Salinity: 0.32
- Discharge: 0.025 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
15	15.8	B (Good)	1	0
Dominant Species	(1) *Achnanthidium minutissimum (Kützing) Czarnecki*			
	(2) *Achnanthidium spp.*			
Preferences	(1) Found in well-oxygenated, clean, fresh waters. Usually attached to a substratum by a short mucilage stalk.			
	(2) Moderate to good quality waters			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	3	• Simple and stable cross section along a straight channel	• A single observation for this new site
Fish	3	• Easy access • Wadable • High weir to concentrate fish moving upstream • Slow-deep, slow shallow and fast shallow habitats represented • Substrate, overhanging vegetation and water column cover features respresented	• Single observation • Possible seasonal limitations
Macroinvertebrates	3	• Diversity of aquatic biotopes • Varying flow velocities • DWS REMP site: Q9KATR-BRIDG (located downstream of this EWR site however, same Ecoregion Level 2 and geoclass)	• Low water bridge and weir directly upstream from site resulting in pooling High filamentous algae

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation at this new site
Fish						• FFROC (Kleynhans; 2008)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited) • Current river survey (September 2022)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts) • DWS REMP site: Q9KATR-BRIDG (located downstream of this EWR site however, same Ecoregion Level 2 and geoclass)
Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity. • Green Drop Report 2011, 2013 and 2021. • 2022 Diatoms data

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla mossambica, Enteromius mandelai, Glossogobius callidus, Labeo umbratus, Sandelia bainsii*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Atyidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Polymitarcyidae, Telagonodidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Protoneuridae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Empididae, Ephydridae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae
Physical-chemical	No reference data could be obtained for the site. Diatom data were used to infer the reference conditions at the site. Diatom data indicated good water – well oxygenated and free from organic pollution. These conditions very likely resemble the reference conditions of the site and especially with no impacts from the Fort Beaufort WWTW upstream.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	E (26.2%)	F/NF	• Presence of non-native fish, including *Labeobarus aeneus* and *Clarias gariepinus*

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Significant habitat fragmentation due to present of many weirs within the system • Flow modification due to weirs and abstraction for citrus industry • Water quality impairment
Macroinvertebrates	C (67.49%)	F/NF	• Water quality (nutrients, irrigation, high fibrous algae) • Loss of floods owing to reduced release pattern from various upstream dams, including the main Katrivier Dam • Considerable Simuliidae (Blackfly larvae) outbreak, an indication of sustained high flows potentially owing to return flows and loss of floods due to upstream impoundments/weirs
Habitat Integrity: Instream	D (51%)	F	• Extensive irrigation • Release pattern from dam and loss of floods • Bed and channel modification owing to large number of weirs along reach (resulting in changes in instream habitat availability)
Habitat Integrity: Riparian	C (68%)	F	• Flow modification (loss of floods)
ECOSTATUS (PES)	**C/D (59.64%)**		

Component	**Causes Present/Absent**
Fish	Only 1 of the expected 5 native fish species were confirmed within the reach during the September 2022 field survey, with the remainder largely expected to be present in lower frequencies of occurrence than under reference conditions, with only one species, *Sandelia bainsii*, likely absent from the fish assemblage. Of relevance is that the number of weirs located within the system downstream of the reach are impacting the migration of eels in particular, with only a single specimen collected during the September 2022 field survey. These weirs support the citrus industry within the catchment which abstracts water from the system, thus resulting in flow modification in addition to the physical barriers imposed by such weirs. The species present under current conditions therefore largely reflects an assemblage that is tolerant to no-flow conditions and with a preference for slow-deep velocity-depth classes. Of additional concern was the presence of non-native fish within the reach, including *Labeobarus aeneus* and *Clarias gariepinus*, which will out-compete the native fish species. Consequently, the fish assemblage present within the reach was noted to be seriously modified (Ecological Category E).

METRIC GROUP	**REFERENCE WEIGHTS (%)**	**PRESENT WEIGHTS (%)**
VELOCITY-DEPTH	**91.57**	**80.83**

PES and causes			
Component	**Causes Present/Absent**		
	COVER	**100.00**	**84.36**
	FLOW MODIFICATION	**36.70**	**45.32**
	PHYSICAL-CHEMICAL	**69.01**	**67.44**
	MIGRATION		**63.24**
	IMPACT OF INTRODUCED		**100.00**
	FRAI	**PRESENT**	
	FRAI (%)	**26.2**	
	EC: FRAI	**E**	

Macroinvertebrates

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	68.2	*0.321*	21.9107	2	90
HABITAT	H	78.5	*0.304*	23.836	3	85
WATER QUALITY	WQ	56.9	*0.357*	20.3125	1	100
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.42857	4	5
						280
INVERTEBRATE EC				67.4878		
INVERTEBRATE EC CATEGORY				C		

Although a diversity of biotopes and varying flow velocities were present at this site, owing to loss of release patterns from upstream dams, coupled with a large number of weirs, there is a change taking place in habitat type from riffle to pools, as well as water quality owing to extensive irrigation. The aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately modified (Ecological Category C, 67.49%). A total of 36 taxa were recorded in the last hydrological year (September 2021 to September 2022) out of a reference community of 61 taxa (59% of the reference community was present). The macroinvertebrate assemblage was mostly driven by standing water, cobbles and low requirement for unmodified Physical-chemical conditions.

50% of the expected sensitive and very sensitive taxa were recorded at this site (11 out of an expected 22 taxa). These included Hydracarina, Baetidae >2spp, Heptageniidae, Leptophlebiidae, Polymitarcyidae, Trichorythidae, Chlorocyphidae, Ecnomidae, Elmidae, Psephenidae and Athericidae. Those taxa absent with a high froc included Perlidae, Protoneuridae, Aeshnidae, Corduliidae, Pyralidae, Hydropsychidae >2spp, Philopotamidae, Helodidae and Hydraenidae. These absent taxa had a preference towards higher water quality, moderate fast to fast flowing water and cobbles. However, the reason behind some of these taxa being absent may be a consequence of again the dominant taxa within the assemblage (particularly in September 2022) being Simuliidae in their outbreak densities. This is likely primarily owing to sustained high flows, coupled with high turbidity in this system (Rivers-Moore & de Moor, 2020). This outbreak may also have the potential to smother the SIC/bedrock biotopes, thus creating space competition for other biota such as the above.

PES and causes	
Component	**Causes Present/Absent**
	Overall, the community was primarily driven by water quality (56.9%) (high nutrient input resulting in considerable filamentous algae), flow modification (68.2%) (loss of floods, outbreak of Simuliidae), and then habitat (78.5%). The ASPT for the community was 5.8 (77% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), and of which was dominated by an outbreak of Simuliidae.

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	3
Macroinvertebrates	Decline	• Outbreak of Simuliidae and dominating the macroinvertebrate assemblage (changes in natural flow regimes) • Although potential decline trend, drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Riparian	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
ECOSTATUS (PES)	Decline	• Decline from Class B to a C/D owing potentially to the above	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR CHANGE
ECOSTATUS	B	C/D	• Extensive irrigation • Water quality (nutrients, irrigation, high fibrous algae) • Loss of floods owing to reduced release pattern from various upstream dams, including the main Katrivier Dam • Presence of non-native fish species (CGAR, BAEN) • Indigenous fish species at low frequency of occurrence

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2022***

Moderate, Moderate	Moderate, Moderate

Physical-chemical state of the system

Elevated pH was recorded during the site assessment. Fort Beaufort sewage treatment works discharges in the river upstream before the confluence with the Xuxuwa River. Although not in the same SQ reach as the monitoring point, the Green Drop Score of the sewage treatment works has been on a steady decline since 2011. The discharge on noncompliant effluent is likely to have impacts on the physical-chemical state of the river downstream, and with a % change in flow of -95% between 2013 and 2021, most of the raw sewage ends up in the river and not the WWTW. Diatom results, however, suggest moderate to good water quality in the system.

C/D	C/D	• Maintain the PES.

OVERALL ASSESSMENT

Table 6-12: Overall EcoStatus assessment for KAT02_R (Lower Kat)

River	**Lower Kat**
EWR Site Code	**KAT02_R**
Driver component	**PES**
Diatoms	
IHI (instream)	D
IHI (riparian)	C
Response component	**PES**
FRAI	E
MIRAI	C
Ecostatus	C/D
EI	**Moderate**
ES	Moderate
REC	C/D

The overall EcoStatus was categorised as a Class C/D, with an unchanged REC (**Table 6-12**). The fish community was dominated by non-native fish species with a preference for slow-deep velocity-depth classes, with the many weirs within the system resulting in habitat fragmentation and severely impacting upstream migration of catadromous eels. Consequently, the fish assemblage was considered seriously modified. The aquatic macroinvertebrate community was overall in a moderately modified state primarily comprising tolerant taxa. During September 2022, a major outbreak of Simuliidae (Blackfly larvae) was taking place. Overall, the community was driven mostly by water quality, flow modification and then the habitat metric.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach;
- Flow restrictions (to be assessed during the EWR stage) for a selected period of time (up to a full month), in order to reduce the winter population of the family Simuliidae within the system and to avoid the typical spring outbreaks of the blackfly (Rivers-Moore *et al.,* 2008);
- Implementation and maintenance of riverine buffers especially around new developments and agricultural activities; and
- Maintenance of sewage infrastructure and stormwater infrastructure within Fort Beaufort.

6.13 SUND02_R: Sundays River (lower)

Although initially identified as an intermediate, due to the extensive water use, transfer of water from upstream weir and diversion into canals, a rapid 3 assessment for the river linked to the intermediate estuarine assessment will be used to evaluate scenarios for socio-economic trade-offs.

Sample Date	23 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	SUND02_R	**IUA**	IUA_N01
River	Sundays	**IUA description**	Sundays downstream Darlington Dam
Altitude (m.a.s.l.)	97	**Prioritised RU**	R_RU04_R
Latitude	-33.404384	**Longitude**	25.407919
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	N40C
Level 2 EcoRegion	20.01	**SQ Reach**	N40C-08566
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: Fish, aquatic macroinvertebrates, *in situ* water quality, diatoms, cross-section, discharge			
Site Photographs: Survey 1 (September 2022)			
			
Site Description:			
The site is located 3.5 km upstream from Kirkwood. The site is located in an unconfined valley setting with a single macro channel and narrow flood features. The macro channel is deeply incised into the valley floor. The channel has a sinuous planform along the broad and relatively flat valley floor. It follows a pool-riffle reach type and is dominated by cobble and gravel substrates along riffles. The banks and benches are composed of gravel, sand and silt. The banks are densely vegetated with reeds and sedges. There is very low embeddedness along riffles with fine sediment. Th aquatic macroinvertebrate biotopes were dominated by SIC and SOOC. The marginal vegetation was limited to reeds and the GSM was primarily within the interstitial spaces of the SIC and SOOC. The fish habitats included SS, FS and SD.			
Site impacts:			
• Abstraction • Irrigation • Return flows			

- Upstream weir (Korhaansdrift) and dam (Darlington Dam)
- Vehicle crossing through channel
- Algae, high electrical conductivity and salinity
- Low bank erosion
- Aliens within the riparian zone (Spanish reed, Syringa)

SUMMARY RESULTS

In situ water quality and discharge:

- pH: 7.79
- EC: 3018 µS/cm
- TDS: 2.271 g/l
- DO: 7.31 mg/l
- DO%: 77.2 %
- Clarity: 65 cm
- Temperature: 17.9 °C
- Salinity: 1.85
- Discharge: 0.141 m^3/s

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
36	8.2	D (Poor)	19.8	**3.5**
Dominant Species	*(1) Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
	(2) Cyclotella atomus Hustedt			
Preferences	(1) Nutrient and salinity increase (eutrophication)			
	(2) Euplanktonic. Found in alkaline waters. Saline and nutrient tolerant. a-mesosaprobic (moderately oxygenated environment in which considerable organic material). These species when in abundance is a good indicator of eutrophication.			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2.5	• Simple straight channel with stable bed	• Single observation at low flow for this new site • Very dense vegetation along banks, high flows with higher uncertainty
Fish	2	• Easy access • Slow-deep,slow-shallow and fast-shallow velocity-depth classes represented • Variety of clover features present	• Significant growth of reeds limiting sampling effectiveness • Deep pool upstream limiting extent of wadable reach • Possible seasonal limitations
Macroinvertebrates	2	• Good availability of stones biotope	• Although good marginal vegetation – it is entirely woody vegetation (Phragmites and Spanish reeds encroaching the banks) • High algae content smothering biotopes (eutrophication)

			• Severe flow modification due to the extensive water use, transfer of water from upstream weir and diversion into canals sp. and Spanish reed encroaching the banks • Limited GMS owing to bed dominated by the stones biotope

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation for this new site
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records • Current survey (September 2022)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)
Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity • Green Drop Report, 2011, 2013 and 2021 • 2022 diatom data

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Fish	*Anguilla marmorata, Anguilla mossambica, Enteromius mandelia, Enteromius pallidus, Gilchristella aestuaria, Glossogobius callidus, Labeo umbratus, Monodactylus falciformis, Oreochromis mossambicus*
Macroinvertebrates	Porifera, Turbellaria, Oligochaeta, Hirudinea, Amphipoda, Potamonautidae, Atyidae, Paleomonidae, Hydracarina, Baetidae >2spp, Caenidae, Leptophlebiidae, Chlorocyphidae, Coenagrionidae, Lestidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Polycentropodidae, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Ceratopogonidae, Chironomidae, Culicidae, Ephydridae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Planorbinae, Corbiculidae

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
Physical-chemical	Historical data for the site could not be obtained. Diatoms were used to infer the reference conditions of the site. Diatom results indicated poor water quality linked to organic and inorganic pollutants, expected to be minimal if not absent under reference conditions.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish	D (50.4%)	F/NF	• Flow modification due to the extensive water use, transfer of water from upstream weir and diversion into canals • Habitat fragmentation due to presence of downstream weirs and water quality impairment • Water quality impairment due to agricultural and industrial runoff • Presence of non-native fish species, including translocated *Clarias gariepinus and Tilapia sparrmanii* as well as alien *Cyprinus carpio* and *Gambusia affinis*
Macroinvertebrates	C/D (58.63%)	F/NF	• Severe flow modification due to the extensive water use, transfer of water from upstream weir and diversion into canals • Water quality impairment (irrigation and abstraction, sewage from the town of Kirkwood)
Habitat Integrity: Instream	D (50%)	F	• Darlington Dam and Korhaansdrift weir (limited flows) • Armoured bed and narrowing of bed • River crossings • Extensive irrigation from abstraction from upstream Korhaansdrift weir
Habitat Integrity: Riparian	D (52%)	F/NF	• Exotic vegetation encroachment • Loss of floods and/or freshetts
ECOSTATUS (PES)	**D (52.98%)**		

Component	Causes Present/Absent
Fish	From the perspective of the fish assemblage, all but 1 of the fish species expected under reference conditions are likely to still be associated with the reach, albeit within greatly reduced frequencies of occurrence. The reach associated with the EWR is noted to have undergone significant modification from a flow perspective, with higher flows in the system due to return flows and releases from upstream impoundments for agriculture which has also impacted water quality. Flow modification and water quality impairment is further likely to impact upstream migration of fish (particularly eels), as are the various weirs and impoundments within the system. Flow modification has also resulted in a modification to instream habitat, with stabilisation of Phragmites being the result of modulation of flood events that would

Component	Causes Present/Absent

otherwise clean the system. Of further relevance was the presence of several non-native fish species, including translocated *Clarias gariepinus and Tilapia sparrmanii* as well as alien *Cyprinus carpio* and *Gambusia affinis.*

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	93.96	99.25
COVER	100.00	100.00
FLOW MODIFICATION	34.48	46.33
PHYSICAL-CHEMICAL	62.90	73.49
MIGRATION		73.63
IMPACT OF INTRODUCED		67.50
FRAI	PRESENT	
FRAI (%)	50.4	
EC: FRAI	D	

Macroinvertebrates

There is severe flow modification along the lower Sundays reach owing to extensive citrus farming throughout and thus, extensive water use, transfer of water from the upstream weir and the major diversion into canals from the weir (just upstream of this site).

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	67.6	*0.345*	23.3078	1	100
HABITAT	H	56.5	*0.328*	18.499	2	95
WATER QUALITY	WQ	49.8	*0.310*	15.4415	3	90
CONNECTIVITY & SEASONALITY	CS	80.0	*0.017*	1.37931	4	5
						290
INVERTEBRATE EC				58.6276		
INVERTEBRATE EC CATEGORY				C/D		

Consequently, the aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately to largely modified (Ecological Category C/D, 58.63%). A total of 17 taxa were recorded during September 2022, out of a reference community of 54 taxa (31% of the reference community was present). The macroinvertebrate assemblage was mostly driven by standing water, cobbles and low to very low water quality conditions. The most dominant taxa were Simuliidae, clearly in their outbreak densities primarily owing to sustained high flows, coupled with high turbidity in this system (Rivers-Moore & de Moor, 2020). Although this outbreak may not smother the SIC/bedrock biotopes, they do have the potential to impact on the abundance of other taxa owing to the overwhelming abundance of the Simuliidae (Rivers-Moore et al., 2007).

PES and causes	
Component	**Causes Present/Absent**
	Biota expected but not recorded with these preferences included Aeshnidae, Libellulidae, Hydropsychidae >2spp, Philopotamidae, Elmidae and Tabanidae, also of which are mostly driven by moderate requirement for unmodified Physical-chemical conditions. In terms of the sensitive to very sensitive macroinvertebrates (QV 8-15), only Baetidae >2spp was recorded, as well as individuals of Leptophlebiidae, Chlorocyphidae and Hydraenidae were recorded. The other 14 sensitive taxa were absent. Overall, the community was primarily driven by water quality (49.8%) (high irrigation and return flows), habitat (56.5%) (no GSM, woody vegetation encroachment along the banks) and then flow modification (67.6%). The ASPT for the community was 5.1 (75% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002) and dominated by an outbreak of Simuliidae.

Ecological trends for the EWR site (include components that were assessed)

Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Macroinvertebrates	Stable	• Impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Decline	• Darlington Dam and major abstraction at upstream Korhaansdrift weir (limited flows)	2
Habitat integrity: Riparian	Decline	• Darlington Dam and major abstraction at upstream Korhaansdrift weir (limited flows)	2
ECOSTATUS (PES)		•	2

** 0 – no confidence to 5 – high confidence*

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	D	D	Remained unchanged

EI/ES, 2014	**Re-assessed, 2022***
Moderate, Moderate	Low, Moderate

Physical-chemical state of the system
Elevated TDS and EC were recorded *in situ.* Extensive agricultural activities along the length of the river is the likely cause of the altered physical-chemical state of the system. Diatom results indicated elevated nutrients in the system. Kirkwood WWTW discharging downstream in the Uie River, a tributary of the Sundays River. The Green Drop Report suggests a lack of data on the Kirkwood WWTW; however, it is indicated that the WWTW infrastructure is failing.

D	D• F: Major upstream weir (Korhaansdrift) and dam (Darlington Dam);	• F: Concern owing to linkage to the Sundays Estuary owing to possible negative impact on the estuary, owing to possible reduced floods and reduced flows (to be addressed by the estuarine team); • F: Irrigation schemes aid in social economic upliftment; and • Ecological Importance reduced from Moderate.

OVERALL ASSESSMENT

Table 6-13: Overall EcoStatus assessment for SUND02_R (Lower Sundays)

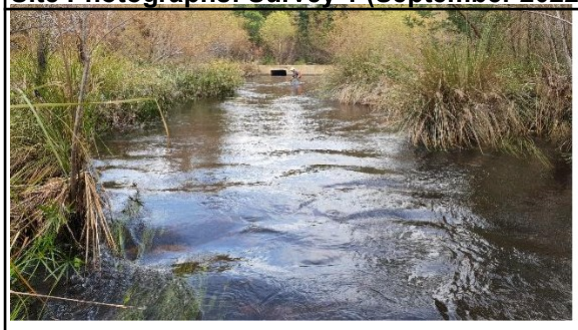
River	Lower Sundays
EWR Site Code	**SUND02_R**
Driver component	**PES**
Diatoms	D
IHI (instream)	D
IHI (riparian)	D
Response component	**PES**
FRAI	D
MIRAI	D
Ecostatus	**D**
EI	Low
ES	Moderate
REC	**D**

The overall EcoStatus was categorised as a Class D, with an unchanged REC (**Table 6-13**). The fish community was regarded as largely modified, with flow modification, water quality impairment and habitat fragmentation considered to be significant drivers. In addition, several non-native fish species were confirmed or expected within the reach at the time of the field assessment. The aquatic macroinvertebrate community was overall in a largely modified state primarily comprising tolerant taxa. During September 2022, a major outbreak of Simuliidae (Blackfly larvae) was taking place. Overall, the community was driven mostly by flow modification, habitat and closely followed by the water quality metric.

RECOMMENDATIONS

- Refer to Chapter 10 for general recommendations;
- Further studies to be undertaken in terms of the Simuliidae outbreak taking place along this river reach; and
- Flow restrictions (to be assessed during the EWR stage) for a selected period of time (up to a full month), in order to reduce the winter population of the family Simuliidae within the system and to avoid the typical spring outbreaks of the blackfly (Rivers-Moore *et al.,* 2008).

6.14 KOUG01_R: Kouga River

Sample Date	26 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	KOUG01_R	**IUA**	IUA_L01
River	Kouga	**IUA description**	Kouga to Kouga Dam, Baviaanskloof
Altitude (m.a.s.l.)	321	**Prioritised RU**	R_RU05_R
Latitude	-33.788449	**Longitude**	24.025821
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L82D
Level 2 EcoRegion	19.02	**SQ Reach**	L82D-08977
Geomorphological zone	E (slope 0.003)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, cross-section, discharge			
Site Photographs: Survey 1 (September 2022)			
			
Site Description:			
The site is located 15 km east of the town Joubertina. The Kouga reach is located in a confined valley or gorge setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle and pool-rapid reach type and is dominated by boulder, cobble, gravel, sand and silt sediment types. The banks, benches and bars are composed of boulders, cobble, gravel and sand. Aquatic macroinvertebrate biotopes comprised SIC, SOOC and both marginal and aquatic vegetation. The sand and mud from the GSM biotope were limited to none. The fish habitats included FD, SS and SD.			
Site impacts:			
• Extensive alien invasive plants within the riparian zone (Black wattle) • Downstream weir • Low water bridge crossing • Irrigation (upstream)			
In situ water quality and discharge: • pH: 7.11 • EC: 126.8 µS/cm • TDS: 0.0988 g/l • DO: 7.94 mg/l • DO%: 80.5 %			

- Clarity: >1m
- Temperature: 15.9 °C
- Salinity: 0.07 ppt
- Discharge: 2.23 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
35	15.9	B (Good)	6.6	2
Dominant Species	*(1) Achnanthidium minutissimum (Kützing) Czarnecki*			
	(2) Achnanthidium spp.			
	(3) Cocconeis placentula Ehrenberg			
Preferences	(1) Found in well-oxygenated, clean, fresh waters. Usually attached to a substratum by a short mucilage stalk.			
	(2) Moderate to good quality waters			
	(3) Occurring in mesotrophic to eutrophic flowing and standing waters. Found in abundance on plants, wood and stone.			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	3	• Simple, straight and stable channel	• A single flow observation during moderate flows
Fish	3	• Easy access • Wadable • All velocity-depth classes represented • Most cover elements present	• Possible seasonal limitations •
Macroinvertebrates	4	• Varying flow conditions • Diversity of aquatic biotopes • Existing DWS REMP site • DWS REMP site: L8KOUG-OPKOM (same site)	• Low water bridge at site • Large weir just downstream of site changing habitat from riffles to pools downstream • Flow modification (high abundance of Simuliidae)

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• This is a new site with a single observation
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records (although limited largely to tributaries) • Current river survey (September 2022)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES Assessment (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• DWS REMP site: L8KOUG-OPKOM
Hydrology						• Natural and present day flows • Daily flows from gauging weir
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity • NCMP data site L8H005Q01 (1990 to 2022, n= 509) • 2022 diatoms data

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**		
Fish	*Enteromius pallidus, Labeo umbratus, Pseudobarbus swartzi, Sandelia capensis*		
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Telagonodidae, Trichorythidae, Chlorocyphidae, Chlorolestidae, Coenagrionidae, Lestidae, Platycnemidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Hydrometridae, Naucoridae, Nepidae, Notonectidae, Pleidae, Veliidae, Corydalidae, Ecnomidae, Hydropsychidae >2spp, Philopotamidae, Polycentropodidae, Barbarochthonidae, Glossosomatidae, Hydroptilidae, Lepidostomatidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Haliplidae, Helodidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Dixidae, Empididae, Ephydridae, Muscidae, Psychodidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Bulinae, Lymnaeidae, Planorbinae, Corbiculidae, Sphaeridae, Unionidae		
Physical-chemical	Reference condition data obtained from DWS began in the early 1990s (1990 – 1992, n = 212)		
	Physical Variable	pH	Reference condition data obtained from DWS began in the early 1990s. DWAF (2008) manual warns about the pH results during this time. Upon assessment several inconsistencies were noticed in the earliest dataset (1990 – 1992, n = 212) This was especially noted during the May to July 1990 monitoring period. These unusual data were removed such that the 5th percentile was 6.3 pH units and the 95th percentile was 7.8 pH units, which fell within the DWAF (2008) Natural (0) rating.
		EC	The reference data indicated a 95th percentile of 27.2 mS/m, which fell within the Natural (0) rating as stipulated in the DWAF (2008) benchmark tables.
		Temperature	Upon analyses of the available temperature data it noted that the there were gaps for other months where temperature was not recorded. The

Reference Conditions			
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**		
			temperature rages would have therefore not been representative. DWA (2008) benchmark tables are used for a low confidence, qualitative assessment of temperature RC
		Clarity	There are no clarity/turbidity records available for reference condition assessment. Reference condition is taken as that qualitatively described in the DWA (2008) benchmark tables.
		Oxygen:	No dissolved oxygen records are available for this site. DWA guideline benchmark tables (2008) have been utilised to characterise the site's reference condition.
	Nutrients	PO_4	PO_4 reference data indicated that the 50th percentile was 0.015, which is higher than the DWAF (2008) natural (0) rating.
		TIN	TIN reference data indicated that the 50th percentile was 0.02 mg/l which is within the Natural (0) rating by DWAF 2008.
	Toxins	Fluoride	Reference data indicated that fluoride was only toxin recorded. The data showed that the 95th percentile for fluoride was 0.3 mg/l, which is within the DWAF (2008) benchmark tables

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	F (7.1%)	NF	• Complete dominance of non-native fish species, including translocated *Clarias gariepinus* and alien *Lepomis macrochirus, Micropterus dolomieu* and *Micropterus salmoides* • Habitat fragmentation due to presence of weirs
Macroinvertebrates	B/C (78.93%)	F/NF	• Considerable Simuliidae (Blackfly larvae) outbreak, an indication of changes in natural flows • Water quality (nutrients from return flows and high irrigation in upper catchment)
Habitat Integrity: Instream	B/C (81%)	F	• Loss of baseflows due to groundwater abstractions for irrigation • High irrigation in upper catchment (fruit)
Habitat Integrity: Riparian	C (75%)	NF	• Exotic vegetation encroachment
ECOSTATUS (PES)	**C (65.05)**		

Component	**Causes Present/Absent**
Fish	Due to the complete dominance of non-native predatory fish species within the mainstem Kouga River (including translocated *Clarias gariepinus* and

Component	Causes Present/Absent

alien *Lepomis macrochirus, Micropterus dolomieu* and *Micropterus salmoides*), there are no collection records for *Pseudobarbus swartzi* and *Sandelia capensis* within main Kouga stem and they seem to be confined to tributaries where non-nature species are less frequent. They may however have incidental occurrence within mainstem from movement down the tributaries, although their frequencies of occurrence would be very low. Furthermore, the presence of weirs in the system has resulted in habitat fragmentation as well as created favourable lentic habitat for the persistence of non-native fish species which have a preference for such habitat. Consequently, the fish assemblage within the mainstem Kouga River is considered to be critically modified (Ecological Category F), with a complete dominance of non-native fish species.

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	60.08	57.60
COVER	100.00	79.26
FLOW MODIFICATION	70.18	55.58
PHYSICAL-CHEMICAL	46.20	50.07
MIGRATION		32.50
IMPACT OF INTRODUCED		100.00
FRAI	PRESENT	
FRAI (%)	7.1	
EC: FRAI	F	

Macroinvertebrates

INVERTEBRATE EC METRIC GROUP		METRIC	CALCULATED WEIGHT		RANKOF METRIC	
FLOW MODIFICATION	FM	78.4	*0.364*	28.4943	1	100
HABITAT	H	82.8	*0.291*	24.0961	3	80
WATER QUALITY	WQ	76.1	*0.327*	24.89	2	90
CONNECTIVITY & SEASONALITY	CS	80.0	*0.018*	1.45455	4	5
INVERTEBRATE EC				78.9349		275
INVERTEBRATE EC CATEGORY						

A diversity of biotopes was present at this site, although limited GSM owing to the bed being dominated by cobbles. The aquatic macroinvertebrate assemblage collected was determined to be representative of being largely natural to moderately modified (Ecological Category B/C, 78.93%). During the last hydrological year (September 2021 to September 2022), a total of 40 taxa were recorded out of a reference community of 61 taxa (66% of the reference community was present). The macroinvertebrate assemblage appeared to have a preference for both moderately fast to fast flowing water and standing water, cobbles and moderate to low requirement for unmodified Physical-chemical conditions. Whilst the rest of the expected reference taxa which were absent from the site had preferences for moderate to high water quality. Although the most dominant taxa recorded during the September 2022 survey, were Simuliidae (a clear indication of their outbreak densities)

PES and causes	
Component	**Causes Present/Absent**
	primarily owing to sustained high flows. Although this outbreak may not smother the SIC/bedrock biotopes, they do have the potential to impact on the abundance of other taxa owing to the overwhelming abundance of the Simuliidae (Rivers-Moore et al., 2007). A number of sensitive to very sensitive taxa (QV 8 – 15) with preferences for very fast flowing water and cobbles were recorded. These included Hydracarina, Baetidae >2spp, Heptageniidae, Leptophlebiidae, Chlorocyphidae, Chlorolestidae, Aeshnidae, Corduliidae, Ecnomidae, Philopotamidae, Elmidae, Psephenidae, Athericidae and Dixidae. Those expected taxa with these preferences absent from the reach with a high froc (3-5) were only Trichorythidae, Platycnemidae and Hydropsychidae >2spp. Overall, the community was primarily driven by water quality (76.1%) (those taxa absent had a preference for moderate to high water quality), flow modification (78.4%) (outbreak of Simuliidae's and of which was the dominant taxon) and then the habitat metric (82.8%). The ASPT for the community was 6.0 (86% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002), and which was dominated by Simuliidae and its associated outbreak.

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers are unchanged due to impacts remainingunchanged(nonew developments and since PES, 2014, Google Earth) •	4
Macroinvertebrates	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth) • In the last hydrological year at this site, the ASPT has ranged from 5.4 to 6.7 and the SASS5 score 118 and 145.	5
Habitat integrity: Instream	Decline	• Loss of baseflows due to groundwater abstractions for irrigation • Increase Black Wattle encroachment	3
Habitat integrity: Riparian	Decline	• Loss of baseflows due to groundwater abstractions for irrigation • Increase Black Wattle encroachment	3
ECOSTATUS (PES)	Decline	• Decline from a Class B to a C potentially owing to the above	3

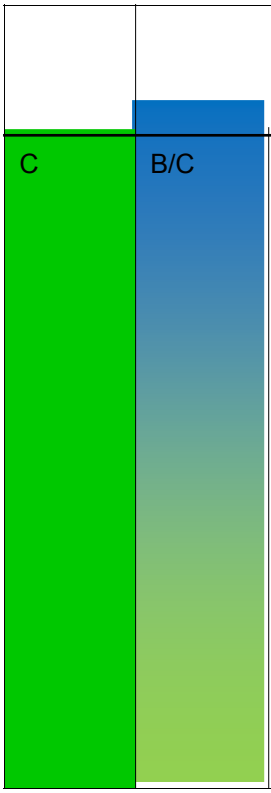
** 0 – no confidence to 5 – high confidence*

Overall change and reason for deviation			
COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	B	C	• Water quality (nutrients from return flows and high irrigation in upper catchment) • Loss of baseflows due to groundwater abstractions for irrigation • Fish (F) • System dominated by non-native fish species (CGAR, LMAC, MDOL, MSAL) • Indigenous fish species at low frequency of occurrence

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2022***
Moderate, Moderate	High, High

Physical-chemical state of the system

In situ water quality parameters were recorded within limits. The system is likely to receive some impacts from the upstream town of Joubertina, and the Joubertina WWTW discharging into the system. The WWTW is currently classified as high risk and the % change in flow between 2013 and 2021 for the system was 358% suggesting that the system is overloaded. Diatom results do however indicate moderate to good water quality. Most recent data for NCMP site L8H005Q01 (2016-2018, n=24) indicate an EC range of 13.4-35.3 mS/m, TIN range of 0.05-0.815 mg/l and PO_4 range of 0.005-0.573 mg/l.



- Ecological Importance reassessed to High (habitat diversity class)
- Ecological Sensitivity reassessed to High (stream size sensitive to modified flow/water level changes
- F/NF: Presence of aquatic macroinvertebrates with a preference for very fast flow flowing waters (excluding the Simuliidae larvae) and moderately unmodified water quantity conditions;
- F: Potential improvement to baseflows owing to reduced groundwater use;
- F: Priority wetland identified within the same quaternary catchment area was W_RU03 (L82D) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of this wetland within the same quaternary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas;
- F: As a result of the above, aim to potentially introduce working for water programs to manage the AIPs along this reach and implement programs to stabilised banks and prevent erosion once the aliens have been removed;
- NF: Clearing of the AIP within the riparian zone; and
- NF: Ensure that water quality does not deteriorate with the continued maintenance of the upstream WWTW (Twee-Riviere, Nabooms etc).

OVERALL ASSESSMENT

Table 6-14: Overall EcoStatus assessment for KOUG01_R (Kouga)

River	**Kouga**
EWR Site Code	**KOUG01_R**
Driver component	**PES**
Diatoms	B
IHI (instream)	B/C
IHI (riparian)	C
Response component	**PES**
FRAI	**F**
MIRAI	B/C
Ecostatus	C
EI	**High**
ES	High
REC	B/C

The overall EcoStatus was categorised as a Class C, with an unchanged REC (**Table 6-14**). The fish community was considered to be critically modified as a result of being completely dominated by non-native predatory fish species, with native fish species likely to only occur in low frequencies of occurrence, if at all. The aquatic macroinvertebrate community was overall in a largely natural to moderately modified state primarily comprising tolerant taxa. Thus, the community was driven mostly from water quality, flow modifications and then the habitat metric.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Develop and implement alien vegetation control plan for riparian zone of the catchment, with primary focus on controlling *Acacia* (Wattle) species; and
- Maintenance of sewage infrastructure associated with upstream towns of Twee-Reviere, Nabooms, etc.

6.15 KROM01_R: Kromme River

Sample Date	5 May 2023	**Reserve Level Assessment**	Rapid 3 *(higher confidence, including VEGRAI)*
Site Code	KROMM01_R	**IUA**	IUA_K01
River	Kromme	**IUA description**	Tsitsikamma and headwaters of Kromme to Kromme Dam
Altitude (m.a.s.l.)	239	**Prioritised RU**	R_RU01_I
Latitude	-33.9370951	**Longitude**	24.2690587
Level 1 EcoRegion	South-Eastern Coastal Belt	**Quaternary catchment**	K90A
Level 2 EcoRegion	20.02	**SQ Reach**	K90A-09040
Geomorphological zone	D (slope: 0.005)	**PES (DWS, 2014)**	D
Ecological Importance	High	**Ecological Sensitivity**	High

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge

Site Photographs: Survey 2 (May 2023)





Site Description:

The site is located along the Kromme River valley with cobble-bed or mixed bedrock-cobble bed habitats, with a mix of sand, gravel and cobbles. There are large gravel and cobble bars along the left bank of the channel, with the benches composed of silt and sand. There is very low embeddedness along riffles, runs and pools. This may be owing to sediment starvation from the upstream weir. The active channel has narrow flood benches and is relatively incised into the valley floor. The channel is straight to wandering and follows the sinuous valley alignment The channel is braided in some areas along the reach, and which is densely vegetated with shrubs, sedges and pockets of peat. There are sections of steep bank erosion, likely owing to the last flood event which took place in 2015.

Biota habitats available

All biotopes for aquatic macroinvertebrate habitats were available. Fish habitats only included FS, SS and SD.

Site impacts:

- Incision of the river channel (flow related);
- Extensive erosion;
- Cattle farming
- Upstream weir
- Irrigation
- Bridge crossing (newly built in 2018)
- Channelled valley-bottom wetland (positive impact)

In situ water quality and discharge (May 2023 only):

- pH: 7.95
- EC: 198 µS/cm
- TDS: 0.152 g/l
- DO: 8.24 mg/l
- DO%: 84.0 %
- Clarity: >1m
- Temperature: 16.95 °C
- Salinity: 0.11 ppt
- Discharge: 1.156 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
May 2023				
28	15.7	B (Good)	4.2	2.25
Dominant Species	*(1) Achnanthidium sp.*			
	(2) Psammothidium oblongellum (Oestrup) Van de Vijver			
Preferences	(1) Moderate to good water quality conditions			
	(2) Tolerant of mild pollution only and also pollution sensitive. This was the only site with endemic species: Achanthes subaffinis Cholnok. Its preference is slow flowing water and oligotrophic streams			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	2.5	• Straight section with simple channel shape	• Dense vegetation and single observation, so higher uncertainty regarding high flows
Fish	3	• Easy access • Wadable • Slow-deep,slow-shallow and fast-shallow velocity-depth classes represented • Most cover elements present	• None
Macroinvertebrates	4	• SIC, SOOC, GSM and marginal vegetation (including high densities of fringing palmiet vegetation) • Varying flow velocities • DWS REMP Site code: K9KROM-MELHO	• No instream aquatic vegetation • Cattle trampling and grazing (localised erosion impacting on the marginal vegetation biotope)

Component	Confidence Score*	Advantages	Disadvantages
Riparian vegetation	3	• Ease of access, both banks and all features accessible • Good representation of riparian indicators	• Proximity to agricultural practices and pastures • AIP (Wattles)

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Single observation at site
Fish						• FFROC (Kleynhans; 2008) • PES-EI-ES Assessment (DWS, 2014) • GBIF Collection Records • Current river survey (May 2023)
Macroinvertebrates						• Current survey (May 2023) • PES-EI-ES Assessment (DWS, 2014) • Quarterly data from the DWS REMP site K9KROM-MELHO
Hydrology						• Natural and present day flows
Riparian vegetation						• Riparian vegetation data collected during field verification visits. • Updated vegetation map: spatial data and metadata with detailed vegetation type, Biome and Bioregion descriptions. • Google Earth © & Bing satellite imagery. • PES-EI-ES Assessment (DWS, 2014). • Regions / Centres of Plant Endemism. • Level 1 and 2 Ecoregions. • Spatial distribution of threatened ecosystems • Threatened wetland / riparian plant species distribution data. • Land cover data Spatial distribution of dams in the study area
Diatoms						• Current survey (May 2023)
Physical-chemical						• Current survey (May 2023) only measured *in situ* water quality and clarity. • Green Drop Report, 2011, 2013 and 2021 • NCMP data site 1-10490 (2007 to 2016)

** 0 (no information) to 4 (large amount of data available)*

Reference Conditions	
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla mossambica, Pseudobarbus senticeps, Sandelia capensis*
Macroinvertebrates	Turbellaria;Oligochaeta;Hirudinea;Potamonautidae;Atyidae; Paleomonidae; Hydracarina; Notonemouridae; Perlidae; Baetidae >2spp;

COMPONENT	DESCRIPTION OF REFERENCE CONDITIONS
	Caenidae; Heptageniidae; Leptophlebiidae; Trichorythidae; Chlorocyphidae; Chlorolestidae; Coenagrionidae; Lestidae; Platycnemidae; Protoneuridae; Aeshnidae; Corduliidae; Gomphidae; Libellulidae; Pyralidae; Belostomatidae; Corixidae; Gerridae; Hydrometridae; Naucoridae; Nepidae; Notonectidae; Pleidae; Veliidae; Dipseudopsidae; Ecnomidae; Hydropsychidae >2spp; Philopotamidae; Polycentropodidae; Hydroptilidae; Lepidostomatidae; Leptoceridae; Pisuliidae; Dytiscidae; Elmidae; Gyrinidae; Haliplidae; Helodidae; Hydraenidae; Hydrophilidae; Psephenidae; Athericidae; Ceratopogonidae; Chironomidae; Culicidae; Dixidae; Ephydridae; Muscidae; Simuliidae; Tabanidae; Tipulidae; Ancylidae; Lymnaeidae; Planorbinae; and Corbiculidae
Riparian vegetation	This site occurs within the Fynbos Biome, Eastern Fynbos-Renosterveld Bioregion, and the Langkloof Shale Renosterveld vegetation type (Mucina & Rutherford, 2018) and while this represents its terrestrial setting, the riparian zone should be influenced by the inclusion and dominance of its macro-channel features by woody species associated with this vegetation type. The marginal zone and active channel features are expected to be dominated by non-woody riparian species, grasses, sedges and broad-leaf emergent macrophytes, with a scattered to narrow shrub component lining pool areas or confined banks and overhanging pool habitats. The banks are expected to be dominated by dense woody vegetation comprising both riparian and fynbos shrub species mainly but with some riparian trees.
Physical-chemical	Historical NCMP data for the reach began in 2007. These data, therefore, does not represent reference physical-chemical state of the system. Diatom results were used to infer the reference physical-chemical state of the system. Diatom results indicate moderate to good water quality, characterised by low nutrient concentrations. Satellite imagery shows no minimal activity upstream, suggesting that this this stretch of the river has not significantly changed from reference conditions.

Diatom results suggested good water quality at this stretch of the river. Kareedouw WWTW discharging into a tributary of the Kromme downstream. According to the 2022 Green Drop report no sufficient data exits to fully assess the risk on the receiving river system, however penalties were issued as a result of sewage not reaching the WWTW. This sewage is likely flowing into the river.

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Fish	E/F (20.8%)	NF	• Complete dominance of non-native fish species, including alien *Lepomis macrochirus* and *Micropterus salmoides* • Downstream Krom River Dam limiting upstream migration of catadromous eels
Macroinvertebrates	C (70.0%)	F/NF	• Nearby upstream small weirs and downstream low water bridge resulting in some inundation (flow modification). • Abstraction, irrigation and return flows (flow modification and water quality impairments).

PES per component for EWR site and EcoStatus			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
			• Cattle grazing and trampling resulting in bank erosion thus hampering marginal vegetation biotope, particularly along the left bank.
Riparian vegetation	C (73.5%)	NF	• AIP (Wattles) • Grazing and trampling and clearing for pastures
ECOSTATUS (PES)	**D (56.71%)**		

Component	**Causes Present/Absent**
Fish	During the May 2023 field survey, a complete dominance of non-native fish species within the mainstem Kromme River was noted, with only alien *Lepomis macrochirus* and *Micropterus salmoides* being collected. Although there are collection records of *Pseudobarbus senticeps* within the Kromme River within the reach, according to Chakona & Skelton (2017) the species has a restricted known distribution range, surviving in a few relatively unimpacted and uninvaded tributaries of the Krom River system. As such, species such as *Pseudobarbus senticeps* or *Sandelia capensis* may however have incidental occurrence within mainstem from movement down the tributaries, although their frequencies of occurrence would be very low should they occur. In addition, Krom River Dam is likely to act as a significant migration barrier for catadromous Anguilla mossambica, thus limiting their presence within the reach associated with the EWR site. Consequently, the fish assemblage within the mainstem Kromme River is considered to be critically modified (Ecological Category F), with a complete dominance of non-native fish species.

METRIC GROUP	**REFERENCE WEIGHTS (%)**	**PRESENT WEIGHTS (%)**
VELOCITY-DEPTH	**87.73**	**92.49**
COVER	**100.00**	**100.00**
FLOW MODIFICATION	**67.02**	**73.35**
PHYSICAL-CHEMICAL	**62.25**	**70.43**
MIGRATION		**58.20**
IMPACT OF INTRODUCED		**90.54**
FRAI	**PRESENT**	
FRAI (%)	**9.2**	
EC: FRAI	**F**	

Macroinvertebrates	The EWR site along the Kromme River exhibited a diverse range of biotopes, including SIC, SOOC, boulders, bedrock, marginal vegetation (with pockets of peat), aquatic instream vegetation, and GSM. During the survey conducted in May 2023, a total of 22 taxa were identified, with a total of 34 recorded for the last hydrological year (May 2022 – May 2023). Overall, the aquatic macroinvertebrate community assemblage collected was determined to be representative of moderately modified conditions (Ecological Category C, 70.0%).

PES and causes

Component	Causes Present/Absent
	Despite the presence of sensitive taxa, such as Baetidae >2spp, Hydropsychidae >2spp, Philopotamidae, and Dixidae, which prefer fast flowing water and unmodified physical-chemical conditions, water quality impairments were suspected. Most of the community favoured low to very low water quality, possibly due to the adjacent land use being cattle farm and other impacts including irrigation and introducing nutrients to the system through return flows. From a habitat perspective, most of the community preferred cobbles but some taxa were absent compared to reference conditions. However, their low frequency of occurrences did not raise concerns. Despite the availability of marginal and instream aquatic vegetation, some taxa were also absent, including Hydroptilidae and Hydrophilidae. The majority of the macroinvertebrate assemblage preferred standing water, regardless of varying flow conditions at the site. A limited number of taxa requiring very fast to moderate flowing waters were expected to be present, but the survey only recorded four and five taxa respectively, over the last hydrological year. Highly sensitive to flow and water quality, the absent taxa, included Notonemouridae, Trichorythidae, Hydraenidae, Perlidae, Heptageniidae, and Psephenidae, although having low frequency of occurrences. Flow conditions could be improved by addressing the excess water issue resulting from upstream irrigation, which the weir confirmed. **INVERTEBRATE EC METRIC GROUP** / **METRIC GROUP CALCULATED SCORE** / **CALCULATED WEIGHT** / **WEIGHTED SCORE OF GROUP** / **RANK OF METRIC GROUP** / **%WEIGHT FOR METRIC GROUP** **FLOW MODIFICATION** FM: 68.7 / *0.333* / 22.9012 / 2 / 90 **HABITAT** H: 79.0 / *0.296* / 23.4188 / 3 / 80 **WATER QUALITY** WQ: 63.9 / *0.370* / 23.6842 / 1 / 100 **CONNECTIVITY & SEASONALITY** CS: 100.0 / *0.000* / 0 / 3 / 0 270 **INVERTEBRATE EC** 70.0042 **INVERTEBRATE EC CATEGORY** C Overall, the community was primarily driven by water quality (63.9%), followed by flow modification (68.7%) and habitat (79.0%). The ASPT for the communities identified in May 2023, September 2022, and May 2023 was 5.8 and 5.7 respectively, indicating that the community mostly comprised tolerant taxa (Dickens and Graham, 2002).
Riparian vegetation	Overall, the riparian vegetation VEGRAI score was 73.5%, which is a C category. The most notable impacts resulting in the ecoststus score, as observed at site, were the presence of invasive alien species, mainly Wattles, on banks and recruiting along flood features, and high grazing and trampling pressure by livestock. The marginal zone and within-channel active features were dominated by non-woody vegetation, mainly grasses (*Miscanthus ecklonii*) and sedges (*Juncus lomatophylus*), but also with a shrub component, notably *Cliffortia linearifolia* scattered or surrounding pool areas and creating overhanging cover. The zone was bedrock controlled, mainly cobble / boulder / gravel but with alluvial deposits and backwaters. Perennial alien

PES and causes	
Component	**Causes Present/Absent**

species were recruiting on alluvial bars (*Acacia mearnsii*). Overall, the zone was in a B/C category. The macro channel banks was dominated by woody vegetation, fragmented in places and with non-woody cover, mainly grasses. There was a mixture of riparian (*Nuxia floribunda*) and Fynbos species, but invasive alien tree species also occurred in high numbers in places (*Acacia mearnsii, A. dealbata*). Disturbance by humans and livestock was high and vegetation clearing for pastures had taken place in some areas. Overall, the zone was in a C category with AIP being the main reason.

LEVEL 3 ASSESSMENT		**Kromme**		**05 May 2023**	
RIPARIAN VEGETATION EC METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**WEIGHT**
Macro channel valley	78.8	29.5	3.0	1.0	37.5
Macro channel bank	70.4	44.0	3.0	2.0	62.5
LEVEL 3 VEGRAI (%)				73.5	
VEGRAI EC				**C**	
AVERAGE CONFIDENCE				3.0	
	Sub-zone				
VEGRAI % (Zone) **EC (Zone)** Confidence (Zone)		Macro channel valley 78.8 B/C 3.0		Macro channel bank 70.4 C 3.0	

Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Alien fish species well established and completely dominant in mainstem. Ecological state is unlikely to improve unless alien eradication programme is implemented.	4
Macroinvertebrates	Stable	• Range of biotopes and hydraulic conditions remain. However, some water quality impairments are visible and silt loads over the stones biotope.	2.5

Component	Trend (stable, decline, improvement)	Reason	Confidence (0-5)*
Riparian vegetation	Negative	• Invasive alien species, mainly Wattles, have the potential to increase	3
ECOSTATUS (PES)		•	

** 0 – no confidence to 5 – high confidence*

COMPONENT	PES 2014	EcoStatus (PES) 2023	REASON FOR CHANGE
ECOSTATUS	D	D	• Non-flow issue • Fish (category F) – complete dominance of non-native fish species (LMAC and MSAL). No indigenous fish recorded at this site.

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2023***
High, High	High, High

Physical-chemical state of the system

In situ water quality parameters were recorded within limits. The system is likely to receive some impacts from the upstream town of Kareedouw and the Kareedouw WWTW discharging into the system (located south-west of this EWR site). The WWTW is currently classified as critical risk. The 2021 Green Drop Score was 1% compared to 22% in 2013. Unfortunately, no flow data is available for the works. However, the Green Drop report does state that penalties have been applied to the Kareedouw WWTW for pumpstation defects and sewage not reaching the treatment facility"

However, the diatom results suggested good to moderate water quality and that the benthic algae are mostly responding to tolerant to mild pollution within the system. Interestingly, an endemic species was recorded at this site (*Achanthes subaffinis Cholnok*), which has a preference for slow flowing water and oligotrophic streams.

Status (PES)		
D C	• Previous	studies undertaken on the Kromme River – EWR1 (DWS, 2007), identified the EcoStatus as a category C • EI-ES both remained High, which is imperative for the protection of the Geelhout tributary which supports the main Kromme River; • F: System forms part of the very important Kromme wetland system and provides ecological goods and services and hence requires specific management and protection ecological specifications to support the high importance status; and • F: Priority wetland identified within the same quaternary catchment area was W_RU02 (K90A) (Report No. WEM/WMA7/00/CON/RDM/1223). As a result, the pivotal role lies in the rehabilitation of this wetland within the same quaternary catchment area, affected by the aforementioned influences. The restoration of these wetlands' ecological infrastructure has the potential to gradually enhance conditions in both the river and riparian areas. Ecological Importance reassessed to High (habitat diversity class)

Status (PES)		
		• F: Ecological Sensitivity reassessed to High (stream size sensitive to modified flow/water level changes • F/NF: Presence of aquatic macroinvertebrates with a preference for very fast flow flowing waters and moderately unmodified water quantity conditions

OVERALL ASSESSMENT

Table 6-15: Overall EcoStatus assessment for KROM01_R (Kromme)

River	**Kromme**
EWR Site Code	**KROM01_R**
Driver component	**PES**
Diatoms	
Response component	**PES**
FRAI	E/F
MIRAI	C
Riparian vegetation	D
Ecostatus	**D**
EI	High
ES	High
REC	**C**

The overall EcoStatus was categorised as a Class D, thus the system being largely modified (**Table 6-15**). This was driven by the fish and riparian vegetation component. From a fish perspective, the system is primarily dominated by non-native fish species and the riparian vegetation is highly compromised by extensive bank erosion and alien invasive plant species. The aquatic macroinvertebrate community was overall in a moderately modified state. Despite the presence of several sensitive macroinvertebrate taxon, water quality impairments were suspected, as majority of the community favoured low to very low water quality conditions, possibly due to the adjacent land use being cattle farm and other impacts including irrigation and introducing nutrients to the system through return flows.

The riparian vegetation is highly compromised by extensive bank erosion and alien invasive plant species. The aquatic macroinvertebrate community was overall in a moderately modified state. Despite the presence of several sensitive macroinvertebrate taxon, water quality impairments were suspected, as majority of the community favoured low to very low water quality conditions, possibly due to the adjacent land use being cattle farm and other impacts including irrigation and introducing nutrients to the system through return flows.

RECOMMENDATIONS

- Refer to Chapter 11 for general recommendations;
- Avoid over abstraction, if possible to avoid the river from drying out downstream;
- Maintenance of sewage infrastructure associated with upstream towns of Kareedouw.

7. SUPPLEMENTARY INFORMATION FOR SMALLER TRIBUTARIES: FIELD VERIFICATION SITES

7.1 MTAK01_FV: Mtakatye River

Sample Date	7 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	MTAK01_FV	**IUA**	IUA_T04
River	Mtakatye	**IUA description**	Pondoland coastal
Altitude (m.a.s.l.)	31	**Prioritised RU**	-
Latitude	-31.61528	**Longitude**	29.05771
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	T70E
Level 2 EcoRegion	16.06	**SQ Reach**	T70E-06459
Geomorphological zone	E (Slope 0.005)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: *In situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			
			
Site impacts:			
• Localised washing/chemicals • Erosion • Cattle trampling/grazing • In-stream/riparian litter			
In situ water quality: • pH: 8.39 • EC: 447.6 µS/cm • TDS: 0.3498 g/l • DO: 8.59 mg/l • DO%: 87.5 % • Clarity: 70 cm • Temperature: 16.2 °C • Salinity: 0.26 ppt			

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
21	15.5	B (Good)	1.5	1
Dominant Species	(1) *Achnanthes thienemannii Hustedt*			
	(2) *Achnanthidium spp.*			
Preferences	(1) Limited research on this diatom species however the specialists feel that it may be indicative of low nutrient/low EC (previously identified in high mountainous streams in SA and Lesotho)			
	(2) Moderate to good quality waters			

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	B/C (81%)	NF	• Channel modification (localised at road crossings, bank erosion due to cattle grazing, grazing and crossings) • Physical-chemical modification (upstream community i.e., Libode
Habitat Integrity: Riparian	B (87%)	F	• Bank erosion (river crossings, cattle grazing and trampling)
ECOSTATUS (PES)	B/C		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	B/C	• Diatoms Indicative of good quality conditions • Instream habitat integrity categorised as B/C

B/C	• F: Better management of alien invasive vegetation within the riparian zone; and • NF: Better general catchment management (cattle activity).

7.2 KLIP01_FV: Klipplaats River

Sample Date	11 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	KLIP01_FV	**IUA**	IUA_SO2
River	Klipplaat	**IUA description**	Black Kei
Altitude (m.a.s.l.)	1093	**Prioritised RU**	-
Latitude	-32.259687	**Longitude**	26.856693
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	S32G
Level 2 EcoRegion	18.02	**SQ Reach**	S32G-07224
Geomorphological zone	E (Slope 0.004)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: I*n situ* water quality, diatoms, IHI			

Site Photographs: Survey 1 (September 2022)



Upstream



Downstream

Site impacts:

- Bridges
- Alien invasive plants along riparian zone (*Salix sp.*)
- Downstream from Waterdown Dam

SUMMARY RESULTS

In situ water quality:

- pH: 8.02
- EC: 93 µS/cm
- TDS: 0.0725 g/l
- DO: 9.84mg/l
- DO%: 100.6 %
- Clarity: 47cm
- Temperature: 16.3°C
- Salinity:0.06 ppt

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
46	12.8	C (Moderate)	3.2	0.5
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preferences	Nutrient and salinity increase (eutrophication)			

IHI			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	B/C (78%)		• Flow modification (changes to the flow component due to the upstream dam and possible releases during dry or low flow months) • Channel modification (upstream Waterdown Dam, bridges)
Habitat Integrity: Riparian	C (71%)		• Channel modification (confinement of floodplain)
ECOSTATUS (PES)	C		

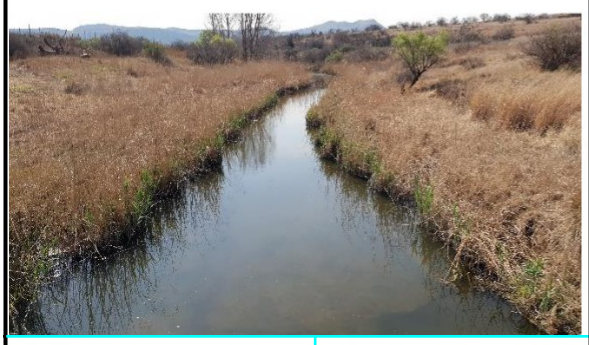
COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	D	C	• Instream habitat integrity categorised as a B/C • Riparian habitat integrity categorised as a C • Diatoms indicative of moderately modified

REC	
C	• F: Upstream Waterdown Dam remains (flow modification); and • NF: Aim for water quality improvements (maintain dysfunctional WWTW).

7.3 KSMI01_FV: Klaas Smits River

This river was identified for a rapid 3 assessment. However due to very low flows, mainly sewage from the Komani River that flows through Queenstown, it was seen as a health hazard to undertake the surveys. Only diatom and in situ water quality sampling were taken.

Sample Date	11 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	KSMI01_FV	**IUA**	IUA_S02
River	Klaas Smits	**IUA description**	Black Kei
Altitude (m.a.s.l.)	975	**Prioritised RU**	R_RU22_R
Latitude	-31.99845	**Longitude**	26.89427
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	S31G
Level 2 EcoRegion	18.02	**SQ Reach**	S31G-06899
Geomorphological zone	E (Slope 0.003)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: *In situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- Eutrophication based on the *in situ* water quality data, mainly from WWTW (Queenstown) in the Komani River
- Abstraction for irrigation and off-channel dams
- Alien invasive species within the riparian zone (Salix, Eucalyptus and *Populus sp.)*

SUMMARY RESULTS

In situ water quality:

- pH: 9.12
- EC: 1284 µS/cm
- TDS: 0.906 g/l
- DO: 24.17 mg/l
- DO%: 269.6 %
- Clarity: 25 cm
- Temperature: 20.3 °C
- Salinity: 0.70 ppt

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells

18	1.7	E (Serious)	50.9	0.25
Dominant Species	*(1) Navicula veneta Kützing*			
	(2) Nitzschia palea (Kützing) W.Smith			
Preferences	(1) Cosmopolitan, common in heavily eutrophic waters, electrolyte-rich to brackish water. Very pollution tolerant, often the dominant species in industrially impacted waters.			
	(2) A cosmopolitan and very commonly occurring species found in eutrophic and very heavily polluted to extremely polluted waters with moderate to high electrolyte content			

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	C/D (59%)	F/NF	• Physical-chemical modification (diatoms indicative of seriously modified water quality conditions, irrigation return flows, WWTWs) • Water abstraction (extensive irrigation in lower Komani and Klaas Smits, domestic and industrial activities in Komani) • Some bed modification (weirs, bridges, low water crossings)
Habitat Integrity: Riparian	B/C (81%)	F/NF	• Water abstraction (very low baseflows) • Some flow modification (Number of off-channel dams – reduced freshets and low flows)
ECOSTATUS (PES)	C/D		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	C/D	• System driven by poor water quality • Diatoms indicative of critically modified conditions

REC	
C/D	• F: High irrigation; • NF: Poor water quality driven – the site is located downstream from confluence of Komani River (very poor water quality conditions); and • NF: Aim to ensure water quality improvements through maintenance of upstream WWTW and the town of Queenstown and Komani.

7.4 BUFF03_FV: Buffalo River (Upper)

Sample Date	14 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	BUFF03_FV	**IUA**	IUA_R02
River	Buffalo	**IUA description**	Buffalo/ Nahoon
Altitude (m.a.s.l.)	418	**Prioritised RU**	-
Latitude	-32.80347	**Longitude**	27.37056
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	R20B
Level 2 EcoRegion	16.07	**SQ Reach**	R20B-07915
Geomorphological zone	E (slope: 0.003)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Components sampled: *In situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- Nutrient enrichment (algae)
- Alien invasive plants along riparian zone (*Eucalyptus sp.)*

In situ water quality:

- pH: 8.15
- EC: 755 µS/cm
- TDS: 0.569 g/l
- DO: 8.65 mg/l
- DO%: 91.3 %
- Clarity: 85 cm
- Temperature: 17.8 °C
- Salinity: 0.43 ppt

No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
31	11.4	C (Moderate)	10.6	0.7
Dominant Species	*Cocconeis placentula var. euglypta (Ehrenberg) Grunow*			
Preferences	Nutrient and salinity increase (eutrophication)			

IHI			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	B/C (80%)	F/NF	• Physical-chemical modification (diatoms indicative of moderately modified water quality, upstream villages/rural areas) • Flow modification (upstream dams and forestry) • Bed modification (Bridge, weirs)
Habitat Integrity: Riparian	B/C (79%)	NF	• Bank erosion (crossings, scouring around bridges, weirs) • Exotic vegetation
ECOSTATUS (PES)	B/C		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	B/C	• Diatoms indicative of moderately modified water quality • Both instream and riparian habitat integrity categorised as B/C

B/C	• F: Flow limitations (forestry – thus reduced low flows).

7.5 BUFF02_FV: Buffalo River (Lower)

Sample Date		**Reserve Level Assessment**	Field verification
Site Name	BUFF02_R	**IUA**	IUA_R02
River	Buffalo	**IUA description**	Buffalo/ Nahoon
Altitude (m.a.s.l.)	55m	**Prioritised RU**	R_RU20_R
Latitude	-32.991768	**Longitude**	27.775910
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	R20F
Level 2 EcoRegion	31.02	**SQ Reach**	R20F-08045
Geomorphological zone	D (Slope 0.011)	**PES (DWS, 2014)**	D
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Components sampled: *In situ* water quality, diatoms			
Site Photographs: Survey 1 (September 2022)			
			
Site impacts:			
• Weir • Water abstraction • Alien invasive aquatic macrophytes (*Eichhornia crassipes* – Hyacinth) • Nutrients (algae) mainly from WWTW pipeline leakage downstream • Cattle trampling and grazing • Alien invasive trees within riparian zone (Syringa sp., *Caesalpinia pulcherrima* - Pride of Barbados) • Downstream of Bridle Drift Dam			
SUMMARY RESULTS			
In situ water quality: • pH: 8.17 • EC: 384.4 µS/cm • TDS: 0.2965 g/l • DO: 7.17 mg/l • DO%: 73.7 % • Clarity: 15 cm • Temperature: 16.8 °C • Salinity: 0.22 ppt • Discharge: not measured			

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
30	8.2	D (Poor)	43	0
Dominant Species	(1) *Eolimna subminuscula (Manguin) Moser, Lange-Bertalot & Metzeltin*			
	(2) *Nitzschia frustulum (Kützing) Grunow*			
	(3) *Planothidium engelbrechtii (Cholnoky) Round & Bukhtiyarova*			
Preferences	(1) A cosmopolitan species common in electrolyte-rich, strongly polluted rivers and flowing waters.			
	(2) A cosmopolitan species found in electrolyte-rich and brackish waters. Tolerant of fluctuations in osmotic pressure and of critical levels of pollution.			
	(3) Found abundantly in saline inland waters with very high electrolyte content. Capable of tolerating critical to very heavy organic pollution.			

Physical-chemical state of the system
The Mdantsane and Potsdam WWTW are discharging upstream of the monitoring site. Reeston WWTW also discharging immediately downstream of the site. The WWTW Green Drop Scores have been on a steady decline since 2011, suggesting impacts on the Physical-chemical state of the system through elevated nutrient loading. The % change in flow at the Mdantsane and Potsdam WWTW between 2013 and 2021 are -39% and -46% respectively, suggesting that untreated wastewater/sewage ends up in the river. Clarity/visibility was also very low.

IHI			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	D/E (38%)	F/NF	• Water released from Bridle Drift Dam is abstracted at weir just upstream of the site to the water works • Limited baseflows and freshets, only large floods overtopping Bridle Drift Dam • Sediment starvation due to Bridle Drift Dam and abstraction weir downstream • Instream exotic macrophytes • Poor waste management resulting in high volumes of instream macroplastics
Habitat Integrity: Riparian	B/C (79%)	F	• Upstream weirs • Loss of baseflows and floods
ECOSTATUS (PES)	D/E		

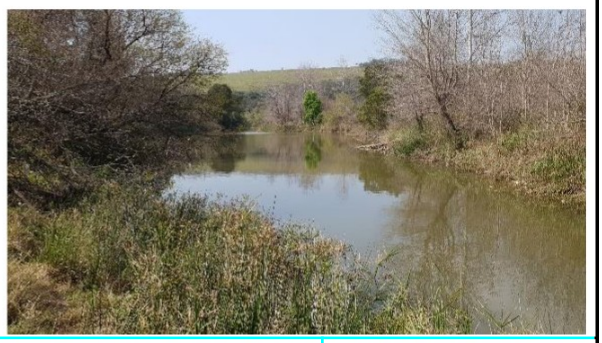
COMPONENT	PES 2014	EcoStatus (PES) 2022	REASON FOR CHANGE
ECOSTATUS	C	D/E	• Diatoms indicative of poor water quality o0wing to high organics (sewage • Instream habitat integrity categorised as D/E

REC	
D	• NF: Improve water quality owing from raw sewage inputs.

7.6 KUBU01_FV: Kubusi River (Upper)

Sample Date	14 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	KUBU01_FV	**IUA**	IUA_S03
River	Kubusi	**IUA description**	Lower Great Kei
Altitude (m.a.s.l.)	779	**Prioritised RU**	-
Latitude	-32.595016	**Longitude**	27.423866
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S60A
Level 2 EcoRegion	16.07	**SQ Reach**	S60A-07606
Geomorphological zone	E (slope: 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: I*n situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- Forestry
- Nutrient enrichments (algae)
- Alien invasive plant species within riparian zone
- Solid waste
- Bank erosion/collapse

SUMMARY RESULTS

In situ water quality:

- pH: 8.08
- EC: 205.1 µS/cm
- TDS: 0.1570 g/l
- DO: 9.79 mg/l
- DO%: 101.2 %
- Clarity: 79 cm
- Temperature: 17.1 °C
- Salinity: 0.12 ppt

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
35	12.1	C (Moderate)	14.3	3.5
Dominant Species	(1) *Achnanthidium crassum (Hustedt) Potapova & Ponader*			
	(2) *Achnanthidium spp.*			

	(3) Nitzschia sp.
Preferences (2)	(1) Alkaline and slow flowing water
	Moderate to good quality waters
	(3) Generally, siltation and moderate pollution

IHI			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	C (77%)	F/NF	• Flow modification (forestry, upstream Gubu Dam, resulting in reduced baseflows) • Physical-chemical modification (diatoms indicative of moderately modified water quality, high algae indicative of nutrient enrichment) • Bed modification (bridges and weirs) • Channel modification (alien vegetation resulting in bank collapse, scouring of banks)
Habitat Integrity: Riparian	C (72%)	NF	• Exotic vegetation
ECOSTATUS (PES)	C		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	D	C	• Diatoms, instream and riparian habitat integrity all moderately modified.

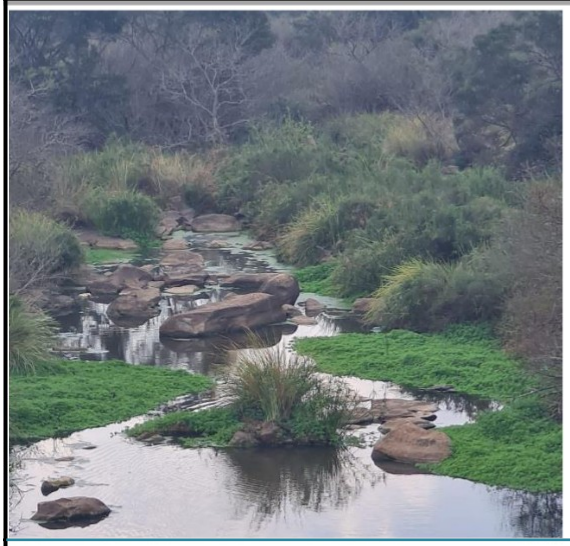
C	• F: Flow limitations (forestry – thus reduced low flows).

7.7 KUBU02_FV: Kubusi River (Middle)

Sample Date	14 September 2022	**Reserve Level Assessment**	Rapid 3
Site Name	KUBU02_FV	**IUA**	IUA_S03
River	Kubusi	**IUA description**	Lower Great Kei
Altitude (m.a.s.l.)	779 m	**Prioritised RU**	R_RU0_12
Latitude	-32.595016	**Longitude**	27.423866
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S60B
Level 2 EcoRegion	16.06	**SQ Reach**	S60B-07635
Geomorphological zone	D (slope 0.012)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

Bedrock with no flows, limited aquatic biotopes and pools.

Site impacts:

- Agriculture and irrigation
- Alien invasive plants within the riparian zone
- Forestry
- Nutrient enrichment (high algae)

SUMMARY RESULTS

In situ water quality and discharge:

- pH: 8.08
- EC: 205.1 µS/cm

- TDS: 0.1570 g/l
- DO: 9.79 mg/l
- DO%: 101.2 %
- Clarity: 79 cm
- Temperature: 17.1 °C
- Salinity: 0.12
- Discharge: not measured

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
28	6.3	D (Poor)	50.2	0.3
Dominant Species	(1) *Eolimna minima(Grunow) Lange-Bertalot*			
	(2) *Nitzschia sp.*			
Preferences	(1) Cosmopolitan, found in a wide range of waters including heavily polluted biotopes. May possibly be associated with organic detritus			
	(2) Generally, siltation and moderate pollution			

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Habitat Integrity: Instream	C (77%)	F/NF	• Extensive forestry • Gubu Dam and thus reduced baseflows • Water quality (nutrient enrichment)
Habitat Integrity: Riparian	C (72%)	NF	• Exotic vegetation encroachment
ECOSTATUS (PES)	C		

Refer to Appendix A for the Habitat Integrity assessment scores for the riparian and instream zone

Overall change and reason for deviation			
COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	D	C	• Instream habitat integrity categorised as a B/C • Riparian habitat integrity categorised as a C • Diatoms indicative of moderately modified

REC	
C	• F: Upstream Waterdown Dam remains; and • NF: Aim for water quality improvements, although diatoms indicative of moderately modified conditions.

7.8 GCUW01_FV: Gcuwa River

Sample Date	9 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	GCUW01_R	**IUA**	IUA_S03
River	Gcuwa	**IUA description**	Lower Great Kei
Altitude (m.a.s.l.)	536	**Prioritised RU**	R_RU26_R
Latitude	-32.319770°	**Longitude**	28.136094°
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S70D
Level 2 EcoRegion	16.06	**SQ Reach**	S70D-07307
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: Diatoms			
Site Photographs: Survey 1 (September 2022)			



Site impacts:

- Upstream town of Butterworth
- Raw sewage impacts
- Macroplastics in-stream and along the riparian zone
- Erosion
- Cattle trampling and grazing

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
Downstream of town diatom results				
27	7.3	D (Poor)	45.2	0.75
Dominant Species	*Fragilaria ulna var.acus (Kützing) Lange-Bertalot*			
	Gomphonema parvulum (Kützing) Kützing			

	Navicula veneta Kützing
Preferences	tolerates slightly saline water, alkalibontic (only in water pH>7), tolerates moderate organic pollution. Found in standing and flowing water.
	A cosmopolitan species which is very widespread in a range of waters, from small pools to lakes and rivers and generally considered to be tolerant of extremely polluted conditions
	Cosmopolitan, common in heavily eutrophic waters, electrolyte-rich to brackish water. Very pollution tolerant, often the dominant species in industrially impacted waters.

Physical-chemical state of the system

Historical data for the site consists of 1980 to 1999 data, with only n = 11 data entries, which is not enough for a low confidence assessment of reference conditions. Diatom data were used to infer the reference conditions of the site. The diatom results indicated poor water quality linked to organic pollution from the Butterworth WWTW effluent discharge U/S. It is expected that under reference conditions, lower nutrient concentrations would prevail at the site. The available historical monitoring data (1980 to 1999, n = 11) indicated TIN concentrations range of 0.04 – 5.24 mg/l and PO_4 range of 0.01 – 6.03 mg/l.

Butterworth WWTW discharging U/S, and with a sludge and effluent compliance of 6% its is expected to have significant impacts on the physical-chemical state of the system. Additionally, the % change in flow of -90% between 2013 and 2021, most of the untreated sewage ends up in the river. The Trankei Quarries is also located upstream, and is likely to impact on the TDS, conductivity and suspended solids of the system downstream.

Overall change and reason for deviation

COMPONENT	PES 2014	EcoStatus (PES) 2022	REASON FOR CHANGE
ECOSTATUS	D	E	• Diatoms indicative of poor water quality • Raw sewage inputs

D	• NF: Water quality improvements through the upgrade and functionality of the Butterworth WWTW.

7.9 GFIS04_FV: Great Fish River (upstream of Cradock)

Sample Date	21 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	GFIS04_FV	**IUA**	IUA_Q01
River	Great Fish (upstream of Cradock)	**IUA description**	Upper Fish
Altitude (m.a.s.l.)	857m	**Prioritised RU**	-
Latitude	-32.16074	**Longitude**	25.61178
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q30E
Level 2 EcoRegion	18.01	**SQ Reach**	Q30E-07122
Geomorphological zone	E (Slope 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: I*n situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- Interbasin transfer (flow modification)
- Irrigation and return flows
- Sedimentation
- Weirs
- Bridges
- Alien invasive plants within riparian zone (Spanish Reed)

In situ water quality:

- pH: 8.42
- EC: 272.6 µS/cm
- TDS: 0.2172 g/l
- DO: 8.52 mg/l
- DO%: 85.8 %
- Clarity: 7 cm
- Temperature: 15.4 °C
- Salinity: 0.16 ppt

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
32	11.1	C (Moderate)	7	0

Dominant Species	*(1) Cyclostephanos dubius (Fricke) Round*
	(2) Cyclostephanos invisitatus (Hohn & Hellerman) Theriot, Stoermer & Håkansson
	(3) Gomphonema pumilum var. rigidum Reichardt & Lange-Bertalot
Preferences	(1) A euplanktonic species found in inland waters with elevated chloride concentration (high conductivity) as well as calcareous, alkaline waters. Sensitive to siltation (i.e., will disappear).
	(2) Cosmopolitan, common in summer plankton nutrient-rich streams. These species when in abundance is a good indicator of eutrophication.
	(3) A cosmopolitan species found in mesotrophic to eutrophic waters with moderate electrolyte content. Not tolerant of more than critical levels of pollution.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	C (66%)	F/NF	• Physical-chemical modification (diatoms indicative of moderately modified water quality) • Flow modification (increased flows due to transfer of water) • Bed modification (scouring, bed armouring due to increased flows) • Inundation (macroinvertebrate habitats inundated)
Habitat Integrity: Riparian	D (46%)	NF	• Vegetation removal (due to recreational areas, burning of riparian vegetation) • Bank erosion (inset bench erosion) • Exotic vegetation (extensive Spanish reeds)
ECOSTATUSC/D			

Overall change and reason for deviation			
COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	D	C/D	• System highly modified • Riparian zone dominated by Spanish Reed • Interbasin transfer (flow modification)

C/D	• F: Interbasin transfer (flow modification); and • F: Irrigation schemes aid in social economic upliftment.

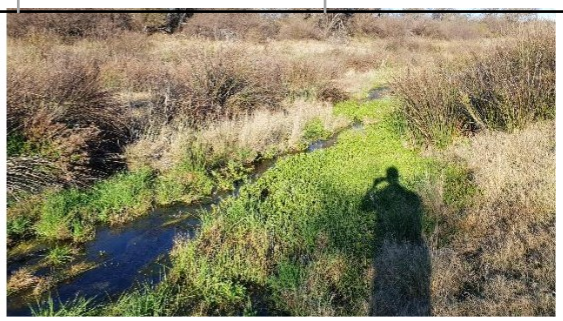
7.10 FISH01_FV: Great Fish River (Upper)

Sample Date	22 September 2022	**Reserve Level Assessment**	Field Verification *(including fish and macroinvertebrates)*
Site Name	FISH01_R	**IUA**	IUA_Q01
River	Great Fish	**IUA description**	Upper Fish
Altitude (m.a.s.l.)	994 m	**Prioritised RU**	R_RU12_R
Latitude	-31.919527	**Longitude**	25.390974
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q21B
Level 2 EcoRegion	18.01	**SQ Reach**	Q21B-06817
Geomorphological zone	E (slope 0.003)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate

Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, discharge

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located near Visrivier and 2.2 km from the N10 and is upstream of the Fish transfer scheme.

The site is located in a partly confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by thick silty deposits over bedrock and gravel sediment types. Extensive aquatic weed beds are present along the pools and riffle sections. The banks and benches are composed of gravel and sand. There is very high embeddedness along riffles with silt.

Aquatic macroinvertebrate biotopes were limited owing to the thick silty deposits. Limited SIC and SOOC. There was good availability of both marginal and instream vegetation. Fish habitats included SD and SS.

Site impacts:

- Agriculture (localised)
- Cattle trampling and grazing
- Upstream weir and diversion into canal
- Water abstraction
- Algae owing to reduced flows
- Low water bridge
- Instream macrophytes (red water fern)
- Bank erosion on microchannel

In situ water quality and discharge:

- pH: 7.77

- EC: 864 µS/cm
- TDS: 0.700 g/l
- DO: 8.5 mg/l
- DO%: 84.5 %
- Clarity: >100 cm
- Temperature: 14.6 °C
- Salinity: 0.54
- Discharge: 0.009 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
32	11.2	C (Moderate)	20.2	**2.75**
Dominant Species	*(1) Amphora pediculus (Kützing) Grunow*			
	(2) Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot			
Preferences	(1) A cosmopolitan species found in waters with moderate electrolyte content (Increased salts and cultivated areas) and tolerating critical levels of pollution. pH>7			
	(2) A common species in standing and flowing, circumneutral to alkaline waters with a moderate to high electrolyte content. Capable of tolerating critically polluted conditions.			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	Not done	• Single straight channel	• High algae mass and instream vegetation driving siltation
Fish	2	• Submergent and marginal vegetation	• High algal content • Low hydraulic diversity • Limited velocity-depth classes
Macroinvertebrates	2	• Good marginal and in-stream vegetation biotope	• Limited aquatic biotopes (SIC, SOOC) • High algae content smothering vegetation, mud biotopes (eutrophication) • High siltation Increased flows (Interbasin Transfer (IBT) of water) – unnatural flow regimes

** Confidence scores: 0 = no confidence; 5 = high confidence*

COMPONENT	INFORMATION AVAILABILITY*					DESCRIPTION OF INFORMATION
	0	1	2	3	4	
Hydraulics						• Hydraulics not done, no previous observations
Fish						• PES-EI-ES ASSESSMENT (DWS, 2014) • Current survey (September 2022)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES ASSESSMENT (DWS, 2014)

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
						• River Eco-status Monitoring Programme (REMP) river database (inverts)
Hydrology						• Natural and present day flows
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity • 2022 diatom data • REMP data (2007-2019, n=57)

** 0 (no information) to 4 (large amount of data available)*

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Enteromius mandelai, Labeo umbratus*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Naucoridae, Notonectidae, Pleidae, Veliidae, Hydropsychidae >2spp, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Lymnaeidae, Physidae, Corbiculidae
Physical-chemical	Earliest monitoring data for the site were collected in 2007 up to 2019, with only n = 57 data during this period. Diatom data were used to infer the reference conditions of the site. The diatom results indicated moderate water quality characterised by organic and inorganic pollution as well as basic pH conditions. Under reference conditions it is expected that the organic and inorganic pollutants would be lower.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	E/F (18.9%)	F	• Upstream offtake limiting flows downstream
Macroinvertebrates	C/D (60.63)	NF	• Limited aquatic biotopes (SIC, SOOC) • High algae content (eutrophication) • High siltation • Extensive irrigation
Habitat Integrity: Instream	C (66%)	F	• Scoring and bed armouring due to increased flows
Habitat Integrity: Riparian	D (46%)	F	• Inset bench erosion
ECOSTATUS (PES)	**D (44.25%)**		

Refer to Appendix A for the Habitat Integrity assessment scores for the riparian and instream zone
Refer to Appendix C for the fish and aquatic macroinvertebrate inventories

<table>
<tr><td></td><td></td></tr>
<tr><td>Component</td><td>Causes
Present/Absent</td></tr>
<tr><td>Fish</td><td>The lack of hydraulic diversity and limited flow due to offtake from the upstream wier has resulted in the loss of diverse hydraulic habitat and velocity-depth classes within the system. In addition, agricultural runoff has resulted in nutrient enrichment of the system, with the reach supporting significant instream vegetation that resembles valley-bottom wetlands that would otherwise limit the occurrence of fish.

<table>
<tr><th>METRIC GROUP</th><th>REFERENCE WEIGHTS (%)</th><th>PRESENT WEIGHTS (%)</th></tr>
<tr><td>VELOCITY-DEPTH</td><td>93.40</td><td>100.00</td></tr>
<tr><td>COVER</td><td>100.00</td><td>98.00</td></tr>
<tr><td>FLOW MODIFICATION</td><td>30.59</td><td>65.33</td></tr>
<tr><td>PHYSICAL-CHEMICAL</td><td>58.33</td><td>68.33</td></tr>
<tr><td>MIGRATION</td><td></td><td>83.75</td></tr>
<tr><td>IMPACT OF INTRODUCED</td><td></td><td>87.10</td></tr>
<tr><td>FRAI</td><td>PRESENT</td><td></td></tr>
<tr><td>FRAI (%)</td><td>18.9</td><td></td></tr>
<tr><td>EC: FRAI</td><td>E/F</td><td></td></tr>
</table></td></tr>
<tr><td>Macroinvertebrates</td><td>
<table>
<tr><th>INVERTEBRATE EC METRIC GROUP</th><th></th><th>METRIC GROUP CALCULATED SCORE</th><th>CALCULATED WEIGHT</th><th>WEIGHTED SCORE OF GROUP</th><th>RANK OF METRIC</th><th>%WEIGHT FOR METRIC GROUP</th></tr>
<tr><td>FLOW MODIFICATION</td><td>FM</td><td>72.5</td><td>0.291</td><td>21.0909</td><td>3</td><td>80</td></tr>
<tr><td>HABITAT</td><td>H</td><td>61.2</td><td>0.364</td><td>22.2496</td><td>1</td><td>100</td></tr>
<tr><td>WATER QUALITY</td><td>WQ</td><td>48.4</td><td>0.327</td><td>15.8318</td><td>2</td><td>90</td></tr>
<tr><td>CONNECTIVITY & SEASONALITY</td><td>CS</td><td>80.0</td><td>0.018</td><td>1.45455</td><td>4</td><td>5</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>275</td></tr>
<tr><td>INVERTEBRATE EC</td><td></td><td></td><td></td><td>60.6269</td><td></td><td></td></tr>
<tr><td>INVERTEBRATE EC CATEGORY</td><td></td><td></td><td></td><td>C/D</td><td></td><td></td></tr>
</table>
Aquatic biotopes were limited at this site, with the exception of good marginal and in-stream aquatic vegetation. The aquatic macroinvertebrate assemblage collected was determined to be representative of being moderately to largely modified (Ecological Category C/D, 60.63%). A total of 19 taxa were recorded during September 2022, out of a reference community of 46 taxa (41% of the reference community was present). The macroinvertebrate assemblage was mostly driven by standing water, vegetation and low to very low requirements for unmodified Physical-chemical conditions. At the time of the survey, considerable algae mass was observed and eutrophic conditions. Only 3 out of the expected 15 sensitive to very sensitive taxa (QV: 8-15) were recorded (Baetidae >2spp, Hydracarina and Hydraenidae). The absent sensitive to very sensitive taxa</td></tr>
</table>

PES and causes	
Component	**Causes Present/Absent**
	all are driven by moderately to high water quality, cobbles and moderately to fast flow conditions, all features absent from the site. Overall, the community was primarily driven by water quality (48.4%) (high nutrient input resulting in considerable algae mass), habitat (61.2%) (lack of aquatic biotopes), and then flow modification (72.5%). The ASPT for the community was 4.8 (69% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002).

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Macroinvertebrates	Stable	• Impaired water quality (irrigation) • Drivers are unchanged due to impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Decline	• Major lack of flow variation	2
Habitat integrity: Riparian	Decline	• Major lack of flow variation	2
ECOSTATUS (PES)	Stable	• Remains a Class D	2

** 0 – no confidence to 5 – high confidence*

Physical-chemical state of the system
In situ water quality parameters were within limits, although concentrations of TDS and EC recorded were elevated. Very high clarity/visibility was recorded.

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2022***
Moderate, Moderate	Moderate, Moderate

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	D	D	• Remains unchanged • Fish (E/F) • Although, system dominated by non-native fish species (ASCL, CGAR) • Only 2 indigenous fish species at low frequency of occurrence

			• Aquatic biotopes availability is limited for aquatic macroinvertebrates

REC	
D	• F: Area heavily dependent on the water diversion into canal; and • F: No water or flow sensitive aquatic macroinvertebrates.

OVERALL ECOSTATUS ASSESSMENT

The overall EcoStatus was categorised as a Class D, with an unchanged REC. The fish community was limited due to limited flow within the system and the significant aquatic vegetation present. The aquatic macroinvertebrate community was overall in a moderately to largely modified state primarily comprising tolerant taxa. Overall, the community was driven mostly by water quality, habitat and then the flow modification metric.

RECOMMENDATIONS

- Refer to Chapter 10.1 for general recommendations

7.11 TARK01_FV: Tarka River

Sample Date	21 September 2022	**Reserve Level Assessment**	Field Verification *(including fish and macroinvertebrates)*
Site Name	TARK01_R	**IUA**	IUA_Q02
River	Tarka	**IUA description**	Great Fish
Altitude (m.a.s.l.)	830 m	**Prioritised RU**	R_RU14_R
Latitude	-32.283315	**Longitude**	25.759280
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q44C
Level 2 EcoRegion	18.01	**SQ Reach**	Q44C-7276
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: Fish, aquatic macroinvertebrates, IHI, in situ water quality, diatoms, discharge			

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located 8 km downstream (straight distance) from Kommandodrift Dam and Lake Arthur and 3 km form the N10.

The site is located in a partly confined valley setting with a single channel and narrow flood features within the historical macro channel. The channel is incised into the surrounding landscape and has subsequently filled in with sediment from tributaries due to reduced flooding along the mainstem Tarka. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by sand and silt sediment types. Gravel and cobble are locally present, but possibly introduced for river crossings. The banks and benches are composed of sand and silt. The local landowner mentioned channel siltation of 2+m due to reduced flows downstream of the dam.

Biotopes for aquatic macroinvertebrates were of poor habitat availability. Limited SIC were available, however there was some SOOC, GSM and marginal and aquatic vegetation. The marginal vegetation was dominated by Phragmites sp. encroaching the channel due to the silt sediment types. Fish habitats only included SS and limited FS habits.

Site impacts:

- 2 x large upstream dams with no releases into the river
- River crossings
- Agriculture (irrigation mainly from canals with water released from upstream dams)
- Return flows (irrigation)

- Sedimentation and siltation
- High nutrients (algae)

SUMMARY RESULTS

In situ water quality and discharge:

- pH: 8.25
- EC: 3049 µS/cm
- TDS: 2.616 g/l
- DO: 7.79 mg/l
- DO%: 74.6 %
- Clarity: 75 cm
- Temperature: 12.8 °C
- Salinity: 2.14 ppt
- Discharge: 0.007 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
23	7.1	D (Poor)	25.5	1
Dominant Species	(1) *Craticula buderi (Hustedt) Lange-Bertalot*			
	(2) *Planothidium sp.*			
Preferences	(1) Nutrient and salinity increase (eutrophication)			
	(2) First time our Diatom specialists have identified Planothidium and thus its preference is to be researched.			

Component	Confidence Score*	Advantages	Disadvantages
Hydraulics	Not done		
Fish	2	• None	• Limited extent of open water with limited flow • Limited velocity-depth classes and cover elements
Macroinvertebrates	2	• Some aquatic biotopes (SIC, SOOC)	• Although good marginal vegetation – it is entirely woody vegetation (Phragmites and Spanish reeds encroaching the margins) • High algae content smothering biotopes (eutrophication) • High siltation • Limited flow conditions • Upstream wetland conditions with Phragmites sp. and Spanish reed encroaching the channel

** Confidence scores: 0 = no confidence; 5 = high confidence*

Information Availability						
COMPONENT	**INFORMATION AVAILABILITY***					**DESCRIPTION OF INFORMATION**
	0	1	2	3	4	
Fish						• PES-EI-ES ASSESSMENT (DWS, 2014) • Current survey (September 2022)
Macroinvertebrates						• Current survey (September 2022) • PES-EI-ES ASSESSMENT (DWS, 2014) • River Eco-status Monitoring Programme (REMP) river database (inverts)
Diatoms						• Current survey (September 2022)
Physical-chemical						• Current survey (September 2022) only measured *in situ* water quality and clarity. • 2022 diatom data • REMP data (1973 -2019, n = 1404)

** 0 (no information) to 4 (large amount of data available)*

Reference Conditions	
COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**
Fish	*Anguilla mossambica*, *Enteromius mandelai, Labeo umbratus*
Macroinvertebrates	Turbellaria, Oligochaeta, Hirudinea, Potamonautidae, Hydracarina, Perlidae, Baetidae >2spp, Caenidae, Heptageniidae, Leptophlebiidae, Trichorythidae, Chlorocyphidae, Coenagrionidae, Aeshnidae, Corduliidae, Gomphidae, Libellulidae, Pyralidae, Belostomatidae, Corixidae, Gerridae, Naucoridae, Notonectidae, Pleidae, Veliidae, Ecnomidae, Hydropsychidae >2spp, Hydroptilidae, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Hydraenidae, Hydrophilidae, Psephenidae, Athericidae, Ceratopogonidae, Chironomidae, Culicidae, Muscidae, Simuliidae, Tabanidae, Tipulidae, Ancylidae, Physidae, Corbiculidae
Physical-chemical	Analyses of the historical data (dating back to 1973) of the site showed that the data did not represent the reference conditions of the site. pH, EC, PO4 and TIN all significantly higher than their respective Natural (0) ratings in the DWS (2008) benchmarks table, suggesting that impacts on Physical-chemical state of the river were already evident. Satellite imagery also showed extensive agriculture in the area around the 1980s, expected to have been present for a longer period before then. Therefore, diatom data were used to infer the reference conditions at the site. The diatom results indicated a poor water quality, linked to organic pollution, and elevated salinities. Under reference conditions, lower nutrient and salinity conditions are expected to prevail at the site.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Fish	F (10.3%)	F	• Limited flow within the system due to upstream Lake Arthur and Kommandodrift Dams
Macroinvertebrates	D (47.29)	F/NF	• Impaired water quality (high algae content, eutrophication, high salinity from irrigation return flows and somewhat natural, anoxic sediments)

			• Lake Arthur and Kommandodrift Dams upstream (no releases into river) • Limited flow conditions • Limited aquatic biotopes (SIC, SOOC) • Habitat modification - high siltation (bed built-up more than 2m over time)
Habitat Integrity: Instream	D (49%)	F	• Lake Arthur and Kommandodrift Dams upstream – no releases into river • Silted (bed built-up more than 2m over time) • High salinity (natural and from irrigation return flows) • Anoxic sediments
Habitat Integrity: Riparian	C (76%)	F	• Flow modification (no floods or freshets)
ECOSTATUS (PES)	**D (56.73%)**		

Refer to Appendix A for the Habitat Integrity assessment scores for the riparian and instream zone
Refer to Appendix C for the fish and aquatic macroinvertebrate inventories

PES and causes			
Component	**Causes Present/Absent**		
Fish	The fish assemblage within the system was regarded as being critically modified due to limited flow within the system as a result of the lack of flow releases from the upstream Lake Arthur and Kommandodrift Dams, with no fish collected during the September 2022 assessment.		

METRIC GROUP	REFERENCE WEIGHTS (%)	PRESENT WEIGHTS (%)
VELOCITY-DEPTH	93.42	95.47
COVER	100.00	100.00
FLOW MODIFICATION	29.91	51.76
PHYSICAL-CHEMICAL	48.32	64.42
MIGRATION		77.91
IMPACT OF INTRODUCED		77.91
FRAI	PRESENT	
FRAI (%)	10.3	
EC: FRAI	F	

PES and causes	
Component	**Causes Present/Absent**
Macroinvertebrates	

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	FM	29.0	*0.392*	11.3725	1	100
HABITAT	H	62.6	*0.314*	19.6331	2	80
WATER QUALITY	WQ	53.6	*0.275*	14.7206	3	70
CONNECTIVITY & SEASONALITY	CS	80.0	*0.020*	1.56863	4	5
						255
INVERTEBRATE EC				47.2949		
INVERTEBRATE EC CATEGORY				D		

Owing to limited flows and Phragmites and Spanish reed encroachment within the channel, aquatic biotopes were limited. The aquatic macroinvertebrate assemblage collected was determined to be representative of being largely modified (Ecological Category D, 47.29%). A total of 16 taxa were recorded during September 2022, out of a reference community of 46 taxa (35% of the reference community was present). The macroinvertebrate assemblage was mostly driven by standing water and low to very low requirements for unmodified Physical-chemical conditions. At the time of the survey, considerable algae mass was observed, high salinity (although somewhat natural and due to irrigation return flows) and anoxic sediment.

Of the 16 expected sensitive taxa expected for this reach, 4 were recorded, of which included only 1 individual of Perlidae and Heptageniidae. The absent sensitive to very sensitive taxa all are driven by moderately to high water quality, cobbles and moderately to fast flow conditions, all features limited from the site. The rest of the absent taxa with high froc scores (3-5) were Turbellaria, Oligochaeta, Hydracarina, Leptophlebiidae, Trichorythidae, Aeshnidae, Gomphidae, Libellulidae, Belostomatidae, Gerridae, Veliidae, Hydropsychidae >2spp, Leptoceridae, Dytiscidae, Elmidae, Gyrinidae, Psephenidae, Tabanidae, Ancylidae, Physidae, Corbiculidae, some of which have preference for cobbles, standing water and moderately fast flowing water and cobbles.

Overall, the community was primarily driven by flow modification (29.0) (abstraction from canals, upstream Lake Arthur and Kommandodrift Dams where there are no releases into the river), water quality (53.6%) (nutrients from irrigation resulting in algae growth, anoxic sediments), then habitat (62.6%) (limited aquatic biotopes). The ASPT for the community was 5.4 (78% of the reference ASPT), indicative of the community being mostly tolerant taxa (Dickens and Graham, 2002).

Ecological trends for the EWR site (include components that were assessed)			
Component	**Trend (stable, decline, improvement)**	**Reason**	**Confidence (0-5)***
Fish	Stable	• Impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Macroinvertebrates	Decline	• Continued impairment of water quality, Anoxic sediments • High siltation build-up • Upstream canalisation of reach • Erosion increasing which may have future impacts on the community • Impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Instream	Decline	• Flow modification (no floods or freshets) • Although on a potential decline trend, impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
Habitat integrity: Riparian	Decline	• Flow modification (no floods or freshets) • Although on a potential decline trend, impacts remaining unchanged (no new developments and since PES, 2014, Google Earth)	2
ECOSTATUS (PES)	Stable	• Remains a Class D	2

** 0 – no confidence to 5 – high confidence*

Physical-chemical state of the system
Highly elevated levels of TDS and EC were recorded during *in situ*. These are likely to be impacts of the extensive agriculture along the length of the river.

Revised Ecological Importance and Ecological Sensitivity	
EI/ES, 2014	**Re-assessed, 2022***
Moderate, Moderate	Moderate, Moderate

COMPONENT	**PES 2014**	**EcoStatus (PES) 2023**	**REASON FOR CHANGE**
ECOSTATUS	D	D	• Remains unchanged • Fish (F) • No fish sampled • Likely presence of two non-native fish species (CCAR, LMAC) • Indigenous fish species at low frequency of occurrence

REC	
D	• F: Upstream dams cannot release into the river – water diverted straight into the canal

OVERALL ECOSTATUS ASSESSMENT

The overall EcoStatus was categorised as a Class D, with an unchanged REC. The fish community was regarded as being critically modified due to the lack of flow within the system, with no fish present during the September 2022 assessment. The aquatic macroinvertebrate community was overall in a largely modified state primarily comprising tolerant taxa. Overall, the community was driven mostly by flow medication, water quality and then the habitat metric.

RECOMMENDATIONS

- Refer to Chapter 10.1 for general recommendations

7.12 FISH02_FV: Great Fish River (Middle)

Sample Date	21 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	FISH02_FV	**IUA**	IUA_Q02
River	Great Fish	**IUA description**	Great Fish
Altitude (m.a.s.l.)	695	**Prioritised RU**	R_RU07_R
Latitude	-32.604885	**Longitude**	25.751772
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q50C
Level 2 EcoRegion	18.02	**SQ Reach**	Q50C-07657
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: In situ water quality, diatoms			
Site Photographs: Survey 1 (September 2022)			







Site Photographs: Survey 2 (May 2023)





Site Description:

The site is located near the Witmos Primary School and just downstream of the confluence with the Kariega river and 8.5 km downstream of the Fish?? Dam.

The site is located in a partly confined valley setting with a single channel and narrow flood features. The channel is incised into the surrounding landscape. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated by cobble, gravel, fine sand and silt sediment types. The banks and benches are composed of sand and silt. Dense reeds are stabilising the active channel banks, leading to steep active channel banks. Grazing is absent from the channel banks and flood features, leading to low bank and marginal zone degradation. Finer sediment bars, such as sand and gravel bars, are missing, possibly due to increased transport rates entraining these sediment types, limiting their residence time along the system.

Site impacts:

- Agriculture
- Irrigation and return flows
- Interbasin Transfer scheme (flow modification)
- High turbidity

SUMMARY RESULTS

In situ water quality and discharge:

- pH: 8.57
- EC: 396.7 µS/cm
- TDS: 0.3256 g/l
- DO: 8.12 mg/l
- DO%: 79.1 %
- Clarity: 7 cm
- Temperature: 14.1 °C
- Salinity: 0.24 ppt
- Discharge: 10.22 m^3/s

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
34	13.4	B (Good)	7	0
Dominant Species	*(1) Cyclostephanos invisitatus (Hohn & Hellerman) Theriot, Stoermer & Håkansson*			

	(2) *Nitzschia dissipata (Kützing) Grunow*
Preferences	(1) Cosmopolitan, common in summer plankton nutrient-rich streams. These species when in abundance is a good indicator of eutrophication.
	(2) A cosmopolitan species found in waters of moderate to high electrolyte content, not present in waters of low electrolyte content.

COMPONENT	**DESCRIPTION OF REFERENCE CONDITIONS**		
Physical-chemical	Physical variables	Historical monitoring data (1978 – 1982, n = 112) was used to determine the reference conditions of the site.	
		pH	Reference data indicated a 5th percentile of 7.3 pH units and a 95th percentile of 8 pH units, which fall within the Natural (0) rating in the DWS (2008) benchmarks table.
		EC	Reference data indicated a 95th percentile of 27.43 mS/m, which falls within the Natural (0) rating in the DWS (2008) benchmarks table.
		Temperature	No historical temperature records are available for the site. The DWS(2008) benchmark tables were used for a low confidence assessment of expected reference temperature conditions.
		Clarity	There are no clarity records available for reference condition assessment. Reference condition is taken as that qualitatively described in the DWA (2008) benchmark tables.
		Oxygen	No dissolved oxygen records are available for this site. DWA guideline benchmark tables (2008) have been utilised to characterise the site's reference condition.
	Nutrients	PO_4	Reference data indicated a 50th percentile of 0.06 mg/l. The Natural (0) rating was therefore re-benchmarked, such that <0.06 mg/l was the Natural (0) rating for the site.
		TIN	Reference data indicated a 50th percentile of 0.58 mg/l. The Natural (0) rating was therefore re-benchmarked, such that <0.58 was the Natural (0) rating for the site.
	Toxics	Fluoride	In terms of the toxics listed within the DWA (2008) rating tables, Fluoride and ammonia were monitored. Reference indicated a 95th percentile of 1090 ug/l, which falls within the Natural (0) rating, DWS (2008).

Physical-chemical state of the system
Very low clarity/visibility recorded during the site assessment, suggesting high sediment loading in the system possible as a result of modified flows in the system. The pH was elevated but within limits along with all other water quality parameters assessed.

Overall change and reason for deviation			
COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	D	*Not assessed*	-

7.13 GBRA01_FV: Great Brak River

Sample Date	21 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	GBRA01_FV	**IUA**	IUA_Q01
River	Great Brak	**IUA description**	Upper Fish
Altitude (m.a.s.l.)	979 m	**Prioritised RU**	-
Latitude	-31.89216	**Longitude**	25.43476
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q13B
Level 2 EcoRegion	18.01	**SQ Reach**	Q13B-06763
Geomorphological zone	E (slope: 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: I*n situ* water quality, diatoms, IHI (part of Fish transfer scheme)			

Site Photographs: Survey 1 (September 2022)





Site impacts:

- Sedimentation (high turbidity)
- Interbasin Transfer scheme (flow modification)
- Bank erosion (increased flows)

In situ water quality:

- pH: 8.41
- EC: 214.1 µS/cm
- TDS: 0.1722 g/l
- DO: 8.75 mg/l
- DO%: 87.6 %
- Clarity: 7 cm
- Temperature: 15.0 °C
- Salinity: 0.13 ppt

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
30	11.9	C (Moderate)	3	0
Dominant Species	*(1) Cyclostephanos invisitatus (Hohn & Hellerman) Theriot, Stoermer & Håkansson*			
	(2) Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot			

Preferences	(1) Cosmopolitan, common in summer plankton nutrient-rich streams. These species when in abundance is a good indicator of eutrophication.
	(2) Tolerates critically to strongly polluted waters

IHI			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	C (63%)	F/NF	• Physical-chemical modification (diatoms indicative of moderately modified water quality) • Flow modification (increased flows due to transfer) • Bed modification (incision and armouring due to increased flows) • Inundation (habitats inundated due to transfer)
Habitat Integrity: Riparian	D (55%)	F/NF	• Bank erosion (increased flows) • Inundation (increased flows inundate riparian zone)
ECOSTATUS (PES)	C/D		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	C/D	• System highly modified • Interbasin transfer (flow modification)

REC	
C/D	• F: Interbasin transfer (flow modification) • F: Irrigation schemes aid in social economic upliftment

7.14 LFIS01_FV: Little Fish River (Upper)

Site dry, only puddles, no flow and stagnant as all water abstracted upstream of site

Sample Date	22 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	LFIS01_FV	**IUA**	IUA_Q01
River	Little Fish	**IUA description**	Upper Fish
Altitude (m.a.s.l.)	1024m	**Prioritised RU**	R_RU13_R
Latitude	-32.50617	**Longitude**	25.42683
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q80B
Level 2 EcoRegion	18.03	**SQ Reach**	Q80B-7445
Geomorphological zone	D (slope 0.008)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Components sampled: IHI, in situ water quality, diatoms			

Site Photographs: Survey 1 (September 2022)





Site Description:

The site is located on the R337.

The site is located in a partly confined valley setting with a single channel and narrow flood features. The channel is straight to wandering and follows the sinuous valley alignment. It follows a pool-riffle reach type and is dominated gravel with localised bedrock, cobble, sand and silt sediment types. The banks and benches are composed of gravel, sand and silt. There is moderate embeddedness along riffles and rapids with silt.

Site impacts:

- Agriculture
- Irrigation
- Significant water abstraction
- Cattle trampling and grazing
- Bank erosion (localised)
- Bridge

In situ water quality:

- pH: 7.53
- EC: 796 µS/cm
- TDS: 0.581 g/l
- DO: 11.18 mg/l
- DO%: 120.5 %

- Clarity: >100 cm
- Temperature: 18.6 °C
- Salinity: 0.44

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
37	11.6	C (Moderate)	9.2	0.5
Dominant Species	*Gomphonema pumilum (Grunow) Reichardt & Lange-Bertalot*			
Preferences	Tolerates critically to strongly polluted waters			
Discharge: <0.01 m^3/s				

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	C (74%)	F	• Physical-chemical modification (diatoms indicative of moderately modified water quality) • Water abstraction (majority of the flows are abstracted for irrigation)
Habitat Integrity: Riparian	B (87%)	F	• Bank erosion (cattle trampling and grazing, bridges)
ECOSTATUS (PES)	C		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	B	C	• Instream habitat integrity categorised as a C • Diatoms indicative of moderately modified water quality

REC	
B/C	• High Ecological Importance; and • F: Improve flows.

7.15 LFIS02_FV: Little Fish River (Lower)

Sample Date	20 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	LFIS02_FV	**IUA**	IUA_Q01
River	Little Fish	**IUA description**	Upper Fish
Altitude (m.a.s.l.)	471m	**Prioritised RU**	-
Latitude	-33.09345	**Longitude**	25.82152
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q80G
Level 2 EcoRegion	18.03	**SQ Reach**	Q80G-08143
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Components sampled: I*n situ* water quality, diatoms, IHI			

Site Photographs: Survey 1 (September 2022)





Site impacts:

- Interbasin Transfer scheme (flow modification)
- Bank erosion
- Cattle trampling and grazing
- Irrigation and return flows

In situ water quality:

- pH: 8.48
- EC: 1246 µS/cm
- TDS: 1.003 g/l
- DO: 8.55 mg/l
- DO%: 85.1 %
- Clarity: 8 cm
- Temperature: 15.0 °C
- Salinity: 0.78

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
38	10.6	C (Moderate)	17.1	0.75

Dominant Species	(1) *Cocconeis placentula var. euglypta (Ehrenberg) Grunow*
	(2) *Cyclostephanos dubius (Fricke) Round*
	(3) *Cyclostephanos invisitatus (Hohn & Hellerman) Theriot, Stoermer & Håkansson*
Preferences	(1) Nutrient and salinity increase (eutrophication)
	(2) A euplanktonic species found in inland waters with elevated chloride concentration (high conductivity) as well as calcareous, alkaline waters. Sensitive to siltation (i.e., will disappear).
	(3) Cosmopolitan, common in summer plankton nutrient-rich streams. These species when in abundance is a good indicator of eutrophication.

IHI

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Habitat Integrity: Instream	C (77%)	F/NF	• Physical-chemical modification (diatoms indicative of moderately modified water quality) • Flow modification (increased flows from Great Fish) • Channel modification (incision of channel) • Bed modification (increased flows are washing out fine sediments)
Habitat Integrity: Riparian	B (85%)	F/NF	• Inundation (increased flows)
ECOSTATUS (PES)	C		

COMPONENT	PES 2014	EcoStatus (PES) 2022	REASON FOR CHANGE
ECOSTATUS	C	C	• System highly modified • Interbasin transfer (flow modification)

REC

C	• F: Interbasin transfer (flow modification); and • F: Irrigation schemes aid in social economic upliftment.

7.16 BOES01_FV Boesmans River

Site dry and only desktop assessment will be undertaken with field verification (diatoms, IHI, in situ water quality) if flows available during the May 2023 surveys

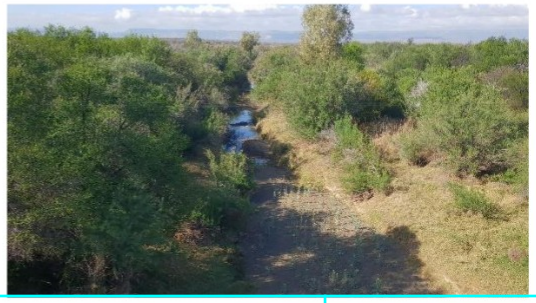
Sample Date	19 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	BOES01_FV	**IUA**	IUA_P01
River	Boesmans	**IUA description**	P primary catchment
Altitude (m.a.s.l.)	93	**Prioritised RU**	R_RU10_R
Latitude	-33.543899°	**Longitude**	26.391105°
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	P10G
Level 2 EcoRegion	20.01	**SQ Reach**	P10G-08723
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Components sampled: None - dry			
Site Photographs: Survey 1 (September 2022)			
			

7.17 SUND01_FV: Sundays River (Upper)

Dry riverbed with isolated and shallow pools. In situ water quality was measured and a diatom sample collected. Desktop assessment to be undertaken.

Sample Date	23 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	SUND01_FV	**IUA**	IUA_LN01
River	Sundays	**IUA description**	Grootto Kouga confluence, Upper Sundays to Darlington Dam
Altitude (m.a.s.l.)	259 m	**Prioritised RU**	R_RU09_R
Latitude	-33.07812	**Longitude**	25.01548
Level 1 EcoRegion	Great Karoo	**Quaternary catchment**	N22C
Level 2 EcoRegion	21.05	**SQ Reach**	N22C-08199
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: None - dry			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- Cattle trampling and grazing
- Bank erosion
- Bridge
- Upstream weir
- Canal (left bank)
- Exotic vegetation within riparian zone (*Tamarisk parviflora, Nicotiana glauca, Eucalyptus sp., Terminalia australis, Onopordum acanthium)*

SUMMARY RESULTS

In situ water quality:

- pH: 8.22
- EC: 771 µS/cm
- TDS: 0.602 g/l
- DO: 8.14 mg/l
- DO%: 83.1 %
- Clarity: 87 cm
- Temperature: 16.2 °C
- Salinity: 0.46

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
14	15.1	B (Good)	14	0
Dominant Species	(1) *Gomphonema minutum (Agardh) Agardh*			
	(2) *Rhopalodia gibba (Ehrenberg) O.Müller*			
Preferences	(1) A cosmopolitan species found in eutrophic waters but not tolerant to more than moderate levels of pollution.			
	(2) A cosmopolitan species found in standing and slow flowing waters, especially springs, of moderate to high electrolyte content			

IHI

COMPONENT	PES category & score	Flow/ Non-flow	EXPLANATION
Habitat Integrity: Instream	C (75%)	NF	• Flow modification (limited impacts from Nqweba Dam) • Bed modification (sedimentation)
Habitat Integrity: Riparian	C (73%)	NF	• Exotic vegetation (*Tamarisk parviflora*, *Nicotiana glauca*, *Eucalyptus*, *terminalia australis)* • Bank erosion (cattle trampling and grazing)
ECOSTATUS (PES)	C		

COMPONENT	PES 2014	EcoStatus (PES) 2022	REASON FOR CHANGE
ECOSTATUS	C	C	Both instream and riparian habitat integrity both categorised as a B.

C	• Impacts remain consistent; and • Limited impacts from Nqweba Dam.

7.18 KABE01_FV: Kabeljous River (Lower)

Sample Date	24 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	KABE01_FV	**IUA**	IUA_K01
River	Kabeljous	**IUA description**	Kromme from Kromme Dam to estuary and Gamtoos
Altitude (m.a.s.l.)	29	**Prioritised RU**	-
Latitude	-33.970394	**Longitude**	24.906996
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K90G
Level 2 EcoRegion	20.02	**SQ Reach**	K90G-09096
Geomorphological zone	D (slope 0.012)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Components sampled: I*n situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- High water abstraction
- Extensive irrigation
- Citrus farming
- Acidic waters (down to a pH of a 3.0 according to the farmer)
- Various dams throughout

SUMMARY RESULTS

In situ water quality:

- pH: 6.87
- EC: 573 µS/cm
- TDS: 0.4511 g/l
- DO: 8.29 mg/l
- DO%: 83.4 %
- Clarity: >1m
- Temperature: 15.8 °C
- Salinity: 0.34 ppt

DIATOMS

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
12	11.6	C (Moderate)	4	0

Dominant Species	*Fragilaria biceps (Kützing) Lange-Bertalot*
Preferences	This cosmopolitan taxon is found in the benthos of rivers and lakes and is easily suspended in the plankton due to its relatively large surface area. Often found in mesotrophic to eutrophic waters.

COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	C (71%)	F/NF	• Physical-chemical modification (diatoms indicative of moderately modified water quality. Possible acidic return flows – farmland owner recorded a pH of approximately 3 along the Kabeljous prior to the survey conducted in September 2022) • Flow modification (numerous dams on Kabeljous and tributaries)
Habitat Integrity: Riparian	B (84%)	F/NF	• Inundation (dams in catchment)
ECOSTATUS (PES)	C		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	C	• Extensive citrus farming (high irrigation), in addition to further new citrus farm developments • High number of small dams/weirs along the Kabeljous River and tributaries

B/C	• Linkage to downstream Kabeljous Estuary

7.19 GROO01_FV: Groot River (Upper)

Sample Date	25 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	GROO01_FV	**IUA**	IUA_K01
River	Groot	**IUA description**	Tsitsikamma and headwaters of Kromme to Kromme Dam
Altitude (m.a.s.l.)	51	**Prioritised RU**	-
Latitude	-34.032091	**Longitude**	24.195888
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K80D
Level 2 EcoRegion	20.02	**SQ Reach**	K80D-09182
Geomorphological zone	E (slope 0.005)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Components sampled: I*n situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- Weir upstream
- Extensive forestry
- Forestry roads
- Alien vegetation within riparian zone (Black Wattle, Bugweed, Bramble)

In situ water quality:

- pH: 5.45
- EC: 177.7 µS/cm
- TDS: 0.1443 g/l
- DO: 8.94 mg/l
- DO%: 87.4 %
- Clarity: 24 cm
- Temperature: 14.8 °C
- Salinity: 0.11 ppt

No. species	SPI	Categorisation (quality)	%PTV	%Deformed cells
19	15.3	B (Good)	13	0

Dominant Species	*Psammothidium oblongellum (Oestrup) Van de Vijver*
Preferences	Tolerant of mild pollution only and also pollution sensitive

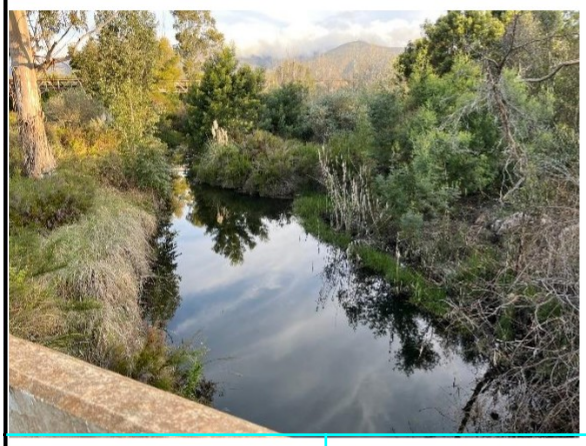
IHI			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	B/C (81%)	F	• Flow modification (forestry and farm dams)
Habitat Integrity: Riparian	C (66%)	NF	• Exotic vegetation (extensive bugweed, bramble, black wattle, pine plantation)
ECOSTATUS (PES)	B/C		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	B/C	• Diatoms indicative of good water quality conditions

REC	
B/C	• F: Better management of alien invasive vegetation within the riparian zone; and • F: Implementation of riverine buffers from the outer edge of the riparian zone to ensure forestry does not encroach within the riparian.

7.20 TWEE01_FV: Twee Riviere

Sample Date	25 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	TWEE01_FV	**IUA**	IUA_KL01
River	Twee Riviere	**IUA description**	Kromme from Kromme Dam to estuary and Gamtoos
Altitude (m.a.s.l.)	519	**Prioritised RU**	-
Latitude	-33.83039	**Longitude**	23.89823
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L82D
Level 2 EcoRegion	19.02	**SQ Reach**	L82D-08998
Geomorphological zone		**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: I*n situ* water quality, diatoms, IHI			
Site Photographs: Survey 1 (September 2022)			





Site impacts:

- Downstream town of Twee Riviere
- WWTW
- Nutrients from sewage (algae)
- Bridge, river crossings
- and railway crossing
- Some erosion
- Alien invasive plants within riparian zone
- Cattle trampling and grazing

SUMMARY RESULTS

In situ water quality:

- pH: 6.67
- EC: 138.2 µS/cm
- TDS: 0.1090 g/l
- DO: 8.76 mg/l
- DO%: 88.8 %
- Clarity: >1m
- Temperature: 15.8 °C
- Salinity: 0.08

DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
10	4.9	E (Seriously)	54.2	1
Dominant Species	(1) *Achnanthidium saprophilum (Kobayasi & Mayama) Round & Bukhtiyarova*			
	(2) *Gomphonema parvulum (Kützing) Kützing*			
	(3) *Nitzschia palea (Kützing) W.Smith*			
Preferences	(1) Tolerant of poor oxygenation and hypereutrophication caused by nutrient inflows			
	(2) A cosmopolitan species which is very widespread in a range of waters, from small pools to lakes and rivers and generally considered to be tolerant of extremely polluted conditions			
	(3) A cosmopolitan and very commonly occurring species found in eutrophic and very heavily polluted to extremely polluted waters with moderate to high electrolyte content			

IHI			
COMPONENT	**PES category & score**	**Flow/ Non-flow**	**EXPLANATION**
Habitat Integrity: Instream	C (71%)	NF	• Physical-chemical modification (diatoms indicative of seriously modified water quality, dysfunctional WWTW's upstream)
Habitat Integrity: Riparian	B (85%)	NF	• Exotic vegetation (*Eucalyptus*, Black wattle) • Vegetation removal (wood harvesting, cattle grazing and trampling)
ECOSTATUS (PES)	D		

COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	D	• Poor water quality driven (diatoms indicative of seriously modified conditions) • Dysfunctional upstream WWTW

C/D	• NF: Water quality improvements (maintenance, management and auditing of WWTW).

7.21 GAMT02_FV: Gamtoos River (Lower)

Sample Date	25 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	GAMT02_FV	**IUA**	IUA_KL01
River	Gamtoos	**IUA description**	Kromme from Kromme Dam to estuary and Gamtoos
Altitude (m.a.s.l.)	8	**Prioritised RU**	-
Latitude	-33.84453	**Longitude**	24.86604
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L90B
Level 2 EcoRegion	19.2	**SQ Reach**	L90B-09024
Geomorphological zone	F	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Components sampled: I*n situ* water quality, diatoms			
Site Photographs: Survey 1 (September 2022)			
			
Site impacts:			
• Cattle trampling and grazing • Bridge • Citrus farming • Irrigation • Return flows • Nutrients (high algae content) • Some erosion			
In situ water quality: • pH: 7.92 • EC: 2172 µS/cm • TDS: 1.652 g/l • DO: 8.03 mg/l • DO%: 84.83 % • Clarity: >1m • Temperature: 17.4 °C			

• Salinity: 1.32 ppt				
DIATOMS				
No. species	**SPI**	**Categorisation (quality)**	**%PTV**	**%Deformed cells**
19	7.4	D (Poor)	47.5	**6.25**
Dominant Species	*(1) Nitzschia frustulum (Kützing) Grunow*			
	(2) Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot			
Preferences	(1) A cosmopolitan species found in electrolyte-rich and brackish waters. Tolerant of fluctuations in osmotic pressure and of critical levels of pollution.			
	(2) A common species in standing and flowing, circumneutral to alkaline waters with a moderate to high electrolyte content. Capable of tolerating critically polluted conditions.			

IHI not applicable as this site as it is driven by poor water quality. Diatoms indicative of good water quality at the upper parts of the Gamtoos River, compared to this site being categorised as poorly modified water quality conditions.

Overall change and reason for deviation			
COMPONENT	**PES 2014**	**EcoStatus (PES) 2022**	**REASON FOR CHANGE**
ECOSTATUS	C	C/D	• Poor water quality driven (diatoms indicative of seriously modified conditions)

C	• NF: Water quality improvements		

8. DESKTOP SITES

8.1 Elandsbos River

Site Name	ELND01_D	**Reserve Level Assessment**	Desktop
River	Elandsbos	**IUA**	IUA_KO1
Reason	Outlet of K80A	**IUA description**	Tsitsikamma and headwaters of Kromme to Kromme Dam
Altitude (m.a.s.l.)	~200	**Prioritised RU**	-
Latitude	-	**Longitude**	-
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K80A
Level 2 EcoRegion	20.2	**SQ Reach**	K80A-09053
Geomorphological zone	D (Slope: 0.01)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Information source	-		

8.2 Tsitsikamma River

Site Name	TSIT01_D	**Reserve Level Assessment**	Desktop
River	Tsitsikamma	**IUA**	IUA_KO1
Reason	-	**IUA description**	Tsitsikamma and headwaters of Kromme to Kromme Dam
Altitude (m.a.s.l.)	53	**Prioritised RU**	-
Latitude	-34.0961	**Longitude**	24.4427
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K80E
Level 2 EcoRegion	20.2	**SQ Reach**	K80E-09152
Geomorphological zone	D (Slope: 0.08)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Information source	2005 results (site name Tkamma_EWR1)		

8.3 Kromme River (Middle)

Site Name	KROM02_I	**Reserve Level Assessment**	Desktop
River	Middle Kromme	**IUA**	IUA_KL01
Reason	-	**IUA description**	Kromme from Kromriver Dam to Estuary and Gamtoos
Altitude (m.a.s.l.)	144	**Prioritised RU**	R_RU01_I
Latitude	-34.0137	**Longitude**	24.4978
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K90D
Level 2 EcoRegion	20.2	**SQ Reach**	K90D-09127
Geomorphological zone	D (Slope: 0.006)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	2006 results (site name Krom_EWR2)		

8.4 Kromme River (Lower)

Site Name	KROM02_I	**Reserve Level Assessment**	Desktop
River	Middle Kromme	**IUA**	IUA_KL01
Reason	-	**IUA description**	Kromme from Kromriver Dam to Estuary and Gamtoos
Altitude (m.a.s.l.)	13	**Prioritised RU**	R_RU01_I
Latitude	-34.105	**Longitude**	24.7267
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K90E
Level 2 EcoRegion	20.2	**SQ Reach**	K90E-09210
Geomorphological zone	F (Slope: 0.001)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	2006 results (site name Krom_EWR3)		

8.5 Geelhoutboom River

Site Name	GEEL01_D	**Reserve Level Assessment**	Desktop
River	Geelhoutboom	**IUA**	IUA_KL01
Reason	-	**IUA description**	Kromme from Kromriver Dam to Estuary and Gamtoos
Altitude (m.a.s.l.)	5	**Prioritised RU**	-
Latitude	-34.116700°	**Longitude**	24.766700°
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K90E
Level 2 EcoRegion	20.2	**SQ Reach**	K90E-09127
Geomorphological zone	F (Slope: 0.001)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	2006 results (site name GHB_EWR4)		

8.6 Seekoei River

Site Name	SEEK01_D	**Reserve Level Assessment**	Desktop
River	Seekoei	**IUA**	IUA_KL01
Reason	-	**IUA description**	Kromme from Kromriver Dam to Estuary and Gamtoos
Altitude (m.a.s.l.)	230	**Prioritised RU**	-
Latitude	-33.580123°	**Longitude**	24.666505°
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L70G
Level 2 EcoRegion	19.02	**SQ Reach**	L70G-08671
Geomorphological zone	D (Slope: 0.006)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Information source	2006 results (site name Seekoei_EWR5)		

8.7 Swart River

Site Name	SWRT01_D	**Reserve Level Assessment**	Desktop
River	Swart	**IUA**	IUA_KL01
Reason	-	**IUA description**	Kromme from Kromriver Dam to Estuary and Gamtoos
Altitude (m.a.s.l.)	128	**Prioritised RU**	
Latitude	-34.007161°	**Longitude**	24.845613°
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K90F
Level 2 EcoRegion	20.2	**SQ Reach**	K90F-09116
Geomorphological zone	D (Slope: 0.008)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Information source	2006 results (site name Swart_EWR6)		

8.8 Diep River

Site Name	DIEP01_D	**Reserve Level Assessment**	Desktop
River	Diep	**IUA**	IUA_KL01
Reason	-	**IUA description**	Kromme from Kromriver Dam to Estuary and Gamtoos
Altitude (m.a.s.l.)	98	**Prioritised RU**	
Latitude	-34.022	**Longitude**	24.5926
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	K90D
Level 2 EcoRegion	20.2	**SQ Reach**	K90D-09130
Geomorphological zone	E (Slope: 0.005)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Information source	2006 results (site name Diep_EWR7)		

8.9 Baviaanskloof River

Site Name	BAVI01_D	**Reserve Level Assessment**	Desktop
River	Baviaanskloof	**IUA**	IUA_L01
Reason	Confluence with Kouga	**IUA description**	Kouga to Kouga Dam, Baviaanskloof
Altitude (m.a.s.l.)	166	**Prioritised RU**	
Latitude	-33.664914°	**Longitude**	24.388605°
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L81D
Level 2 EcoRegion	19.02	**SQ Reach**	L81D-08798
Geomorphological zone	D (Slope: 0.005)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Information source	-		

8.10 Nabooms River

Site Name	NABO01_D	**Reserve Level Assessment**	Desktop
River	Nabooms	**IUA**	IUA_L01
Reason	Confluence with Kouga	**IUA description**	Kouga to Kouga Dam, Baviaanskloof
Altitude (m.a.s.l.)	355	**Prioritised RU**	-
Latitude	-33.802720°	**Longitude**	23.937796°
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L82D
Level 2 EcoRegion	19.02	**SQ Reach**	L82D-08995
Geomorphological zone	D (Slope: 0.009)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.11 Louterwater River

Site Name	LOUT01_D	**Reserve Level Assessment**	Desktop
River	Louterwater	**IUA**	IUA_L01
Reason	Confluence with Kouga	**IUA description**	Kouga to Kouga Dam, Baviaanskloof
Altitude (m.a.s.l.)	480	**Prioritised RU**	
Latitude	-33.728018°	**Longitude**	23.682080°
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L82C
Level 2 EcoRegion	19.02	**SQ Reach**	L82C-08936
Geomorphological zone	D (Slope: 0.005)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.12 Elands River

Site Name	ELAN01_D	**Reserve Level Assessment**	Desktop
River	Elands	**IUA**	IUA_M01
Reason	Confluence with Swartkops	**IUA description**	M primary catchment
Altitude (m.a.s.l.)	52	**Prioritised RU**	
Latitude	-33.751650°	**Longitude**	25.335358°
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	M10C
Level 2 EcoRegion	20.01	**SQ Reach**	M10C-08921
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Information source	-		

8.13 Sand River

Site Name	SAND01_D	**Reserve Level Assessment**	Desktop
River	Sand	**IUA**	IUA_M01
Reason	Confluence with Elands	**IUA description**	M primary catchment
Altitude (m.a.s.l.)	280	**Prioritised RU**	
Latitude	-33.725224°	**Longitude**	25.113968°
Level 1 EcoRegion	Southern Folded Moutains	**Quaternary catchment**	M10B
Level 2 EcoRegion	19.02	**SQ Reach**	M10B-08916
Geomorphological zone	D (Slope: 0.016)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.14 Chatty River

Site Name	CHAT01_D	**Reserve Level Assessment**	Desktop
River	Chatty	**IUA**	IUA_M01
Reason	Confluence with Swartkops	**IUA description**	M primary catchment
Altitude (m.a.s.l.)	1	**Prioritised RU**	
Latitude	-33.854735°	**Longitude**	25.592450°
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	M10D
Level 2 EcoRegion	20.01	**SQ Reach**	M10D-09011
Geomorphological zone	E (Slope: 0.001)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.15 Kariega River

Site Name	KARI01_D	**Reserve Level Assessment**	Desktop
River	Kariega	**IUA**	IUA_LN01
Reason	Confluence with Sout	**IUA description**	Groot to Kouga confluence, Upper Sundays to Darlington Dam
Altitude (m.a.s.l.)	701	**Prioritised RU**	
Latitude	-33.041377°	**Longitude**	23.465806°
Level 1 EcoRegion	Great Karoo	**Quaternary catchment**	L23D
Level 2 EcoRegion	21.04	**SQ Reach**	L23D-08193
Geomorphological zone	E (Slope: 0.001)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.16 Groot River

Site Name	GRT01_D	**Reserve Level Assessment**	Desktop
River	Groot	**IUA**	IUA_LN01
Reason	Confluence with Kouga	**IUA description**	Groot to Kouga confluence, Upper Sundays to Darlington Dam
Altitude (m.a.s.l.)	88	**Prioritised RU**	
Latitude	-33.743359°	**Longitude**	24.613965°
Level 1 EcoRegion	Southern Folded Mountains	**Quaternary catchment**	L70G
Level 2 EcoRegion	19.02	**SQ Reach**	L70G-08902
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Information source	-		

8.17 Buffels River

Site Name	BFL01_D	**Reserve Level Assessment**	Desktop
River	Buffels	**IUA**	IUA_LN01
Reason	Confluence with Kariga	**IUA description**	Groot to Kouga confluence, Upper Sundays to Darlington Dam
Altitude (m.a.s.l.)	-	**Prioritised RU**	
Latitude	-32.216468°	**Longitude**	23.403831°
Level 1 EcoRegion	Great Karoo	**Quaternary catchment**	L22A
Level 2 EcoRegion	21.05	**SQ Reach**	L22A-07035
Geomorphological zone	D (Slope: 0 .012)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.18 Coerney River

Site Name	COER01_D	**Reserve Level Assessment**	Desktop
River	Coerney	**IUA**	IUA_N01
Reason	Confluence with Sundays	**IUA description**	Sundays downstream Darlington Dam
Altitude (m.a.s.l.)	36	**Prioritised RU**	
Latitude	-33.510516°	**Longitude**	25.658167°
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	N40D
Level 2 EcoRegion	20.01	**SQ Reach**	N40D-08561
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.19 Bloukrans River

Site Name	BLOU01_D	**Reserve Level Assessment**	Desktop
River	Bloukrans	**IUA**	IUA_P01
Reason	Confluence with Kowie	**IUA description**	P primary catchment
Altitude (m.a.s.l.)	149	**Prioritised RU**	
Latitude	-33.409733°	**Longitude**	26.653458°
Level 1 EcoRegion	Southern Folded Montains	**Quaternary catchment**	P40A
Level 2 EcoRegion	10.01	**SQ Reach**	P40A-08472
Geomorphological zone	E (0.004)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Information source	-		

8.20 Pauls River

Small ephemeral system with stagnant pools, very low flow and access limitations. Downgraded from a Rapid 3 to a field verification.

Sample Date	22 September 2022	**Reserve Level Assessment**	Field Verification
Site Name	PAUL01_R	**IUA**	IUA_Q01
River	Pauls	**IUA description**	Upper Fish
Altitude (m.a.s.l.)	1016	**Prioritised RU**	R_RU11_R
Latitude	-32.080663°	**Longitude**	25.413775°
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q30B
Level 2 EcoRegion	18.01	**SQ Reach**	Q30B-07051
Geomorphological zone	E (slope 0.004)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Components sampled: None – no access			





Site impacts:

- Cattle grazing and trampling
- Bank erosion

8.21 Great Fish River

Site Name	FISH05_D	**Reserve Level Assessment**	Desktop
River	Great Fish	**IUA**	IUA_Q02
Reason	Confluence with Little Fish	**IUA description**	Great Fish
Altitude (m.a.s.l.)	437	**Prioritised RU**	
Latitude	-33.087067°	**Longitude**	25.993881°
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q70C
Level 2 EcoRegion	18.02	**SQ Reach**	Q70C-08084
Geomorphological zone	E (Slope: 0.001)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Information source	-		

8.22 Kat River (Middle)

Site Name	KAT03_D	**Reserve Level Assessment**	Desktop
River	Middle Kat	**IUA**	IUA_Q03
Reason	-	**IUA description**	Koonap and Kat
Altitude (m.a.s.l.)	544	**Prioritised RU**	
Latitude	-32.6217	**Longitude**	26.685
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	Q94D
Level 2 EcoRegion	18.02	**SQ Reach**	Q94D-07647
Geomorphological zone	E (Slope: 0.003)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	2996 results (Kat_EWR2)		

8.23 Cata River

Site Name	CATA01_D	**Reserve Level Assessment**	Desktop
River	Cata	**IUA**	IUA_R01
Reason	Confluence with Keiskamma	**IUA description**	Keiskamma
Altitude (m.a.s.l.)	634	**Prioritised RU**	
Latitude	-32.674517°	**Longitude**	27.151715°
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	R10B
Level 2 EcoRegion	16.07	**SQ Reach**	R10B-07640
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Information source	-		

8.24 Yellowoods River

Site Name	YELL01_D	**Reserve Level Assessment**	Desktop
River	Yellowoods	**IUA**	IUA_R02
Reason	Confluence with Buffalo	**IUA description**	Buffalo/ Nahoon
Altitude (m.a.s.l.)	314	**Prioritised RU**	
Latitude	-32.933093°	**Longitude**	27.473251°
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	R20E
Level 2 EcoRegion	31.02	**SQ Reach**	R20E-07775
Geomorphological zone	D (Slope: 0.009)	**PES (DWS, 2014)**	D
Ecological Importance	High	**Ecological Sensitivity**	High
Information source	-		

8.25 Komani River

Site Name	KOMA01_D	**Reserve Level Assessment**	Desktop
River	Komani	**IUA**	IUA_S02
Reason	Confluence with Klaas Smit	**IUA description**	Black Kei
Altitude (m.a.s.l.)	1053	**Prioritised RU**	
Latitude	-31.910323°	**Longitude**	26.848917°
Level 1 EcoRegion	Drought Corridor	**Quaternary catchment**	S31F
Level 2 EcoRegion	18.02	**SQ Reach**	S31F-06731
Geomorphological zone	D (Slope: 0.005)	**PES (DWS, 2014)**	D
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.26 Kubusi River (Lower)

Site Name	KUBU03_I	**Reserve Level Assessment**	Desktop
River	Kubusi	**IUA**	IUA_S03
Reason	-	**IUA description**	Lower Great Kei
Altitude (m.a.s.l.)	203	**Prioritised RU**	
Latitude	-32.465855°	**Longitude**	27.892079°
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	S60E
Level 2 EcoRegion	16.06	**SQ Reach**	S60E-07531
Geomorphological zone	D (Slope: 0.006)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Information source	2002 data (Kubusi_EWR6)		

8.27 Xuka River

Site Name	XUKA01_D	**Reserve Level Assessment**	Desktop
River	Xuka	**IUA**	IUA_T01
Reason	-	**IUA description**	Upper Mbhashe , Upper Mthatha
Altitude (m.a.s.l.)	718	**Prioritised RU**	
Latitude	-31.6677	**Longitude**	28.1122
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	T11C
Level 2 EcoRegion	16.06	**SQ Reach**	T11C-06457
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	Use information from 2011 rapid 3 (Xuka_EWR1)		

8.28 Mthatha River (Upper)

Site Name	MTHA02_D	**Reserve Level Assessment**	Desktop
River	Upper Mthatha	**IUA**	IUA_T01
Reason	Outlet of R20A	**IUA description**	Upper Mbhashe , Upper Mthatha
Altitude (m.a.s.l.)	717	**Prioritised RU**	
Latitude	-31.475254°	**Longitude**	28.605656°
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	T20A
Level 2 EcoRegion	16.06	**SQ Reach**	T20A-06425
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	Low	**Ecological Sensitivity**	Moderate
Information source	Use information from 2011 rapid 3 (Xuka_EWR1)		

8.29 Xura River

Site Name	XURA01_D	**Reserve Level Assessment**	Desktop
River	Xura	**IUA**	IUA_T04
Reason	-	**IUA description**	Pondaland Coastal
Altitude (m.a.s.l.)	586	**Prioritised RU**	
Latitude	-31.327	**Longitude**	29.4869
Level 1 EcoRegion	South Eastern Uplands	**Quaternary catchment**	T60F
Level 2 EcoRegion	16.03	**SQ Reach**	T60F-06141
Geomorphological zone	D (Slope: 0.009)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	Use information from 2014 intermediate (Xura_EWR1)		

8.30 Msikaba River

Site Name	MSIK01_D	**Reserve Level Assessment**	Desktop
River	Msikaba	**IUA**	IUA_T04
Reason	-	**IUA description**	Pondaland Coastal
Altitude (m.a.s.l.)	-	**Prioritised RU**	
Latitude	-31.2518	**Longitude**	29.7489
Level 1 EcoRegion	North Eastern Coastal Belt	**Quaternary catchment**	T60G
Level 2 EcoRegion	17.01	**SQ Reach**	T60G-06145
Geomorphological zone	E (Slope: 0.003)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	Moderate
Information source	Use information from 2014 intermediate (Msikaba_EWR2)		

8.31 Mntafufu River

Site Name	MNTA01_D	**Reserve Level Assessment**	Desktop
River	Mntafufu	**IUA**	IUA_T04
Reason	Outlet of T60K	**IUA description**	Pondaland Coastal
Altitude (m.a.s.l.)	14	**Prioritised RU**	
Latitude	-31.546690°	**Longitude**	29.622705°
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T60K
Level 2 EcoRegion	31.01	**SQ Reach**	T60K-06398
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	Moderate
Information source	-		

8.32 Mzintlava River

Site Name	MZIN01_D	**Reserve Level Assessment**	Desktop
River	Mzintlava	**IUA**	IUA_T04
Reason	Outlet of T60J	**IUA description**	Pondaland Coastal
Altitude (m.a.s.l.)	45	**Prioritised RU**	
Latitude	-31.496351°	**Longitude**	29.647659°
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T60J
Level 2 EcoRegion	31.01	**SQ Reach**	T60J-06476
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Information source	-		

8.33 Bulolo River

Site Name	BULO01_D	**Reserve Level Assessment**	Desktop
River	Bulolo	**IUA**	IUA_T04
Reason	Downstream Bulolo Dam	**IUA description**	Pondaland Coastal
Altitude (m.a.s.l.)	68	**Prioritised RU**	
Latitude	-31.634889°	**Longitude**	29.511227°
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T70B
Level 2 EcoRegion	31.01	**SQ Reach**	T70B-06608
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	B
Ecological Importance	High	**Ecological Sensitivity**	High
Information source	-		

8.34 Xora River

Site Name	XORA01_D	**Reserve Level Assessment**	Desktop
River	Xora	**IUA**	IUA_T04
Reason	Outlet of T80D	**IUA description**	Pondaland Coastal
Altitude (m.a.s.l.)	6	**Prioritised RU**	
Latitude	-32.135524°	**Longitude**	28.973139°
Level 1 EcoRegion	Eastern Coastal Belt	**Quaternary catchment**	T80D
Level 2 EcoRegion	31.02	**SQ Reach**	T80D-06960
Geomorphological zone	E (Slope: 0.002)	**PES (DWS, 2014)**	B
Ecological Importance	Moderate	**Ecological Sensitivity**	High
Information source	-		

9. SITES NOT ASSESSED

The following sites could not be assessed either owing to being dry or from health hazard concerns.

9.1 Bloukrans River

Site not assessed owing to health hazard during the September 2022 survey.

Sample Date	19 September 2022	**Reserve Level Assessment**	Initially selected as a Field Verification
Site Name	Blou01_R	**IUA**	IUA_P01
River	Bloukrans	**IUA description**	P primary catchment
Altitude (m.a.s.l.)	477	**Prioritised RU**	
Latitude	-33.318060°	**Phy**	26.568187°
Level 1 EcoRegion	South Eastern Coastal Belt	**Quaternary catchment**	P40A
Level 2 EcoRegion	20.01	**SQ Reach**	P40A-08472
Geomorphological zone	E (slope 0.002)	**PES (DWS, 2014)**	C
Ecological Importance	High	**Ecological Sensitivity**	High
Components sampled: None - dry			





10. SIMULIIDAE OUTBREAK WITHIN THE CATCHMENT AREAS

One macroinvertebrate taxon detected in this study, which is of particular concern, was the blackfly larvae (family *Simuliidae*). Simuliidae are a major agricultural pest and have been observed in their outbreak densities within several of the systems within the Keiskamma, Fish to Tsitsikamma catchment areas. The Great Kei, being the most impacted. Refer to **Figure 10-1** illustrating the outbreak observed during the September 2022 survey, compared to the re-set system in May 2023 – following the floods in February 2023).



Simuliidae outbreak densitive – September 2022



System re-set owing to recent floods – May 2023

Figure 10-1: Simuliidae outbreak densities in the Great Kei River

Simuliidae's occur in flowing water and, depending on the species, habitats range from highly saline clear trickling desert springs to fast flowing clear or highly turbid rapids in temperate or tropical big river systems (de Moor 2003). Thus, the primary drivers of blackfly species occurrence and abundances are discharge, water clarity, and presence of benthic algae. These pest blackfly adult females will have negative impacts mostly on the agricultural industry in these catchment areas (i.e citrus farms). For the region's livestock (sheep) farming, impacts are also severe, with major financial losses per annum due to sheep deaths, or loss of meat or wool value in poor-condition sheep (Rivers-Moore *et al.* 2014). Although these densities may not be as high as what has been recorded from Prieska all the way downstream to Augrabies falls in the Lower Orange catchment (Rivers-Moore *et al.* 2014), this study has certainly flagged the outbreak potential in this study area and thus should be intensely monitored during the quarterly REMP monitoring (generally picked up during the SASS5 hand picking observations).

With the above mentioned, cognizance of these outbreaks will be taken when quantifying the EWR for those mostly affected sites. The critical periods for controlling population sizes of Simuliidae are generally July to August (winter months) when most of the population is present in the larval or pupal phase (O'Keeffe and de Moor, 1988). Thus, reduced flows, and lower water levels, during these months is critical to expose the substrate to dry out blackfly larvae and pupae in these months (de Moor, 1982b, 1997; O'Keeffe and de Moor, 1988). This may potentially thus avoid the typical spring outbreaks of blackfly's during the end of winter/spring seasonal period (i.e., September). Furthermore, ensuring those freshets or floods come through during the months of January, February, May also to scour the substrate and re-set the systems are applied.

11. RECOMMENDATIONS

11.1 Water Quality Focused

From the results of this study, it is evident that deteriorated water quality is the driving factor in most parts of the streams and rivers in the Keiskamma, Fish to Tsitsikamma catchment area. This is a systemic issue across the catchments illustrated by diatom results that mostly indicate moderate to seriously modified conditions. The causes and sources of this problem are primarily related to nutrient overload, originating from the various WWTWs associated with the towns in the catchment. Most of these are either unmaintained, dysfunctional or have either reached their capacity, if not already over-capacitated. Consequently, the knock-on effect is high nutrient loads and eutrophication in the river systems ultimately resulting in a very poor water quality status throughout the catchment. As water quality is one of the ecological drivers for water quality sensitive aquatic biota and their diversity, these communities are impacted upon compared to reference conditions.

It is the mandate and responsibility of DWS to ensure enforcement and accountability within the municipalities that are responsible for these WWTWs (National Water Act, 1998). Investigations into this issue are essential for the Department to improve and regulate the water quality issues that this catchment area faces.

Management of the water quality status must be regarded as an urgent issue to implement. If not addressed effectively, the current conditions will continue and worsen. This will result in the non-attainment of the desired state or REC for the EWR sites.

This is essential for this part of the study, leading up to the setting of the Reserve.

11.2 General Catchment Based Recommendations

- *In situ* water quality must be monitored bi-annually;
- Diatom samples must be taken minimum every 2 years;
- Macroinvertebrates (MIRAI) must continue to be undertaken bi-annually at these EWR sites. Should the sites overlap the REMP site, these are to be undertaken quarterly. MIRAI models must be continually updated;
- **Table 11-1** lists all the EWR sites whereby Simuliidae outbreak densities were recorded (abundances of >D). Furthermore, these sites are aligned to DWS REMP monitoring sites. Consequently, it is imperative that when DWS undertake their quarterly SASS5 biomonitoring at these REMP sites, that the SASS5 hand picking observation protocol be conducted for 1 minute and during this time, should Simuliidae larvae be observed in these outbreak densities, this is to be red flagged, including the month the monitoring took place for record keeping and trend analysis relating to these outbreaks.

Table 11-1: EWR sites where Simuliidae outbreaks were recorded during the September 2022 survey for this study

BKEI01_I	Black Kei	S3BKEI-TURNS	REMP site located further downstream of this EWR site, however within same Ecoregion Level 2 and geoclass
GKEI01_I	Great Kei	S7GKEI-KEIBR	Same location / reach
MBAS01_I	Middle Mbhashe	T1MBHA-MVEZO	Same location / reach
MBAS02_R	Upper Mbhashe	T1XUKA-CONFL	Located within the same ecoregion Level 2 and geoclass
BUFF01_I	Middle Buffalo:	R2BUFF-ZWELI	Same location / reach
KAT01_I	Upper Kat	Q9KATR-BRIDG	Same location / reach
KAT02_R	Lower Kat	Q9KATR-BRIDG	Located downstream of this EWR site however, same Ecoregion Level 2 and geoclass
MNGA01_R	Mngazi	T7MNGA-LOWER (	Located downstream of this EWR site however, same Ecoregion Level 2 and geoclass
KOON01_r	Koonap	Q9KATR-BRIDG	Located within the same ecoregion Level 2 and geoclass
WKEI01_R	White Kei:	S1WKEI-STMAR	Same location / reach
KEIS02_R	Lower Keiskamma:	R1KEIS-GCINI	REMP site located further upstream however within same Ecoregion Level 2 and geoclass
KOUG01_R	Kouga River	L8KOUG-OPKOM	Same location / reach

- Capacity building (training) regarding fish identification and PES determination (FRAI), for future fish monitoring, must be undertaken annually during wet/summer season (i.e., November to January);
- Fish (FRAI) at all Intermediate Reserve sites should be conducted annually, or bi-annual should there be events (i.e., fish-kill) or other biophysical data triggering an updated FRAI to be run;
- Capacity building (training) on riparian vegetation within the catchment, as well as and PES determination (VEGRAI),
- Desktop vegetation assessment (woody to non-woody to open area comparisons using Google Earth) – annually;
- Belt transect assessments – record cover of life form (reed vs grass vs forbs vs trees vs no vegetation), including presence and absence of species and compare - annually;
- Riparian vegetation (VEGRAI) at all Intermediate Reserve sites to be conducted every 5 years;

- IHI at all EWR Rapid Reserve sites must be conducted annually;
- Catchment management strategies must be developed to assist with the management of overgrazing, etc;
- Riverine buffers must be implemented for all new applications, and grazing management within these buffer zones strictly controlled;
- Satellite imagery must be interrogated regularly (e.g. Google Earth and other sources) and a reach scale PES derived. This information together with physical-chemical and other information sources (OSINT, etc.) must be used to develop Thresholds of Probable concern to trigger follow-up investigations;
- Directives should be issues to all munipalities to invegistate all WWTW located upstream from all EWR sites, as a matter of urgency (see Chapter 11.1 for further insight); and
- Specificatlly, EWR site SWAR01_I (Swartkops), a directive should be issued from DWS as a matter of urgency to the polluters responsible for the illegal sand mining within the Swartkops channel just outside of the Groendal Nature Reserve. Major rehabilistion effort will be required along this reach in order to improve the hydrology (flow), water quality, and overall improving the ecosystem functioning and associated instream biotic health and integrity, to ultimately meet the REC for that site.

12. CONCLUSION

In general, the findings of this study demonstrate that the Keiskamma, Fish to Tsitsikamma catchment areas predominantly exhibits moderately to largely modified conditions (falling under ecological categories C and D). Several Rapid 3 EWR sites, primarily within the Pondoland area (primary catchment T) were still largely natural with few modifications, with their ecosystem functions essentially unchanged. The main factors influencing the catchment are compromised water quality, primarily caused by unmaintained and dysfunctional WWTW. Another significant factor is water quantity, with extensive agricultural activities (sheep farming, citrus) necessitating water abstraction for irrigation purposes throughout. Furthermore, flow modification, particularly noticeable along the Mbhashe River (hydropower) and the Great Fish River (IBT scheme, although both playing a crucial role in fulfilling water and power supply requirements for the Eastern Cape and beyond. Should the proposed recommendations be investigated and applied, the suggested REC can and will be achieved.

Please refer to **Table 12-1** for a summary of the current PES of all EWR sites (Intermediate and Rapid 3 EWR sites and field verification sites). This is further visually illustrated in an infographic in **Figure 12-2**, with the PES trends for all Intermediate, Rapid 3 EWR and field verification sites. The colour codes for the PES are as per **Figure 12-1** below.



Figure 12-1 The PES and REC colour code guide

Table 12-1: Summary of the Present Ecological States of all EWR sites

IUA	RU	EWR site code	River	Quat	PES (DWS, 2014)	EI-ES	EcoStatus 2023	EI-ES	REC
INTERMEDIATE EWR SITES									
IUA_T03	R_RU15_I	MTHA01_I	Mthatha (Lower)	T20G	C	High-High	C	High-High	B/C
IUA_T02	R_RU14_I	MBAS01_I	Mbhashe (Middle)	T13C	B	High-Moderate	C/D	Moderate-Moderate	C/D
IUA_S02	R_RU24_I	BKEI01_R	Black Kei	S32K	C	Moderate-Moderate	D/E	Moderate-Moderate	D
IUA_S03	R_RU13_I	GKEI01_I	Great Kei	S70A	C	Moderate-Moderate	C/D	High-Moderate	C
IUA_S01	R_RU11_I	TSOM01_I	Tsomo	S50G	D	Moderate-Moderate	D	Moderate-Moderate	C/D
IUA_R02	R_RU10_I	BUFF01_I	Buffalo (Middle)	R20F	D	High-Moderate	D	Moderate-Moderate	D
IUA_R01	R_RU09_I	KEIS01_I	Keiskamma (Upper)	R10E	D	Moderate-Moderate	D	Moderate-Moderate	D
IUA_Q03	R_RU08_I	KAT01_I	Kat (Upper)	Q94B	C	Moderate–High	C	Moderate-High	B/C
IUA_Q02	R_RU06_I	FISH03_I	Great Fish (Lower)	Q91B	C	Moderate-Moderate	C	Moderate-Moderate	C
IUA_M01	R_RU03_I	SWAR01_I	KwaZungu/ Swartkops	M10C	D	Moderate-Moderate	C	Moderate-High	B/C
IUA_KL01	R_RU02_I	GAMT01_I	Gamtoos	L90A	C	Moderate-Moderate	D	Moderate-Moderate	D
RAPID 3 EWR SITES									
IUA_T04	R_RU31_R	MNGA01_R	Mngazi	T70B	B	High-Moderate	C	High-High	B/C
IUA_T04	R_RU33_R	NQAB01_R	Nqabarha	T90A	B	Moderate-Moderate	D	Moderate-Moderate	C
IUA_T04	R_RU29_R	MTEN01_R	Mtentu	T60C	B	High-Moderate	C	High-High	B/C
IUA_T01	R_RU27_R	MBHA02_R	Mbhashe (Upper)	T11H	C	Moderate-Moderate	B/C	High-Moderate	B/C
IUA_S03	R_RU26_R	GCUW01_R	Gcuwa	S70D	D	Moderate-Moderate	D	Moderate-Moderate	D
IUA_S01	R_RU21_R	INDW01_R	Indwe	S20D	D	Moderate-Moderate	C/D	Moderate-Moderate	C/D
IUA_S01	R_RU20_R	WKEI01_R	White Kei	S10J	C	Moderate-Moderate	C/D	Moderate-Moderate	C
IUA_S03	R_RU0_12	KUBU03_R	Kubusi (Lower)	S60B	C	High-High	C	High-High	B/C
IUA_R01	R_RU18_R	KEIS02_R	Keiskamma (Lower)	R10L	C	High-High	C	High-High	B/C
IUA_R01	TYUM01_R	TYUM01_R	Tyume	R10H	C	Moderate-High	C	High-High	B/C
IUA_Q03	R_RU16_R	KOON01_R	Koonap	Q92G	B	Moderate-Moderate	D	Moderate-Moderate	D
IUA_Q03	R_RU15_R	KAT02_R	Kat (Lower)	Q94F	B	Moderate-Moderate	C/D	Moderate-Moderate	C/D
IUA_Q01	R_RU12_R	FISH01_R	Great Fish (Upper)	Q21B	D	Moderate-Moderate	D	Moderate-Moderate	D
IUA_Q02	R_RU14_R	TARK01_R	Tarka	Q44C	D	Moderate-Moderate	D	Moderate-Moderate	D
IUA_N01	R_RU04_R	SUND02_R	Sundays (Lower)	N40C	D	Moderate-Moderate	D	Low-Moderate	D
IUA_L01	R_RU05_R	KOUG01_R	Kouga	L82D	B	Moderate-Moderate	C	High-High	B/C
IUA_K01	R_RU01_R	KROM01_I	Kromme	K90A	D	High-High	D	High-High	C
FIELD VERIFICATION SITES									
IUA_T04	R_RU34_R	MTAK01_FV	Mtakatye	T70E	C	Moderate-Moderate	B/C	N/A	B/C
IUA_SO2	R_RU23_R	KLIP01_FV	Klipplaats	S32G	D	Moderate-Moderate	C		C
IUA_S02	R_RU22_R	KSMI01_FV	Klaas Smits	S31G	C	Moderate-Moderate	C/D		C/D
IUA_R02	R_RU35_R	BUFF03_FV	Buffalo (Upper)	R20B	C	Moderate-High	B/C		B/C
IUA_R02	R_RU20_R	BUFF02_R	Buffalo (Lower)	R20F	D	High-Moderate	D/E		D
IUA_S03	R_RU25_R	KUBU01_FV	Kubusi (Upper)	S60A	D	Moderate-Moderate	C		C

IUA	RU	EWR site code	River	Quat	PES (DWS, 2014)	EI-ES	EcoStatus 2023	EI-ES	REC
IUA_S03	R_RU012_I	KUBU02_FV	Kubusi (Middle)	S60B	D	Moderate-Moderate	C		C
IUA_SO3	R_RU26_R	GCUW02_FV	Gcuwa (downstream of Butterworth)	S70D	D	Moderate-Moderate	E		D
IUA_Q01	R_RU36_R	GFIS04_FV	Great Fish (u/s craddock)	Q30E	D	Moderate-Moderate	C/D		C/D
IUA_Q02	R_RU12_R	FISH02_R	Great Fish (Middle)	Q50C	D	Moderate-Moderate	*Not accessible due to high flows*		*Not accessible due to high flows*
IUA_Q01	R_RU37_R	GBRA01_FV	Great Brak	Q13B	C	Moderate-Moderate	C/D		C/D
IUA_Q01	R_RU13_R	LFIS01_FV	Little Fish (Upper)	Q80B	B	High-Moderate	C		B/C
IUA_Q01	R_RU38_R	LFIS02_FV	Little Fish (Lower)	Q80G	C	High-Moderate	C		C
IUA_P01	R_RU10_R	BOES01_FV	Boesmans	P10G	B	High-Moderate	*Dry*		
IUA_P01	R_RU10_R	KARI01_FV	Kariega	P30B	D	High-Moderate	*Dry*		
IUA_LN01	R_RU09_R	SUND01_FV	Sundays (Upper)	N22C	C	Moderate-Moderate	C		C
IUA_K01	R_RU23_R	KABE01_FV	Kabeljous (Lower)	K90G	C	High-High	C		B/C
IUA_K01	R_RU01_R	GROO01_FV	Groot (Upper)	K80D	C	Moderate-High	B/C		B/C
IUA_KL01	R_RU39_R	TWEE01_FV	Twee Riviere	L82D	C	Moderate-Moderate	D		C/D
IUA_KL01	R_RU40_R	GAMT02_FV	Gamtoos (Lower)	L90B	C	Moderate-Moderate	C/D		C

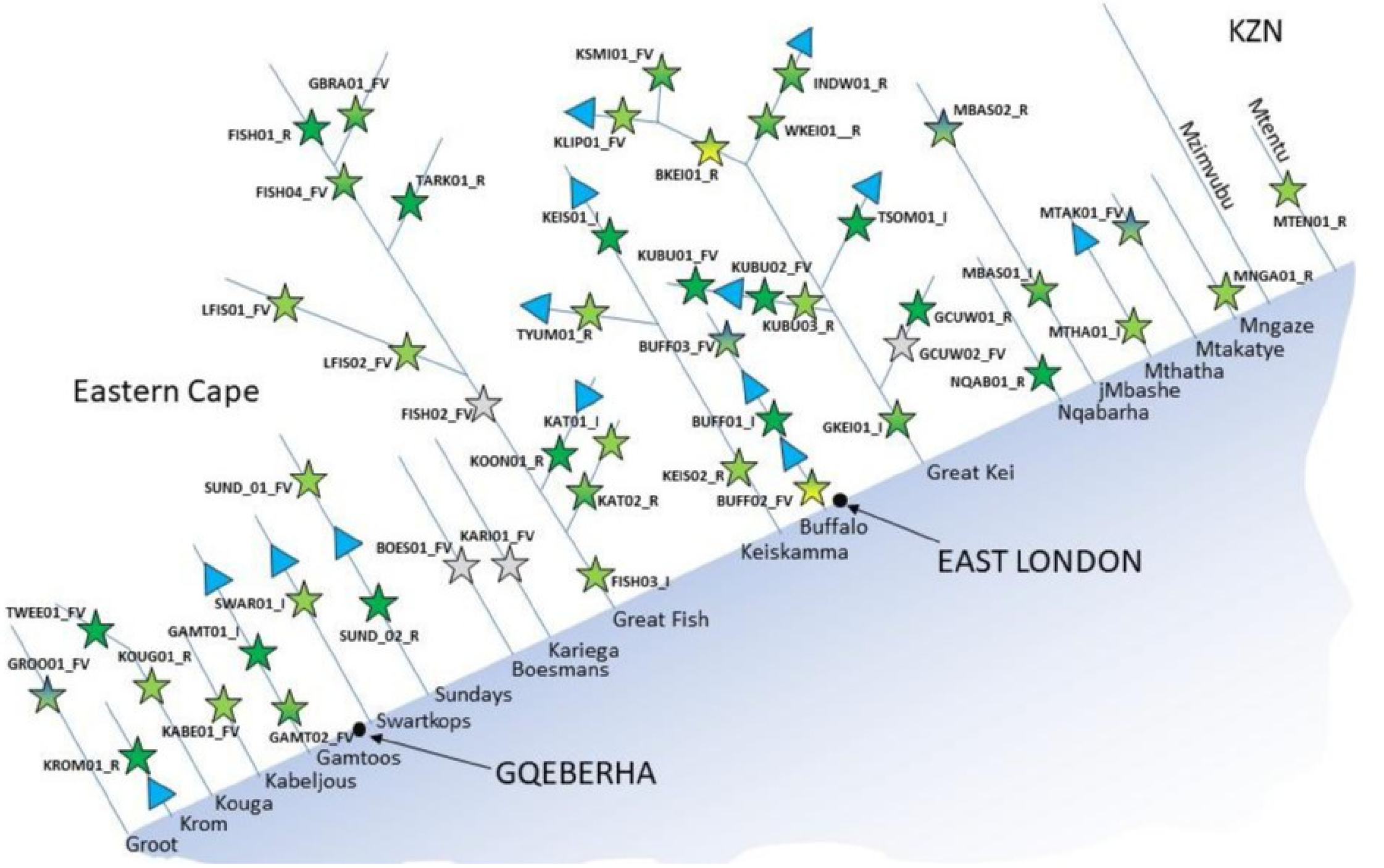


Figure 12-2: Infographic summary of the PES trend for all Intermeidate, Rapid 3 EWR sites and field verification sites

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14. APPENDICES (Volume 2)

Please refer to Volume 2 for all Appendices