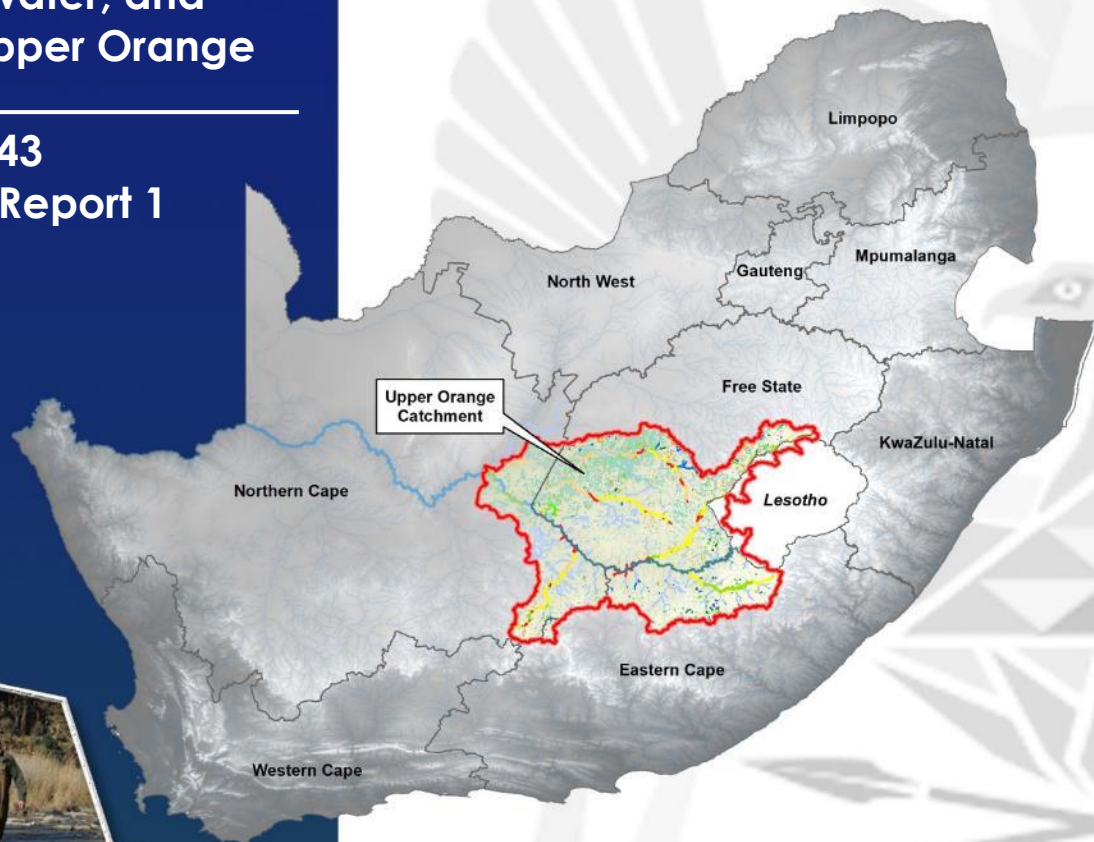


DEPARTMENT OF WATER AND SANITATION

A High Confidence Reserve Determination Study for Surface Water, Groundwater, and Wetlands in the Upper Orange

WP11343 River Survey Report 1



REPORT NO.:
RDM/WMA13/00/CON/COMP/0722

AUGUST 2022



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. August 2022. A High Confidence Reserve Determination Study for Surface Water, Groundwater and Wetlands in the Upper Orange Catchment: River Survey Report 1. No: RDM/WMA13/00/CON/COMP/0722.

Prepared by:

GroundTruth: Water, Wetlands and Environmental Engineering

Title: River Survey Report

Authors: R. Stassen, K. Farrell, B. Grant, B. Van Der Waal

External Reviewer Dr Neels Kleynhans and DWS

Project Name: A High Confidence Reserve Determination Study for Surface Water, Groundwater and Wetlands in the Upper Orange Catchment: WP11343

DWS Report No.: RDM/WMA13/00/CON/COMP/0722

Status of Report Final

First Issue: 30 July 2022

Final Issue: 15 August 2022

Approved for the Professional Service Provided by:

.....

Dr Mark Graham

Director, GroundTruth

.....

Date

DEPARTMENT OF WATER AND SANITATION

Chief Directorate: Water Ecosystems Management

Approved for DWS by:

.....

Ndivhuwo Netshiendeulu (Project Manager)

Date:

.....

Kwazikwakhe Majola (Scientific Manager)

Date:

.....

Director: Yakeen Atwaru

Date

DOCUMENT INDEX

Reports as part of this project:

Bold type indicates this report

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LIST OF ACRONYMS

Acronym	Definition
BHN	Basic Human Need
CD:WEM	Chief Directorate: Water Ecosystems Management
DWS	Department of Water and Sanitation
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
FRAI	Fish Response Assessment Index
GAI	Geomorphology Driver Assessment Index
IHI	Index of Habitat Integrity
MIRAI	Macroinvertebrate Response Assessment Index
NWA	National Water Act
PES	Present Ecological State
RDM	Resource Directed Measures
RU	Resource Unit
UO	Upper Orange
VEGRAI	Riparian Vegetation Response Assessment Index
WWTW	Wastewater Treatment Works
WMA	Water Management Area
WRCS	Water Resource Classification System

1. INTRODUCTION

The National Water Act (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 seriously 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). As part of the RDM, a Reserve must be determined for a significant water resource, as a means to ensure a desired level of protection.

The Reserve (quantity and quality) is defined in terms of the Ecological Water Requirements (EWR), ensuring the water required to protect aquatic systems (water quality, habitat, and biota) of the water resource are provided for; and Basic Human Needs (BHN), ensuring that the essential needs of individuals served by the water resource in question are provided for. These measures collectively aim to ensure that a balance is reached between the need to protect and sustain water resources, while allowing economic development.

The Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS) is tasked with the responsibility of co-ordinating all Reserve Determination studies in terms of the Water Resource Classification System (WRCS). These studies include the surface water (rivers, wetlands and estuaries) and groundwater components of water resources. The Reserve has priority over other water use in terms of the NWA, and should be determined before license applications are processed, particularly in stressed and over utilised catchments.

Consequently, the CD: WEM have identified the need to determine the Reserve for the Upper Orange catchment (rivers, wetlands and groundwater) forming part of the Orange Water Management Area (WMA6) in accordance with the WRCS. This report serves as a summary of the wetland fieldwork component of the study.

2. METHODOLOGY

The following section provides an overview of the methodology adopted. It should be noted that this fieldwork report should be read in conjunction with the Resource Unit (RU) Report (RDM/WMA13/00/CON/COMP/0422), which highlights the selection process for the river RUs, and as such, the methodology associated with the selection process has not been repeated in this report.

Appropriate procedures as prescribed by the Department of Water and Sanitation (DWS) required for the undertaking of the intermediate, Rapid level 3 and field verification Reserve determinations, including the field surveys was followed. These levels of assessment are described as follows:

- (i) **Intermediate** – fish (modelled with the Fish Response Assessment Index – FRAI), macroinvertebrates (modelled with the Macroinvertebrate Response Assessment Index – MIRAI), riparian vegetation (using the Riparian Vegetation Response Assessment Index

- (VEGRAI), geomorphology (using the Geomorphology Driver Assessment Index – GAI), hydraulics and water quality;
- (ii) **Rapid 3** – fish, macroinvertebrates, Index of Habitat Integrity (IHI), hydraulics and water quality where there are specific concerns due to Wastewater Treatment Works (WWTWs), extensive irrigation or where the results of the October 2021 diatom samples indicated poor water quality; and
- (iii) **Field verification** – the objective of these identified reaches is to confirm the desktop PES, EI and/ or ES and to provide specific recommendations for future management of these smaller tributaries. The components included will be a combination of those for the Rapid 3 and will be confirmed during the in-field surveys.

2.1 Site visit

A post-wet season site visit was conducted from the 4 to 15 July 2022 (first of two river surveys) to conduct all three Reserve level assessments (intermediate, Rapid Level 3 and field verification) at the identified priority RUs throughout the Upper Orange catchment. It should be noted that the baseflows at all the sites were higher than expected for this time of the year. This is due to the very wet summer season experienced throughout the study area. These high flows also resulted in no surveys undertaken in the lower Orange River at Marksdrift (discharge > 100 m³/s) that causes un-safe conditions for surveying.

3. PRIORITY RESOURCE UNITS AND RESERVE LEVEL ASSESSMENT CONDUCTED DURING THE FIELD SURVEY

Refer to Table 3-1 and Figure 3-1 for the list of priority RUs identified in the Upper Orange catchment area for this study, coupled with the Reserve level assessment for the river reach that was conducted during the river survey 1 in July 2022.

Table 3-1: River survey sites per priority RU

Resource Unit	River	Quaternaries	Level
R_RU13	Little Caledon	D21D	Rapid 3
R_RU14	Brandwater	D21G	Rapid 3
R_RU31	Meulspruit	D22A-B	Field verification
R_RU16	Mopeli	D22G	Rapid 3
R_RU04	Middle Caledon	D23A	Intermediate
R_RU32	Witspruit	D24A-C	Field verification
R_RU23	Gryskopspruit	D12D	Field verification
R_RU02	Upper Orange	D12F	Intermediate
R_RU01	Sterkspruit	D12B	Intermediate
R_RU27	Karringmelkspruit	D13K	Field verification
R_RU11	Upper Kraai	D13B	Rapid 3
R_RU24	Bokspruit	D13A	Field verification
R_RU25	Joggemspruit*	D13E	Field verification
R_RU28	Holspruit	D13H-J	Field verification
R_RU03	Lower Kraai	D13M	Intermediate
R_RU49	Sterkspruit, tributary of Kraai	D13C	Field verification

Resource Unit	River	Quaternaries	Level
R_RU50	Bell	D13B	Field verification
R_RU12	Wonderboomspruit	D14E	Rapid 3
R_RU05	Lower Caledon	D24J	Intermediate
R_RU51	Groenspruit	D24H	Field verification
R_RU33	Skulpspruit	D24H	Field verification
R_RU06	Seekoei	D32J	Intermediate
R_RU35	Elandskloof*	D32A	Field
R_RU36	Klein-Seekoei*	D32C	Field
R_RU37	Middle Riet**	C51K	Field
R_RU08	Upper Riet	C51F	Intermediate
R_RU19	Kromellenboog	C51H	Rapid 3
R_RU18	Fouriespruit	C51A	Field
R_RU09	Middle Modder	C52G	Intermediate
R_RU39	Rietspruit, small tributary of Modder**	C52G	Field
R_RU20	Little Modder	C52B	Field
R_RU22	Upper Modder	C52B	Rapid 3

* No access

** To be undertaken in November 2022

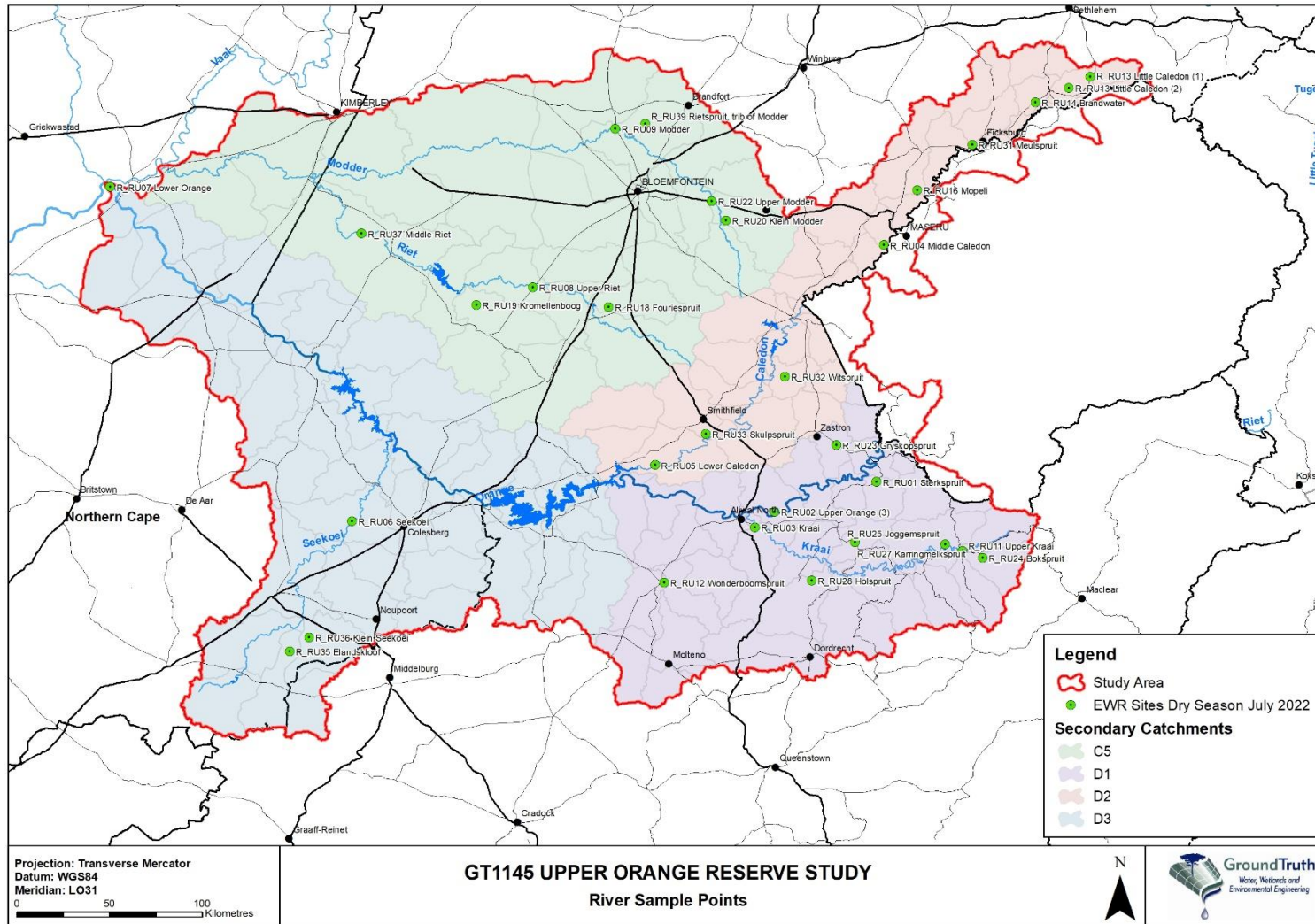


Figure 3-1: Map illustrating the various EWR sites for the Dry season July 2022 survey

4. RIVER SURVEY TEAMS

Table 4-1 includes the list of specialists which conducted the survey, along with a team of DWS members for capacity building purposes.

Table 4-1: River survey teams

Specialist team	DWS team	Additional capacity building colleagues
Retha Stassen	Ndivhuwo Netshiendeulu	Hendrik Sithole (SanParks)
Dr Bennie Van Der Waal	Jan Makhetha	
Byron Grant	Tinyiko Mpete	
Kylie Farrell	Keamogetse Molefe	
	Pule Liatile	
	Basetsana Mokonyama	

5. PREVIOUS SURVEYS



An interim reconciliation survey was conducted last year from 1 to 8 October 2021. The objective of this survey was to:

- Obtain an overview of the study area (prior to this current survey in July 2022);
- Assess pre-selected sites from a hydrological and hydraulics perspective (although this was limiting at the time of the survey owing to flood events in Caledon River and tributaries and upper Orange River on 1-3 October 2021);
- Collection of diatom samples; and
- Visiting of smaller tributaries in upper catchments to inform selection of final priority resource units.

Refer to Appendix A and B for a summary of the reconciliation field survey which took place in October 2021 and a summary of the diatom results, and other sites visited during that survey respectively.

6. RIVER SURVEY SITE DETAILS

6.1 R_RU04: Middle Caledon

Sample Date	5 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR01_I	Prioritised RU	R_RU04
River	Middle Caledon	Altitude (m.a.s.l.)	1474
Longitude	27.405189°	Latitude	-29.368925°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/SQ Reach	D23A D23A-04069
Level 2 EcoRegion	15.01	DWS, 2014 PES, EI, ES	D, Moderate, Moderate
Geomorphological zone	F (Lowland)		
<p>Components sampled: IHI, <i>in situ</i> water quality, diatoms, geomorphology. Intermediate study not conducted during the low flows owing to limited access across the channel and limited habitats for macroinvertebrates. Cross sectional data will be utilised from a previous study conducted in the same eco-region upstream of this site (July 2021), along with JBS3 biological data collected in October 2021. The site will be re-surveyed during the wet season survey in November 2022.</p>			
			
Upstream		Downstream	
<p>Site Description:</p> <p>This site is ORASECOM JBS3 site (15_6) and the DWS River Health Montiroing Programme (REMP) site D2CALE-LADY2. The reach is partly confined with a deeply incised channel. The site is a wide and homogenous channel with limited habitat overall. The confluence with the Phuthiatsana River is just 5 km upstream and the confluence with a bigger river, also called the Phuthiatsana is about 30 km upstream. Lesotho’s capital city of Maseru lies ~7 km upstream. The surrounding area is a mix of settlements, grazing areas and small-scale croplands. The Lesotho side is heavily overgrazed and eroded contributing to the already high fine sediment load and evidence of sediment deposition (but not extensive along both banks). The banks are sandy and steep and potentially highly erodible. The banks have clusters of Salicaceae and Salix trees upstream and a heavy infestation of Populus sp. on the riverbanks downstream of the site. The river is ~50m wide and with some inundated sandbars along the channel. The water is turbid, and the riverbed is very muddy.</p> <p>Biotopes available for macroinvertebrates is dominated by sand and silt, with small gravel deposits over the sandy substrate. Marginal vegetation was absent owing to recent erosion of inset benches</p>			

and lower banks along both banks. There are no Stones-in-Current (SIC) or Stones-Out-Of-Current (SOOC). For fish there was Slow-Deep (SD) and Slow-Shallow (SS) habitats.

Site impacts:

- Sand mining
- Small upstream dams
- Settlements
- Cattle grazing areas
- Small-scale croplands
- Alien invasives (*Salix sp.*, *Populus sp.*, *Wattle sp.*)
- Cultivation
- Vegetation removal
- Macropytes (plastics/litter) along both banks

Preliminary Results

In situ water quality:

- pH: 8.7
- EC: 260 uS/cm
- TDS: 0.230 g/l
- DO: 11.3 mg/l
- DO%: 102.9%
- Clarity: 46cm
- Temperature: 11.0
- Salinity: 0.17

Discharge: Not measured

6.2 R_RU01: Sterkspruit

Sample Date	6 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR02_I	Prioritised RU	R_RU01
River	Sterkspruit	Altitude (m.a.s.l.)	1429
Longitude	27.369058°	Latitude	-30.517806°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D12B D12B-05232
Level 2 EcoRegion	15.01	DWS, 2014 PES, EI, ES	C, Moderate, High
Geomorphological zone	E (Lower Foothills)		

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, geomorphology, cross-section, discharge



Upstream

Downstream

Site Description:

The site is located downstream from the town of Sterkspruit and Hershell, but just upstream of the Sterkspruit sewage treatment pond (which overflow into the Sterkspruit). The valley setting is confined, with cobble, boulder and bedrock forming riffles and pools. The river is ~5m to 10m wide (macro channel 30m wide) with some bed and channel modifications, erosion on both banks, and

cattle trampling and grazing. Biotopes available for macroinvertebrates included SIC, SOOC and slated/fractured bedrock, along with Gravel, Sand, Mud (GSM) and limited marginal vegetation, owing to undercut banks and vegetation die-back. For fish there was SD, SS and Fast-Shallow (FS). Various sections of riffles and runs present. Moderate algae content and very high macroplastics in-stream, including domestic plastic (nappies). The riparian zone is mostly grassed on the left bank, with localised sand mining on the right bank and sediment deposition.

Site impacts:

- Upstream construction and bridge collapse
- Dams (in upper catchment the Jozana Dam for water supply to the towns and villages)
- Localised sand mining
- Upstream sand mining
- The town of Sterkspruit and Hershell (possible water quality impacts)
- Possible impacts from local hospital and other businesses
- Cattle trampling and grazing
- Macroplastics

Preliminary Results

In situ water quality:

- pH: 8.7
- EC: 168 uS/cm
- TDS: 0.138 g/l
- DO: 11.1 mg/l
- DO%: 108.7%
- Clarity: 60cm
- Temperature: 14.2°C
- Salinity: 0.10

Discharge: 0.618 m³/s

6.3 R_RU02: Upper Orange

Sample Date	7 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR03_I	Prioritised RU	R_RU02
River	Upper Orange	Altitude (m.a.s.l.)	1302
Longitude	26.823213°	Latitude	-30.652793°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D12F D12F-05348
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	C, High, High
Geomorphological zone	F (Lowland)		

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge, geomorphology



Upstream

Downstream

Site Description:

The site is located along a partly confined valley setting with terraces and narrow flood benches along both banks with an incised channel. The river is ~120m wide and homogenous sand bed channel with limited habitat diversity and exposed sand bars along the right bank. The site is located ~8 km upstream from the confluence of the Kraai River. The surrounding area is mostly

agriculture with small-scale croplands and grazing areas. Intense in-stream sand mining both downstream and upstream of the site. The macrochannel is sandy and the steep fine sand and silt banks prove to be highly erodible. Both banks show recent erosion along the lower margins, removing inset benches. Thickets of heavy infestation of *Salix sp.* and *Populus sp.* on both sides of the riverbanks. However, it is likely these trees are aiding in stabilising the macro channel banks to limit lateral migration. The water is turbid, and the riverbed is dominated by a featureless sand bed.

Biotopes available for macroinvertebrates is only sand and mud, there is no gravel or any stones biotope. Marginal vegetation comprised fallen down tree debris. Banks are undercut and eroded, owing to recent floods with limited inset bench development or marginal vegetation establishment. For fish there was Fast-Deep (FD) and SS habitats.

Site impacts:

- Upstream intense sand mining
- Future influence: proposed dam upstream (Verbeeldingskraal Dam)
- Small-scale croplands
- Cattle grazing and trampling

Preliminary Results

In situ water quality:

- pH: 8.8
- EC: 155 uS/cm
- TDS: 0.145 g/l
- DO: 10.7 mg/l
- DO%: 93.0%
- Clarity: 27cm
- Temperature: 9.0°C
- Salinity: 0.11

Discharge: 41 m³/s

6.4R_RU05: Lower Caledon

Sample Date	11 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR04_I	Prioritised RU	R_RU05
River	Lower Caledon	Altitude (m.a.s.l.)	1277
Longitude	26.299258°	Latitude	-30.436136°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D24G D24G-04958
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	C, High, High
Geomorphological zone	F (Lowland)		

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge, geomorphology



Upstream



Downstream

Site Description:

Just downstream of the N6 road bridge between Rouxville and Smithfield. The water transfer from the Caledon River to the Knellpoort Dam and the Welbedacht Dam are ~100km upstream. The surrounding land use is extensive sheep farming with localised irrigation of lucerne from the Caledon River. High silt loads in this river, abstracted for irrigation, are causing significant problems for local farmers with “fines” clogging the soil pores and preventing water penetration. The site is located along an unconfined low gradient reach. The channel is relatively straight, incised into the surrounding landscape with narrow flood features. The banks are steep and lined with

invasive trees and annuals. Salix and Populus trees dot the riverbanks from the waterline to ~10 m from the water. The river at this site is ~50-70m wide and defined by a couple of strong basaltic intrusions diagonally across the river defining a narrow (~5m wide) resistant bedrock shelf and providing the key geomorphic structure to this reach of the river. Coarse material (boulder and cobble sized) has been introduced for the bridge construction. This has created a series of concrete shelves under the bridge and boulder and cobble shoots, runs and riffles directly downstream of the bridge. At the reach scale the system is dominated by the finer alluvial sands and silts from active upstream erosional processes. These sediments are regularly and extensively deposited onto the riverbanks and under lower flows defines a fine sediment dominated bed and braided main channel.

Site impacts:

- Agriculture
- Abstraction and irrigation
- Cattle grazing and trampling
- Local water pump just upstream of the bridge
- Artificial habitats (as a result of artificial construction material for the bridge which remain)
- Bank erosion
- Riparian alien invasives

Preliminary Results

In situ water quality:

- pH: 8.7
- EC: 259 uS/cm
- TDS: 0.241 g/l
- DO: 10.1 mg/l
- DO%: 87.9%
- Clarity: 27cm
- Temperature: 9.2
- Salinity: 0.18

Discharge: 14.2 m³/s

6.5 R_RU06: Seekoei

Sample Date	12 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR05_I	Prioritised RU	R_RU06
River	Seekoei	Altitude (m.a.s.l.)	1221
Longitude	24.962895°	Latitude	-30.534359°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D32J D32J-05237
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	D, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge, geomorphology



Upstream



Downstream

Site Description:

The reach is relatively unconfined with the river incised into the valley floor. Flood features are narrow and the river pattern is straight to sinuous with bedrock, boulder, cobble and gravel and finer habitats available at the site. The site is located off a large cross over bridge off a district road R369, approximately 40km northwest from Colesburg and approximately 60km downstream of the Karoo Gariep Nature Reserve. The site continues to have high baseflows following the recent

floods. Various upstream dams and weirs along the river reach, with a gauging weir located just upstream of the site, resulting in inundation upstream, as well as sediment accretion resulting in various instream islands of *Phragmites sp.*, as well as along both banks. Downstream of the weir, the site is dominated primarily by metamorphic sandstone with igneous intrusions forming the bedrock layer along this reach, along with small pockets of SIC and limited gravel. The bedrock was blanketed by algae and silt. Furthermore, both instream and marginal vegetation was present to sample for macroinvertebrates, mostly *Phragmites sp.* and sedges. Along the rest of the reach consists of bedrock pools and both banks fringed with *Phragmites sp.* and beyond lined with an intact riparian zone of grasses, shrubs and trees (including *Acacia sp.*). Fish habitats included FD, FS, SS and SD.

The dominant land use in the area is cultivation on the terraces along the river, game farming and smaller cattle farming areas.

Site impacts:

- Dams and weirs
- Irrigation
- Game farming
- Localised cultivation on terraces

Preliminary Results

In situ water quality:

- pH: 8.8
- EC: 695 uS/cm
- TDS: 0.636 g/l
- DO: 11.2 mg/l
- DO%: 99.2%
- Clarity: 30cm
- Temperature: 9.8
- Salinity: 0.49

Discharge: 1.155 m³/s

6.6 R_RU08: Upper Riet

Sample Date	13 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR06_I	Prioritised RU	R_RU08
River	Upper Riet	Altitude (m.a.s.l.)	1278
Longitude	25.524570°	Latitude	-29.535065°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	C51F C51F-04071
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	C, High, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, aquatic macroinvertebrates, IHI, <i>in situ</i> water quality, cross-section, discharge, geomorphology			
			
			
Upstream		Downstream	

Site Description:

The reach is largely unconfined, with the macro channel incised into the gently sloping hillslopes. The river has a straight to sinuous macro channel pattern, with a braided low flow channel pattern. Bedrock, boulder, gravel and silt common sediment types at the site. This site is located in the upper reaches of the Riet River, upstream of the Kalkfontein Dam Nature Reserve and ~20km upstream of the confluence of the Kromellenboog. Upstream of this site is the DWS REMP site and previous JBS3 site C5RIET-IFR03 and 26_10 respectively. The Riet River is a main tributary of the Vaal River and flows in a western direction. The site is located just downstream of a low water cross-over bridge, where log jams have occurred upstream of the bridge, impeding the hydraulics of the river, as well as inundation of the system upstream.

The turbid channel is ~40m wide and braided downstream of the bridge owing to in-stream vegetated and gravel islands. The substrate at the site is dominated by gravel and cobbles, a section of bedrock along the left side of the channel. The forming braids have resulted in small streams running through the instream island with rocky habitat for macroinvertebrates and fish, sections of SOOC and mud forming allowing for instream vegetation. Small pools have formed as back eddies from the vegetated sedimentation which has formed. The increased flows have allowed aquatic grass to establish in the deep runs. Marginal vegetation was abundant and comprised reeds, grasses and sedges. Bank erosion from cattle trampling was evident, more so along the right bank, along with undercut banks. The surrounding vegetation, particularly along the left side of the river had large *Eucalyptus sp.* plantations.

The catchment is rural in nature with localised irrigated agriculture and widespread grazing and game farming the primary land use.

Site impacts:

- Rural development
- Cattle/game farming
- Cultivation
- Irrigation

Preliminary Results

In situ water quality:

- pH: 8.8
- EC: 486 uS/cm
- TDS: 0.449 g/l
- DO: 9.9 mg/l
- DO%: 87.4%
- Clarity: 22cm
- Temperature: 9.5
- Salinity: 0.34

Discharge: 4.217 m³/s

6.7 R_RU22: Upper Modder (Sannaspos)

Sample Date	14 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR07_I	Prioritised RU	R_RU22
River	Modder	Altitude (m.a.s.l.)	1333
Longitude	26.572492°	Latitude	-29.160017°
Level 1 EcoRegion	Highveld	Quaternary catchment/ SQ Reach	C52B C52B-03819
Level 2 EcoRegion	11.03	DWS, 2014 PES, EI, ES	D, High, High
Geomorphological zone	E (Lower Foothills)		

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge, geomorphology



Upstream



Downstream

Site Description:

The reach is largely unconfined, with gently sloping hillslopes and an incised channel with narrow flood features. The site is bedrock controlled with silty banks and introduced coarser bed material. Gravel and sand bars are present downstream of the site. The site along the upper reaches of the Modder River is located ~30km east of Bloemfontein off the N8, with its confluence downstream with the Riet River near the town of Ritchie. The site is situated approximately 13 km downstream of Rustfontein Dam. It is impeded by two (2) railway crossings and a large bridge. Furthermore, a gauging weir is located just upstream of the site. The river width varies from 3 m to 15 m in places with inundation taking place just upstream of the weir. Owing to these influences and impediments, much of the instream substrate, downstream of the weir comprises riffles with artificial loose SIC, and some SOOC. However, bedrock is the dominant substrate from the bridge and further downstream. There is relatively good GSM, but marginal vegetation, being grasses and sedges, was limited owing to undercut banks and vegetation die back (representative of the season). Sedimentation is present downstream of the weir forming a back eddie along the sandbank with algae on the rocks at the river's edge. Overall, considerable channel and bed modification is present at this site. Both banks are heavily eroded owing to recent flooding, flow modifications and cattle trampling.

Current land uses in the catchment include agricultural activities (primarily irrigated crops), urbanisation and industrial activities. The Modder River supplies water to several urban areas including Bloemfontein, Botshabelo (upstream) and Thabu Nchu although this is supplemented to a large degree by water from the Caledon River via the Caledon - Modder River Government Water Scheme (CMRGWS).

Site impacts:

- Upstream dams
- Weirs
- WWTW works
- Agriculture
- Abstractions and irrigation
- Cattle trampling, grazing
- Industrial

Preliminary Results

In situ water quality:

- pH: 8.4
- EC: 459 uS/cm
- TDS: 0.419 g/l
- DO: 8.7 mg/l
- DO%: 76.6%
- Clarity: 52cm
- Temperature: 9.9
- Salinity: 0.32

Discharge: 0.673 m³/s

6.8 R_RU03: Lower Kraai

Sample Date	7 July 2022	Reserve Level Assessment	Intermediate
Site Name	UO_EWR08_I	Prioritised RU	R_RU03
River	Lower Kraai	Altitude (m.a.s.l.)	1298
Longitude	26.74157°	Latitude	-30.69007°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D13M D13M-05442
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	C, High, High
Geomorphological zone	F (Lowland)		

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge, geomorphology



Upstream



Downstream

Site Description:

This site is ORASECOM JBS3 site (26_11) and the DWS REMP site D1KRAA-ALIWA. The reach has a partly confined valley setting, straight to wandering channel form and pool-riffle sequences. The channel is incised with narrow flood features. The site is immediately downstream of a causeway/bridge which is frequently used by farmers. There is a sluice gate on the right end of the bridge – which can be closed in times of drought or should the Orange River dry up. This functions in pooling up the river upstream of the bridge for Basic Human Needs support. This river is a free flowing river, ~30 m wide and has a range of biotopes. There is a solid igneous bedrock base with riffles and runs below the causeway. Much filamentous algae coverage over the SIC biotopes. Most of the river in the area has deeper, slow flowing pools. The river comprises various sections of riffles and pools downstream of the bridge, providing a range of habitats. All biotopes for the macroinvertebrates are present, SIC, SOOC, GSM, although vegetation is limiting owing to undercut banks and vegetation die back/erosion. For fish, there are FD, SD, SS and FS habitats.

The main land use in the area is agriculture with several centre pivot irrigation fields close to the river immediately upstream. *Salix sp.* line the banks both upstream and downstream. The flood debris line is ~3 m above the water level indicating large volumes passing through during flood events.

Baseflows were higher than expected for the time of year as a results of the high rainfall during the latter part of summer.

Site impacts:

- Agriculture
- Cattle activity
- Irrigation



Preliminary Results

In situ water quality:

- pH: 8.6
- EC: 218 uS/cm
- TDS: 0.204 g/l
- DO: 10.1 mg/l
- DO%: 87.7%
- Clarity: 68cm
- Temperature: 9.1
- Salinity: 0.15

Discharge: 17.3 m³/s

6.9 R_RU13: Little Caledon

Sample Date	4 July 2022	Reserve Level Assessment	Rapid 3
Site Name	UO_EWR01_R	Prioritised RU	R_RU13
River	Little Caledon	Altitude (m.a.s.l.)	1692
Longitude	28.405709°	Latitude	-28.557796°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D21D D21D-03094
Level 2 EcoRegion	15.03	DWS, 2014 PES, EI, ES	C, Moderate, High
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, aquatic macroinvertebrates, IHI, <i>in situ</i> water quality, diatoms, cross-section, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The site is located downstream from the town of Clarens along an incised floodplain reach. Localised channel modification and bank modification are evident. Farm road/bridge crossing, along with just immediately upstream a causeway/bridge which is frequently used by farmers and cattle crossing the river. Both banks show localised erosion. No large upstream dams. The river is ~5m wide and has a range of biotopes for both macroinvertebrates (marginal vegetation, Stones-In-Current and Stones-Out-of-Current (SIC, SOC) and Gravel, Sand, Mud (GSM)). For fish, Slow Deep (SD), Slow Shallow (SS) and Fast Shallow (FS). The marginal vegetation is limited owing to steep undercut banks and vegetation die-back. There is much in-stream vegetation debris, additional habitat for biota. The riparian vegetation zone is modified primarily owing to agriculture/croplands encroachment, although some <i>Phragmites sp.</i> and <i>Salix sp.</i> Just downstream of the bridge there is a section of riffles and runs downstream of the causeway. There are upstream deep pools with a meandering channel. The flows were higher than expected for the dry season owing to enhanced baseflows due to a very wet and late rainfall season.</p> <p>The main land use in the area is agriculture, croplands and cattle trampling and grazing. <i>Salix</i> trees line the banks both upstream and downstream, facilitating erosion, currently taking place along both banks.</p>			
Site impacts:			
<ul style="list-style-type: none"> Seasonal abstraction 			

- Agriculture
- Cattle trampling and grazing
- Upstream town of Clarens (possible water quality impacts)
- Stream crossings and bridges

Preliminary Results:

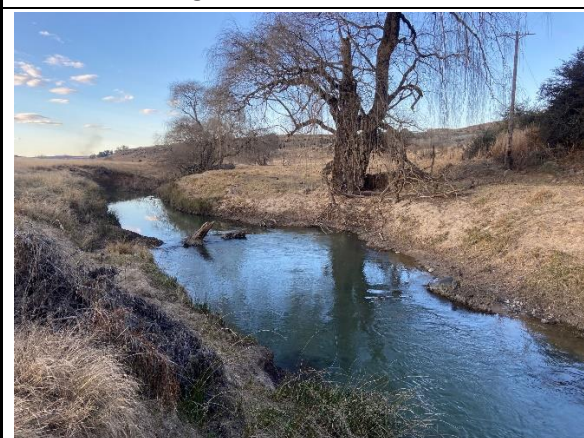
In situ water quality:

- pH: 8.6
 - EC: 246 uS/cm
 - TDS: 0.247g/l
 - DO: 12.7 mg/l
 - DO%: 103.6%
 - Clarity: 87cm
 - Temperature: 6.6
 - Salinity: 0.18
- Discharge: 0.425m³/s

6.10 R_RU14: Brandwater (Groot)

Sample Date	4 July 2022	Reserve Level Assessment	Rapid 3
Site Name	UO_EWR02_R	Prioritised RU	R_RU: 14
River	Brandwater (Groot)	Altitude (m.a.s.l.)	1583
Longitude	28.139926°	Latitude	-28.680340°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D21G D21D-03101
Level 2 EcoRegion	15.01	DWS, 2014 PES, EI, ES	C, High, High
Geomorphological zone	E (Lower Foothills)		

Components sampled: Fish, aquatic macroinvertebrates, IHI, *in situ* water quality, diatoms, cross-section, discharge



Upstream



Downstream

Site Description:

The site is located approximately 10km from the town of Fouriesburg, off a road bridge on the R26. The reach has a partly confined valley setting and the channel is incised. The river is ~5m wide with bed and channel modification owing to the bridge construction, and cattle trampling and grazing. Localized erosion and lateral head cut erosion, mostly upstream of the bridge. Biotopes available for macroinvertebrates included SIC, limited SOOC and GSM. Marginal vegetation was absent owing to undercut banks, grazing and vegetation die back. For fish there was SD, SS and FS. Just upstream of the bridge is a section of riffles and runs, with deep pools upstream. High algae content smothering SIC biotopes. The riparian zone is mostly unvegetated and just grass and shrubs, with *Salix sp* located along mostly the left bank. Overall, floodplains, partly confined valley settings and back swamp wetlands further downstream of the site. Baseflows were higher than expected for the time of year as a result of the high rainfall during the latter part of summer.

Site impacts:



- Water abstraction
- Irrigation
- Cattle trampling and grazing
- Various upstream small dams

Preliminary Results

In situ water quality:

- pH: 8.4
 - EC: 307 uS/cm
 - TDS: 0.299g/l
 - DO: 14.2 mg/l
 - DO%: 118.6%
 - Clarity: 37cm
 - Temperature: 7.6
 - Salinity: 0.22
-
- Discharge: 0.648m³/s

6.11 R_RU16: Mopeli

Sample Date	5 July 2022	Reserve Level Assessment	Rapid 3
Site Name	UO_EWR03_R	Prioritised RU	R_RU16
River	Mopeli	Altitude (m.a.s.l.)	1503
Longitude	27.570751°	Latitude	-29.101205°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/SQ Reach	D22G D22G-03732
Level 2 EcoRegion	15.01	DWS, 2014 PES, EI, ES	D, High, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, aquatic macroinvertebrates, IHI, <i>in situ</i> water quality, diatoms, cross-section, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The site is located off R26 and S872 along a confined valley setting. Upstream of the site is a derelict weir, a cross-over bridge, along with a broken-up causeway bridge, where much of the bridge rubble and log jams are impeding the hydraulics of the river and associated left bank. The site on the Mopeli is considerably modified – both the channel, banks and high flow modification. The highly eroded banks, particularly the right bank is being scoured as a result of the blockage at the bridge altering the local hydraulics. Following recent flood events, much vegetation debris has accumulated upstream by the cross-over bridge, resulting in blocking and slowing the high flows, reducing flow velocities directly downstream of the bridge leading to excessive sediment deposition. This has formed a large lee bar that is diverting the river to the right, eroding the right bank and eroding the side/approach of the bridge. Furthermore, consolidated mud islands have formed further downstream due to erosion of former consolidated floodplain deposits along the channel.</p> <p>Biotopes available for macroinvertebrates is dominated by bedrock, with mud, but limited gravel and sand. Marginal vegetation was absent owing to undercut banks and vegetation die back. For fish there was SD, SS and FS. The system is eutrophic, with significant algae content smothering the bedrock habitat and turbid water. The riparian zone on the left bank is degraded with much of the sediment loading taking place, while the right bank is slightly more vegetation with trees, although some have fallen down due to the erosion. Baseflows were higher than expected for the time of year as a result of the high rainfall during the latter part of summer.</p>			
Site impacts:			



- Cattle trampling and grazing
- Upstream small dams
- Abstraction for irrigation
- Sediment deposition downstream of the bridge driving bank erosion
- Bridge crossings and weir

Preliminary Results

In situ water quality:

- pH: 9.1
 - EC: 230 uS/cm
 - TDS: 0.212g/l
 - DO: 13.1 mg/l
 - DO%: 114.7%
 - Clarity: 35cm
 - Temperature: 9.5
 - Salinity: 0.2
- Discharge: 0.808m³/s

6.12 R_RU11: Upper Kraai

Sample Date	9 July 2022	Reserve Level Assessment	Rapid 3
Site Name	UO_EWR04_R	Prioritised RU	R_RU11
River	Upper Kraai	Altitude (m.a.s.l.)	1714
Longitude	27.77689°	Latitude	-30.85179°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/SQ Reach	D13E D13E-05629
Level 2 EcoRegion	15.06	DWS, 2014 PES, EI, ES	C, High, High
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, aquatic macroinvertebrates, IHI, <i>in situ</i> water quality, cross-section, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The upper Kraai site is located along a partly confined valley. The channel approximately 40m wide and follows a pool-riffle longitudinal pattern. It is located approximately 200m downstream of the confluence of the Bell River with the Sterkspruit. Localised bed and channel modification is observed downstream of the large bridge crossing and upstream weir, along with some cattle trampling along the riparian zone. Localized erosion and lateral head cut erosion, mostly up and downstream of the bridge. Some scouring along both banks with several lee bars in-stream and along the left bank downstream. The riparian zone is partly intact, representative of the season. The left bank is generally covered with grasses, shrubs (blackjacks) and trees (<i>Salix sp.</i>). The right bank is along a cliff face and shrubs.</p> <p>The river comprises various sections of riffles up and downstream of the bridge, composed of boulder, and cobble material along the riffles and gravel and sand along the pools. All biotopes for the macroinvertebrates are present, SIC, SOOC, GSM, although vegetation is limiting owing to undercut banks and vegetation die back. Localised algae covering the SIC biotope and detritus along the substrate. Fish habitats include SD, FD, SS and FS.</p> <p>The land use is predominantly farmlands, with small croplands and cattle grazing.</p> <p>Baseflows were very high as a results of the high rainfall during the latter part of summer.</p>			
Site impacts:			

- Abstraction
- Irrigation
- Cattle grazing
 - Floodplain/terrace cultivation



Preliminary Results

In situ water quality:

- pH: 8.3
- EC: 145 uS/cm
- TDS: 0.152 g/l
- DO: 11.8 mg/l
- DO%: 92.7%
- Clarity: >1m
- Temperature: 5.2
- Salinity: 0.11

Discharge: 2.325m³/s

6.13 R_RU12: Wonderboomspruit

Sample Date	11 July 2022	Reserve Level Assessment	Rapid 3
Site Name	UO_EWR05_R	Prioritised RU	R_RU12
River	Wonderboomspruit	Altitude (m.a.s.l.)	1383
Longitude	26.341938°	Latitude	-31.005262°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D14E D14E-05804
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	C, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, aquatic macroinvertebrates, IHI, <i>in situ</i> water quality, cross-section, diatoms, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The site is located downstream from the town Burgersfort off the R391. There is a large cross-over bridge upstream from the site, and a gauging weir approximately 500m downstream from the site on the Wonderboomspruit, that can result in inundation of the site during very high flows. The river is located within a valley setting which is confined, with cobbles, rocks and small boulders forming riffles and pools. The river is ~5m wide and flows relatively straight towards the gauging weir where it meanders further downstream. Some erosion on both banks, due to cattle trampling and grazing. Biotopes available for macroinvertebrates included SIC, SOOC, both marginal and in-stream aquatic vegetation and limited GSM. Fish habitats included FS, FD and SD. The stones biotopes were heavily smothered with algae and sludge, as the system has a significant input of nutrients with a clear sewage odour as well as black organic muds deposited in slow flowing sections. Very high macroplastics in-stream, as well as littered throughout the riparian zone and beyond. The riparian zone is mostly sedges on both banks, along with alien invasive vegetation namely <i>Eucalyptus sp.</i>, <i>Salix sp.</i> and <i>Populus</i> on both banks.</p> <p>The land use is predominantly urban (Burgersfort), rural development and open lands along the reach. Low intensity agriculture with some croplands and cattle grazing areas.</p> <p>Baseflows were higher than expected as a results of the high rainfall during the latter part of summer.</p>			
Site impacts:			

- The town of Burgersfort (possible water quality impacts)
- Upstream wastewater treatment works
- Dams
- Cattle trampling and grazing
- Macroplastics along the riparian zone

Preliminary Results

In situ water quality:

- pH: 8.5
- EC: 414 uS/cm
- TDS: 0.382 g/l
- DO: 13.2 mg/l
- DO%: 116.0%
- Clarity: 61cm
- Temperature: 9.6
- Salinity: 0.29

Discharge: 1.129 m³/s

6.14 R_RU19: Kromellenboog

Sample Dat	13 July 2022	Reserve Level Assessment	Rapid 3
Site Name	UO_EWR06_R	Prioritised RU	R_RU19
River	Kromellenboog	Altitude (m.a.s.l.)	1258
Longitude	25.43507°	Latitude	-29.65360°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	C51H C51H-04284
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	B, High, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, aquatic macroinvertebrates, IHI, <i>in situ</i> water quality, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The Kromellenboog is a main tributary of the Riet. The site is located along a gravel road amongst private game farms, approximately 20km north of the town Jagersfontein. The confluence with the Prossesspruit, a tributary of the Kromellenboog is approximately 13km upstream. Owing to the recent floods, high baseflows remain within the system which is not representative of this system during the dry season. The reach is located along a partly confined valley setting with a straight to sinuous macro channel plan form. The macro channel is incised into the surrounding landscape, with poorly developed flood features. The active channel is braided downstream of the bridge, owing to various in-stream vegetated islands. Bedrock, gravel, sand and silt are the main substrates forming habitats. The site is located at a low water cross-over bridge, where log jams have occurred upstream of the bridge, impeding the hydraulics of the river and associated left bank. The turbid channel is ~35 m wide. The left bank is dominated by slated bedrock, while the riparian zone along the right bank is intact with grasses, sedges, <i>Phragmites sp.</i> and trees, with limited bank erosion. All biotopes are present for macroinvertebrates, which include SIC (which also comprised broken down slate bedrock), SOOC, GSM and both in-stream (including freshwater alien invasive macrophytes) and marginal vegetation. Some fine silt and algae growth (slimy) predominantly over the SIC biotope. Fish habitats include SS, SD and FD.</p> <p>The primary land use is game farming, small scale cattle farming and upstream mining.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Cultivation 			

- Irrigation
- Game farming
- Small scale cattle farming
- Upstream (along the Prossesspruit) is mining, possible knock-on impacts on the Kromellenboog



Preliminary Results

In situ water quality:

- pH: 8.7
- EC: 535 uS/cm
- TDS: 0.509 g/l
- DO: 9.3 mg/l
- DO%: 80.6%
- Clarity: 56cm
- Temperature: 8.8
- Salinity: 0.38



Discharge: 3.39 m³/s

6.15 R_RU09: Middle Modder (Soetdoring)

Sample Date	14 July 2022	Reserve Level Assessment	Rapid 3
Site Name	UO_EWR7_R	Prioritised RU	R_RU09
River	Modder	Altitude (m.a.s.l.)	1263
Longitude	26.109695°	Latitude	-28.807191°
Level 1 EcoRegion	Highveld	Quaternary catchment/ SQ Reach	C52G C52H-03155
Level 2 EcoRegion	11.08	DWS, 2014 PES, EI, ES	D, High, High
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, aquatic macroinvertebrates, IHI, <i>in situ</i> water quality, diatoms, cross-section, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The site is located off the R700 ~30km north of Bloemfontein, approximately 4km downstream of the confluence with the Doringspruit and within the boundary of the Soetdoring Nature Reserve. Downstream of the site is the Krugersdrif Dam which has resulted in large scale inundation of the lower system. The reach has an unconfined valley setting, with the macro channel incised into the surrounding landscape. Flood features are narrow along the channel margins and the bed is locally controlled by bedrock. The macro channel is straight to moderately sinuous with a pool-riffle sequence where habitats are not drowned out by dams or weirs. Boulder, cobble and gravel are deposited inbetween the bedrock sections, with sandy and silty inset banches forming along the margins. The site is located along a sinuous deep run which is dominated by bedrock and large rocks, smothered in algae and high silt loads. Marginal vegetation is well developed and dominated by Phragmites sp., blackjacks and other shrubs, although forms a small band along the banks with upper marginal zone dominated by large trees in riparian areas. Artificial habitat diversity is present under the road bridge in the form of riffles as well as instream vegetation. Aquatic macroinvertebrate biotopes includes SIC, SOOC, marginal vegetation and limited GSM. Fish habitats comprised FS, FD, SS and SD.</p> <p>Landuse influence on the system results predominantly from agriculture.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Agriculture 			

<ul style="list-style-type: none">• Irrigation
Preliminary Results
<i>In situ</i> water quality: <ul style="list-style-type: none">• pH: 8.8• EC: 426 uS/cm• TDS: 0.392 g/l• DO: 10.4 mg/l• DO%: 91.2%• Clarity: 27cm• Temperature: 9.6• Salinity: 0.29
Discharge: 2.257 m ³ /s

6.16 R_RU31: Meulspruit



Sample Date	5 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR01_FV	Prioritised RU	R_RU31
River	Meulspruit	Altitude (m.a.s.l.)	1536
Longitude	27.834944°	Latitude	-28.885731°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D22B D22B-03442
Level 2 EcoRegion	15.01	DWS, 2014 PES, EI, ES	D, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: Diatoms, IHI, <i>in situ</i> water quality, diatoms, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The site is located just outside Ficksburg off the R26, just downstream of the Meulspruit Dam wall. The Meulspruit Dam has no release capacity and does not release into the Meulspruit. Thus, there are periods of this tributary being dry. The site on the Meulspruit is located upstream of the confluence with the Caledon, with high baseflows owing to recent flooding events.</p> <p>The site is located along a confined reach with possible bedrock influence. The river is ~6m wide with bed and channel modification owing to railway bridges constructed upstream, coupled with the construction of the Meulspruit Dam wall. The channel is highly scoured as a result of longitudinal sediment starvation downstream of the dam. Localised unnatural deposits of rocks at the site owing to a stream crossing. There is further cement barrels instream, along with fallen tree debris within the channel. High bank erosion and lateral head cut erosion at the stream crossing. Biotopes available for macroinvertebrates included SIC, SOOC with riffles and GSM. Marginal vegetation was absent owing to undercut banks and vegetation die-back. For fish there was SD, SS, FS and some deep pools upstream. High algae content and turbid water. The riparian zone is limited to grasses, shrubs, <i>Salix sp</i> and <i>Populus sp.</i> (<i>alien invasive</i>) located along mostly the left bank.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Alien invasives • Meulspruit Dam • Irrigation upstream of dam • Cut and fill associated with the road crossing, including introduced rock aggregate 			

Preliminary Results

In situ water quality:

- pH: 8.9
 - EC: 278 uS/cm
 - TDS: 0.270g/l
 - DO: 11.9 mg/l
 - DO%: 99.6%
 - Clarity: 34cm
 - Temperature: 7.7
 - Salinity: 0.2
- Discharge: 0.741m³/s


6.17 R_RU32: Witspruit

Sample Date	6 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR02_F	Prioritised RU	R_RU32
River	Witspruit	Altitude (m.a.s.l.)	1389
Longitude	26.928315°	Latitude	-30.008260°
Level 1 EcoRegion	Highveld	Quaternary catchment/ SQ Reach	D24C D24C-04692
Level 2 EcoRegion	11.03	DWS, 2014 PES, EI, ES	D, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The site is located downstream from Van Stadensrus along an incised valley with limited floodplain development. The site is inundated through successive weirs with alluvial deposition. There is a weir located upstream with in-stream consolidated sediment islands. The flow is limited by a low water causeway and a downstream weir, resulting in deep slow flowing habitats.</p> <p>The biotopes present for the macroinvertebrates includes both marginal and in-stream vegetation along with GSM. Slow deep and deep pools present for fish. Some algae present within the water column and high turbidity. The riparian zone is intact, with some wetland features, although pockets of high density <i>Populus sp</i> stands along both banks.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Alien invasive vegetation (riparian) • Low water cross-over bridge • Upstream town of Van Stadensrus (possible water quality impacts) • Upstream dam near Van Stadensrus (possible flow modifications) • Upstream and downstream small weirs 			
Preliminary Results			
<i>In situ</i> water quality: <ul style="list-style-type: none"> • pH: 9.6 			

- EC: 201 uS/cm
- TDS: 0.185 g/l
- DO: 10.36 mg/l
- DO%: 91.2%
- Clarity: 18cm
- Temperature: 9.6°C
- Salinity: 0.14

- Discharge: 0.1 m³/s

6.18 R_RU23: Gryskopspruit

Sample Date	6 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR03_FV	Prioritised RU	R_RU23
River	Gryskopspruit	Altitude (m.a.s.l.)	1526
Longitude	27.176878°	Latitude	-30.339629°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D12D D12D-04976
Level 2 EcoRegion	15.01	DWS, 2014 PES, EI, ES	D, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms			
			
Downstream			
Site Description:			
<p>The site is located just upstream of Montegu Dam (Zastron), along an unconfined floodplain reach. The site is further characteristic of a channelled valley bottom wetland, possibly due to the backwater effects of the downstream dam. Upstream is dense wetland vegetation, however once the water flows through the low lying cross-over culverted bridge – the water dissipates downstream through the floodplain.</p> <p>Salix sp. are located within the channel downstream of the low-lying bridge.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Some irrigation • Zastron (possible water quality impacts) 			
Preliminary Results			
<i>In situ</i> water quality:			
<ul style="list-style-type: none"> • pH: 8.5 			

- EC: 337 uS/cm
- TDS: 0.306 g/l
- DO: 11.9 mg/l
- DO%: 105.8%
- Clarity: 48cm
- Temperature: 10.1°C
- Salinity: 0.23

Discharge: Not taken

6.19 R_RU27: Karringmelkspruit

Sample Date	7 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR04_FV	Prioritised RU	R_RU27
River	Karringmelkspruit	Altitude (m.a.s.l.)	1635
Longitude	27.264973°	Latitude	-30.811765°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D13K D13K-05454
Level 2 EcoRegion	15.06	DWS, 2014 PES, EI, ES	B, Very High, High
Geomorphological zone	D (Upper Foothills)		

Components sampled: IHI, *in situ* water quality, diatoms



Upstream



Downstream

Site Description:

The Karringmelkspruit is a tributary of the Kraai River. The site was located along a confined valley dominated by boulder and cobble bed material. This pristine and bedrock meandering river within a gorge comprises all biotopes for the macroinvertebrates, SIC, SOOC, GSM, although vegetation is limiting owing to undercut banks and vegetation die-back. There is large fallen down boulders from the adjacent gorge in-stream, some with sediment abrasions from previous floods. The fish habitats comprise FS, SS and SD. Limited impacts, clear water and no algae present. Some bank erosion on both banks due to the recent floods. The riparian zone is partly intact, representative of the season, particularly the left bank while the right bank has some areas of bare soils. Some encroachment of alien invasives along the riparian, including blackjacks.

Site impacts:

- Abstraction
- Irrigation
- Cattle grazing

Preliminary Results



In situ water quality:

- pH: 8.5
- EC: 106 uS/cm

- TDS: 0.125 g/l
- DO: 9.2 mg/l
- DO%: 81.3%
- Clarity: >1m
- Temperature: 9.7
- Salinity: 0.1

Discharge: Not taken ~0.4 m³/s

6.20 R_RU24: Bokspruit

Sample Date	9 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR05_FV	Prioritised RU	R_RU24
River	Bokspruit	Altitude (m.a.s.l.)	1760
Longitude	27.884557°	Latitude	-30.884690°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D13A D13A-05679
Level 2 EcoRegion	15.06	DWS, 2014 PES, EI, ES	C, Moderate, High
Geomorphological zone	E (Lower Foothills)		
Components sampled: Fish, IHI, <i>in situ</i> water quality, diatoms, discharge			
			
Upstream		Downstream	
Site Description:			
<p>The Bokspruit, a tributary of the Sterkspruit (Kraai River system), is in good condition (full river reach) and approximately 10m wide. The reach has a partly confined valley setting with narrow flood features. However, owing to the bridge at the sampling site, coupled with some log and debris jams on the left side, are impeding the hydraulics of the river, scouring and resulting in localised erosion, particularly on the left bank, both up and downstream of the bridge. The scouring is contributing to the downstream lee bar on the left, although further downstream, another lee bar was observed on the right bank. Owing to the <i>Salix sp</i> on the left bank, the banks are stabilised thus avoiding further localised bank erosion. Both bed and channel modification at this site, but localised. The riparian zone is partly intact, representative of the season, mostly covered with grasses, shrubs and trees, most of which are alien invasive namely <i>Salix spp.</i> and <i>Pyracantha</i>.</p> <p>The river comprises various sections of riffles up and downstream of the bridge. All biotopes for the macroinvertebrates are present, SIC, SOOC, GSM, although vegetation is limiting owing to undercut banks and vegetation die back. Localised algae covering the SIC biotope. For fish, there is SD, SS and FS habitats.</p> <p>The land use is predominantly farmlands, with small croplands and cattle grazing.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Abstraction • Irrigation 			

- Cattle grazing

Preliminary Results

In situ water quality:



- pH: 8.9
- EC: 109 uS/cm
- TDS: 0.116 g/l
- DO: 10.9 mg/l
- DO%: 84.4%
- Clarity: >1m
- Temperature: 4.9°C
- Salinity: 0.08

Discharge: 0.649 m³/s

6.21 R_RU25: Joggemspruit

Sample Date	9 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR06_FV	Prioritised RU	R_RU25
River	Joggemspruit	Altitude (m.a.s.l.)	1699
Longitude	27.704313°	Latitude	-30.819478°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/SQ Reach	D13E D13E-05541
Level 2 EcoRegion	15.06	DWS, 2014 PES, EI, ES	C, Moderate, High
Geomorphological zone	E (Lower Foothills)		
<i>Site not sampled owing to access restriction due to locked farm gate</i>			

6.22 R_RU28: Holspruit

Sample Date	10 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR07_FV	Prioritised RU	R_RU28
River	Holspruit	Altitude (m.a.s.l.)	1413
Longitude	27.056639°	Latitude	-30.995316°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D13J D13J-05741
Level 2 EcoRegion	15.06	DWS, 2014 PES, EI, ES	B, High, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms			
			
Upstream		Downstream	
Site Description:			
<p>The site is located near Floukraal along a confined valley. The Holspruit has localised modifications owing to a cross-over bridge which impedes the river channel, along with a small upstream weir and derelict and broken-down culverted bridge coupled with construction debris. Furthermore, beneath the cross-over bridge in-stream are artificial cement slabs. Both banks up and downstream of the bridge is well vegetated although dominated by alien invasives namely <i>Populus sp.</i>, as well as pockets of <i>Salix sp.</i> and <i>Pyracantha</i>. Although these are aiding in bank stability. All these impediments have resulted in the multiple diversions of the river flowing downstream, with a lee bar on the left bank downstream of the bridge. Turbid waters with some algae and sediment loads over the stone's biotopes.</p> <p>Biotopes available for macroinvertebrates is dominated by various sections of riffles, SIC, SOOC, marginal vegetation, although limited owing to undercut banks and vegetation die-back (representative of the season). Fish habitats comprised SD, SS, FD and FS.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Cattle trampling and grazing • Upstream small dams (off-channel) • Abstraction for irrigation • Bridge crossings • Extensive alien vegetation infestation 			


Preliminary Results

In situ water quality:

- pH: 8.4
- EC: 332 uS/cm
- TDS: 0.326 g/l
- DO: 10.4 mg/l
- DO%: 85.8%
- Clarity: 39cm
- Temperature: 7.3
- Salinity: 0.24

Discharge: Not measured

6.23 R_RU49: Sterkspruit (tributary of the Kraai/Bell)

Sample Date	9 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR08_FV	Prioritised RU	N/A
River	Sterkspruit	Altitude (m.a.s.l.)	1740
Longitude	27.800753°	Latitude	-30.917621°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/SQ Reach	D13C D13C-05701
Level 2 EcoRegion	15.06	DWS, 2014 PES, EI, ES	C, Moderate, High
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms			
			
Downstream			
Site Description:			
<p>The Sterkspruit, a tributary of the Bell/Kraai River is in a good condition at the site and approximately 10m wide. The bridge at the sampling site is resulting in scouring of both banks, resulting in localised erosion up and downstream of the bridge. Bank rehabilitation in the form of gabions have been constructed up and downstream of the bridge for stabilisation. However, the gabions on the banks above the bridge have destabilised and disassembled, and gabion material and debris is impeding the flow beneath the bridge and slightly downstream of the bridge, with gabion material observed in-stream. Most of the gabions on the banks below the bridge are still intact and functioning to alleviate bank erosion and further scouring. Nonetheless, the scouring is contributing to the downstream lee bar on the left bank. Both bed and channel modification at this site is localised. The riparian zone is partly intact, representative of the season, mostly covered with grasses, shrubs and trees (limited <i>Salix sp.</i>, further downstream and evidence of <i>Populus sp.</i> upstream.</p>			

The river comprises various sections of riffles and pools up and downstream of the bridge. All biotopes for the macroinvertebrates are present, SIC, SOOC, GSM, although vegetation is limiting owing to undercut banks and vegetation die-back. Localised algae covering the SIC biotope. For fish, there is SD, SS and FS habitats.

The land use is predominantly farmlands, with small croplands along terraces and widespread cattle grazing.

Site impacts:

- Abstraction
- Irrigation
- Cattle grazing



Preliminary Results

In situ water quality:

- pH: 8.6
- EC: 147 uS/cm
- TDS: 0.159 g/l
- DO: 12.2 mg/l
- DO%: 93.0%
- Clarity: >1m
- Temperature: 4.1°C
- Salinity: 0.12

Discharge: 0.763 m³/s

6.24 R_RU50: Bell

Sample Date	9 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR09_FV	Prioritised RU	N/A
River	Bell (DWS – Kraai)	Altitude (m.a.s.l.)	1723
Longitude	27.786557°	Latitude	-30.852601°
Level 1 EcoRegion	Eastern Escarpment Mountains	Quaternary catchment/ SQ Reach	D13B D13B-05474
Level 2 EcoRegion	15.06	DWS, 2014 PES, EI, ES	C, Moderate, High
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms, discharge			
			
Upstream		Downstream	
Site Description:			
<p>This reach of the river is called the Bell (although still named the Kraai according to PES, 2014), and which lies approximately 3km upstream from UO_EWR04_R (upper Kraai). This meandering river is still in a good condition with limited impacts and approximately 10m wide. There is an upstream bridge although it is built on solid boulders and bedrock on the right bank, with slight head cut erosion taking place on the left bank of the bridge. There is some scouring and bank erosion on both banks going downstream, the recent floods being a contributing factor coupled with on-going widespread cattle grazing and trampling. Gravel and cobble bars are common along the reach. The riparian zone is intact, mostly covered with grasses, shrubs (blackjacks) and trees (<i>Salix sp.</i>) along the reach.</p> <p>The river comprises various sections of riffles and pools up and downstream of the bridge. All biotopes for the macroinvertebrates are present, SIC, SOOC, GSM, although vegetation is limiting owing to undercut banks and vegetation die-back. Localised algae covering the SIC biotope. For fish, there is FD, SS and FS habitats.</p> <p>The land use is predominantly farmlands, with small croplands and widespread cattle grazing.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Abstraction • Irrigation • Cattle grazing 			



Preliminary Results

In situ water quality:

- pH: 8.6
- EC: 149 uS/cm
- TDS: 0.145 g/l
- DO: 11.15 mg/l
- DO%: 93.9%
- Clarity: >1m
- Temperature: 7.7°C
- Salinity: 0.11

Discharge: 0.736 m³/s



6.25 R_RU51: Groenspruit

Sample Date	11 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR10_FV	Prioritised RU	R_RU33
River	Groenspruit	Altitude (m.a.s.l.)	1333
Longitude	26.56130°	Latitude	-30.24119°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/SQ Reach	D24H D24H-04835
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	C, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms			
			
Upstream		Downstream	
Site Description:			
<p>The site is located off the N6 on the 1036/1981 bridge (main bridge), downstream of Smithfield. The Groenspruit is a tributary of the Skulpspruit, which is a tributary of the Caledon River within a partly confined floodplain setting. Several small farm dams upstream. A derelict bridge is located just upstream of the main bridge, whereby there is a bottleneck of vegetation debris build up and thus the river pools at this area. Downstream of the main bridge the channel narrows to approximately 1.5m wide, with head-cut erosion occurring along both banks downstream.</p> <p>The habitats available for macroinvertebrate include SIC, SOOC, GSM and no marginal vegetation owing to undercut banks and vegetation die back. Some algae smothering the SIC biotope. Fish habitats include SS, SD and FS. The riparian zone is dominated by grasses and shrubs, but limited trees.</p> <p>The land use is predominantly open lands, low intensity agriculture with some croplands and cattle grazing areas.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Agriculture • Cattle grazing and trampling • Bank erosion 			
Preliminary Results			
<i>In situ</i> water quality:			

- pH: 8.2
- EC: 445 uS/cm
- TDS: 0.419 g/l
- DO: 9.1 mg/l
- DO%: 78.7%
- Clarity: >1m
- Temperature: 8.8
- Salinity: 0.32

Discharge: not measured

6.26 R_RU33: Skulpspruit

Sample Date	11 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR11_FV	Prioritised RU	R_RU33
River	Skulpspruit	Altitude (m.a.s.l.)	1333
Longitude	26.51134°	Latitude	-30.23444°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D24H D24H-04686
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	C, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms			
			
Upstream		Downstream	
Site Description:			
<p>The site is situated off the R701 at a single high water bridge crossing. The Skulpspruit is a tributary of the upper Caledon with no in-stream farm dams upstream, although primarily low intense agricultural activities. The river is further located within a partly confined floodplain setting. The channel is ~10 m wide and relatively homogenous up and downstream of the bridge. Although there is a small diversion whereby the channel has several sections of riffles with SIC and SOOC biotopes for macroinvertebrates. The increased flow has allowed aquatic grass to establish in the deep runs. Marginal vegetation was limiting owing to undercut banks and vegetation die-back/erosion. The habitats available for fish comprise SD, SS, FD and FS. The riparian vegetation is relatively intact with grasses, shrubs, as well as trees (both indigenous – <i>Searsia lancea</i> (Karee) and some <i>Salix sp</i> and wattle).</p> <p>The land use is predominantly open lands, low intensity agriculture with some croplands and cattle grazing areas.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Agriculture • Cattle grazing and trampling • Bank erosion 			
Preliminary Results			
<i>In situ</i> water quality:			
<ul style="list-style-type: none"> • pH: 8.5 			

- EC: 545 uS/cm
- TDS: 0.517 g/l
- DO: 10.8 mg/l
- DO%: 92.0%
- Clarity: >1m
- Temperature: 8.5
- Salinity: 0.39

Discharge: Not measured

6.27 R_RU35: Elandskloof

Sample Date	12 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR12_FV	Prioritised RU	R_RU35
River	Elandskloof	Altitude (m.a.s.l.)	1419
Longitude	24.530701°	Latitude	-31.339047°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D32A D32A-06085
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	D, Low, Moderate
Geomorphological zone	E (Lower Foothills)		
<i>Site not sampled owing to access restriction due to locked farm gate</i>			

6.28 R_RU36: Klein-Seekoei

Sample Date	12 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR13_FV	Prioritised RU	R_RU36
River	Klein-Seekoei	Altitude (m.a.s.l.)	1396
Longitude	24.624178°	Latitude	-31.270242°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	D32C D32C-06210
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	B, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
<i>Site not sampled owing to access restriction due to locked farm gate</i>			

6.29 R_RU37: Middle Riet

Sample Date	12 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR14_FV	Prioritised RU	R_RU37
River	Middle Riet	Altitude (m.a.s.l.)	1163
Longitude	24.878248°	Latitude	-29.315541°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/SQ Reach	C51K C51K-03878
Level 2 EcoRegion	26.02	DWS, 2014 PES, EI, ES	D, Very High, Modeate
Geomorphological zone	F (Lowland)		
<i>Time restrictions, could not sample.</i>			

6.30 R_RU18: Fouriespruit

Sample Date	13 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR15_FV	Prioritised RU	R_RU18
River	Fouriespruit	Altitude (m.a.s.l.)	1357
Longitude	26.074393°	Latitude	-29.671211°
Level 1 EcoRegion	Nama Karoo	Quaternary catchment/ SQ Reach	C51A C51A-04269
Level 2 EcoRegion	26.03	DWS, 2014 PES, EI, ES	D, High, Moderate
Geomorphological zone	E (Lower Foothills)		
Components sampled: IHI, <i>in situ</i> water quality, diatoms			
			
Upstream		Downstream	
Site Description:			
<p>This site is located off the R717 off the N6. It is a tributary of the Upper Riet further upstream of site UO_EWR06_I. The reach valley setting is unconfined, with an incised macro channel. The site is bedrock controlled, with a braided/anastomosing low flow channel. The site is located downstream of a dam. Influences on the system includes a small cross-over bridge, construction rubble downstream of this bridge and an upstream small weir, resulting in inundation upstream and additional weirs further upstream. These impediments are altering the flow and resulting in bed modification. The riparian zone is relatively rocky and well vegetated with limited alien invasive plant species. The turbid channel is ~10m wide and braided downstream of the bridge owing to in-stream vegetated and rocky/gravel islands. The substrate at the site is dominated by bedrock, GSM, and the braids downstream have resulted in small streams running through the instream island with rocky habitat for macroinvertebrates and fish, as well as sections of SOOC.</p> <p>The primary land use is cattle farming, small agricultural activities.</p>			
Site impacts:			
<ul style="list-style-type: none"> • Cattle farming • Cultivation • Irrigation 			
Preliminary Results			
<i>In situ</i> water quality:			

- pH: 8.6
- EC: 481 uS/cm
- TDS: 0.452 g/l
- DO: 10.6 mg/l
- DO%: 91.3%
- Clarity: 48cm
- Temperature: 8.9
- Salinity:0.34

Discharge: Not measured

6.31 R_RU20: Klein Modder

Sample Date	14 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR16_FV	Prioritised RU	R_RU20
River	Klein Modder	Altitude (m.a.s.l.)	1355
Longitude	26.642199°	Latitude	-29.253220°
Level 1 EcoRegion	Highveld	Quaternary catchment/SQ Reach	C52B C52B-03854
Level 2 EcoRegion	11.03	DWS, 2014 PES, EI, ES	D, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
<i>Site not sampled due to almost raw sewage present in the river</i>			

6.32 R_RU39: Rietspruit, tributary of Modder River

Sample Date	14 July 2022	Reserve Level Assessment	Field verification
Site Name	UO_EWR17_FV	Prioritised RU	R_RU39
River	Rietspruit	Altitude (m.a.s.l.)	1298
Longitude	26.251125°	Latitude	-28.783479°
Level 1 EcoRegion	Highveld	Quaternary catchment/ SQ Reach	C52G C52G-03335
Level 2 EcoRegion	11.08	DWS, 2014 PES, EI, ES	B, Moderate, Moderate
Geomorphological zone	E (Lower Foothills)		
<i>Site not sampled due to time constraints</i>			

7. CAPACITY BUILDING

An important component of the river surveys was to share expert knowledge and river survey methodologies with members of the DWS (Table 4-1). The DWS teams were taken through the detail behind what is involved in intermediate, Rapid 3 and field verification river level approaches.

Discussions were had around the characteristics of each site, the associated reach features namely, erosion, available biotopes/habits for the biota, flow velocities, algae/eutrophication, surrounding land use practices, sediment loading, hydraulic features, impediments amongst others. Vital components around how sites are selected were discussed. It was reiterated that those selected sites were those that would provide the information regarding the variety of conditions in a river reach related to the available habitats. Considerations were further discussed namely, their location within the identified priority RU (stressed areas, hotspots), whether there were upstream gauging weirs with good quality hydrological data, coupled with characteristics of tributaries.



From an ecological perspective, the Level II ecoregions was considered, geomorphological zones, habitat diversity for aquatic organisms, marginal and riparian vegetation, all critical for ecosystem functioning. Furthermore, suitability of the sites for accurate hydraulic modelling, where the range of possible flows, especially low flows, was considered. Each specialist then further took the members through their individual components (i.e. *in situ* water quality, diatoms, fish, aquatic

macroinvertebrates, flow/discharge, cross-section and geomorphology) during the first week of the survey. These capacity building sessions included the associated methodologies for each component, identification processes for fish and aquatic macroinvertebrates, and exactly how the cross-sections were conducted, flows/discharge measured and features around the geomorphology.



Overall, the enthusiasm and willingness to learn and ask questions made for a positive learning experience for all involved.

8. APPENDICES

Appendix A: October 2021 Re-con survey and diatom sampling in the Upper Orange Catchment

Site	Co-ordinate		No. spec.	SPI	Category	Water quality	%incl. in SPI	BDI	%incl. in BDI	%PTV	% Deformed cells	Notes
Renoster	29.11632	26.328701	10	4.2	E	Bad	100	3.8	70	93.1	1.5	
Os-Spruit	28.93917	26.511411	33	12.8	C	Moderate	97	12	88	4.5	0.25	
Modder	28.89166	25.656445	22	12	C	Moderate	100	10.8	96	3.8	0	
Hondeblaf	30.205138	24.71803	21	4.6	E	Bad	95	3.9	86	71	0	
Seekoei	30.707689	24.832365	9	4.6	E	Bad	100	3.1	89	89.3	0.5	
Kromllenboog	30.066282	25.681056	34	9.1	C	Moderate	97	11.6	79	9.7	1	
Trib van Zyl	30.031203	25.786463	22	10.5	C	Moderate	100	11.2	91	4.8	0	
Slykspruit			28	14.9	B	Good	96	11.3	68	2.3	0	
Sterkspruit	30.517931	27.36912										No diatom cells present
Tele	30.448588	27.582337										No diatom cells present
Stormbergspruit	31.005419	26.342052	12	3	E	Bad	100	3.6	92	86.8	0.5	
Langkloofspruit	30.954126	27.606129	24	14.1	B	Good	100	14.3	96	9.5	2.75	
Wasbankspruit	31.15554	27.284442	30	12.4	C	Moderate	100	14.1	80	0.7	0.5	
Wonderboomspruit	31.074534	26.307893	27	15	B	Good	96	14.1	78	10.2	0.75	
Orange 1 at R726	30.398757	27.342987										High load of fine sediment, very few diatom cells present
Maghaleng	30.16412	27.398251										High load of fine sediment, very few diatom cells present

Site	Co-ordinate		No. spec.	SPI	Category	Water quality	%incl. in SPI	BDI	%incl. in BDI	%PTV	% Deformed cells	Notes
Ranstho	28.892533	27.722351										Very large sediment particles very few diatom cells present
Little Caledon	28.557815	28.405634	20	8.1	D	Poor	95	9.3	80	10.7	17	Large numbers of deformities across all genera, distinct changes in cell outline with some very extreme examples

Appendix B: Other sites visited in October 2021

Other sites visited:			
River	Place	Date	Comments
Caledon1	D22L	2021/10/01	In flood
Modder1	C52B	2021/10/01	In flood, select site for hydraulic cross-section
Kromspruit	-29.503; 26.593	2021/10/02	In flood
Riet	C51M	2021/10/03	High flows, select site for hydraulic cross-section
Orange4	D33K	2021/10/03	High flows (>90 cumecs), select site for hydraulics cross-section
Orange3	D33G	2021/10/03	High flows (>90 cumecs)
Hondeblaf	-30.204; 24.718	2021/10/04	Pools only
Orange between dams	D34E	2021/10/04	Select site for hydraulic cross-section
Caledon2	D24J	2021/10/04	Very high flows
Orange2	D14J	2021/10/06	Not visited, flows upstream at Aliwal-North >500 cumecs

