APPENDIX D: SPECIALIST REPORTS

Annexure A: Wetland Rehabilitation Extract

FJ JOUBERT EN SEUNS (PTY) LTD

Aquatic Ecosystem Assessment and Rehabilitation Plan Associated with Unauthorised Cultivation of Eighteen Fields in Schoemanskloof

In compliance with:

National Environmental Management Act Section 24G (Act 107 of 1998);
National Environmental Management Biodiversity Act, 2004, (Act 10, of 2004); and
Invasive Species Regulations (July 2016).

Draft 1.0
2nd October 2018

Houtbosloop on Montrose. [4th July 2018].

Prepared for:	Prepared by:
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Disclaimer

This report was based on the author's best scientific and professional knowledge and information available at the time of writing. Although Nepid Consultants has tried to ensure that all information contained within this report is accurate, Nepid does not warrant or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of the information presented in this report.

TERMS OF REFERENCE

… compilation of a riparian and wetland rehab report, including in-stream aquatic component…

The study and report would be focussed on the areas on J&S properties that have been cleared and planted and that have or did have aquatic ecosystems. Should areas in close proximity interface with the aquatic systems these must be included.

The report would form part of an environmental rectification application submitted in terms of Section 24G National Environmental Management Act (Act No. 107 of 1998), for unauthorised clearing of indigenous vegetation as well as infilling a wetland/watercourse.

The report should focus on aquatic ecosystems (wetlands and drainage lines) impacted by the activity.

The report should aim to:

- *to classify and delineate wetlands affected by agricultural development;*
- *assess the Ecological Importance and Sensitivity of wetlands;*
- *assess the Present Ecological State of wetlands;*
- *assess the risks (impacts) of the agricultural development on wetlands; and*
- *recommend a plan to rehabilitate wetlands impacted by the agricultural development.*
- *Include water quality status quo and a programme to monitor this in the future.*

[Email request from Steven Henwood, 2018-04-04].

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- Duncan McKenzi, EcoRex, Nelspruit
- Katedi Mantsho, Environmental Intern, FJ Joubert en Seuns
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- Nthbang Mokomane, Environmental Intern, FJ Joubert en Seuns

Requirements for Specialist Reports: Section 23 of GN R982 (App. 6) of the 2014 EIA Regulations promulgated in terms of National Environmental Management Act (No 107 of 1998):	**Reference**
a(i) the specialist who prepared the report	Section 1.4 Appendix A
a(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix A
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix B
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Chapter 1
(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 3.2
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Chapter 3
(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Sections 4.9 and 5.8
(g) an identification of any areas to be avoided, including buffers;	Section 8.1
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Appendix C Appendix I
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 3.10
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment	Chapter 6
(k) any mitigation measures for inclusion in the EMPr;	Chapter 7
(l) any conditions for inclusion in the environmental authorisation	n/a
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7.4
(n) a reasoned opinion- *(i) as to whether the proposed activity or portions thereof should be authorised; and*	n/a
(ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report	None
(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	n/a
(q) any other information requested by the competent authority	n/a

EXECUTIVE SUMMARY

Terms of Reference

The Terms of Reference for this report were to assess the ecological state aquatic ecosystems impacted by unauthorised clearing of natural vegetation on eighteen fields, and to develop a rehabilitation plan to form part of an environmental rectification application submitted in terms of Section 24 G of the National Environmental Management Act (Act No 107 of 1998).

Exclusions

The report focuses on unauthorised clearing of natural vegetation and does not address various other activities within the Study Area that could impact on aquatic ecosystems, such as water abstraction, water storage, water discharge, ablution facilities and waste disposal.

Methods

This report was based on a review of available data and field surveys conducted in May and July 2018. Data were collected on surface water quality, aquatic macroinvertebrates and fish from 13 aquatic sampling sites. Furthermore, data on riparian health and the composition and abundance of alien invasive plant species were collected from 45 Management Units.

Aquatic Ecosystem Classification

Unauthorised clearing of vegetation impacted on Hillslope Seepage Wetlands and Riparian Habitats along four types of river, namely: Mountain Stream (Junglespruit), Transitional Streams (Sterkspruit and Devils' Creek), Upper Foothill (Crocodile River and lower Houtbosloop), and Lower Foothill (Crocodile River).

Baseline

Flows during the 2017/2018 wet season were very low and classified as drought conditions. Samples of surface water and aquatic macroinvertebrate (SASS5) collected upstream and downstream of cleared fields showed no measurable impacts on surface water quality or the composition or abundance of aquatic macroinvertebrates at the time of the survey. By contrast, clearing of natural vegetation along the Sterkspruit and lower reaches of the Houtbosloop appears to have had a detrimental impact on the composition and abundance of fish, and has created ideal conditions for the proliferation of alien invasive plant species.

Impacts

The main impacts of the agricultural development investigated for this report on aquatic ecosystems were:

- *Impact of vegetation clearing on riparian and seepage wetland habitats*
- *Impact of agricultural drains on seepage wetlands*
- *Impact of access roads and unprotected stream crossings on surface water quality*
- *Impact of woody debris on stream flow*
- *Impact of stone pack and rubble of riparian habitats*
- *Impact of solid waste disposal on riparian habitats*

Rehabilitation Objectives

The proposed rehabilitation plan aims to restore key ecological functions of aquatic ecosystems impacted by unauthorised clearing of natural vegetation by rehabilitating 27.15 hectares of riparian habitat, 1.88 hectares of seepage wetland, and providing buffer zones totalling 63.38 hectares to protect watercourses.

Rehabilitation Actions

The proposed rehabilitation plan focusses on the restoration of riparian and wetland ecosystems within 45 Management Units (MUs), each with specific actions are required. Baseline photographs *were taken in each MU, including one fixed-point location intended for long-term monitoring of riparian vegetation. The main actions needed to implement the proposed rehabilitation plan are:*

- *demarcate MU outer boundaries, where necessary, by the end of 2018;*
- *eradicate High Priority alien plant species from MUs by 2023. These are*

Acacia mearnsii	*Black wattle*
Bambusa balcoa	*Common bamboo*
Casuarina equisetifolia	*Beefwood / Horsetail tree*
Eucalyptus sp.	*Gum*
Gleditsia triacanthos	*Honey locust*
Grevillea robusta	*Australian silver oak*
Melia azedarach	*Seringa*
Parthenium hysterophorus	*Famine weed*
Pinus sp.	*Pine*
Populus x canescens	*Grey poplar*

- *control Medium Priority alien plant species, and ignore Low Priority alien plant species;*
- *plant five species of fast-growing, indigenous trees in riparian zones in each MU to facilitate the recovery process. Tree species recommended for planting are:*
    - *Acacia robusta subsp. clavigera,*
    - *Trema orientalis,*
    - *Ficus sycomorus,*
    - *Combretum erythrophyllum, and*
    - *Syzygium cordatum.*

- *backfill agricultural drains in seepage wetlands within MUs to restore natural drainage patterns in these wetlands;*
- *remove unnecessary stream crossings and rehabilitate, or formalise culverts, where appropriate (and with the relevant Water Use Licence);*
- *divert stormwater into vegetation buffer zones, particularly at approaches to stream crossings;*
- *redirect all access roads from MUs;*
- *remove woody debris from river channels, as well as from riparian and wetland habitats*
- *remove stone packs and rubble from riparian and wetlands habitats and rehabilitate disturbed areas;*
- *remove solid wastes, including excess fencing, pipes, plastics tyres etc, from riparian and wetland habitats*
- *provide environmental awareness training for all staff and contractors*

Monitoring
Annual monitoring and reporting on compliance of the rehabilitation plan is recommended. Monitoring should focus on the composition and abundance of alien invasive plant species and the riparian health index within each Management Unit.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

EIA	Environmental Impact Assessment.
MTPA	Mpumalanga Tourism & Parks Agency.
MU	Management Unit.

GLOSSARY OF TERMS

Alien species
(a) a species that is not an indigenous species; or
(b) an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by natural means of migration or dispersal without human intervention.
[National Environmental Management Biodiversity Act (Act No 10 of 2004)].

Buffer
A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted to reduce the impact of adjacent land use on the wetland or riparian area.
[DWAF 2008].

Indigenous vegetation
vegetation consisting of indigenous plant species occurring naturally in an area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years.
[GNR 324 NEMA Listing Notice 3 of 2014].

Invasive species
Any species whose establishment and spread outside its natural distribution range-
(a) threaten ecosystems, habitats or other species or have demonstrable potential to threaten ecosystems, habitats or other species; and
(b) may result in economic or environmental harm or harm to human health
[National Environmental Management Biodiversity Act (Act No 10 of 2004)].

Rehabilitation
means the process of reinstating natural ecological driving forces within part or the whole of a degraded watercourse to recover former or desired ecosystem structure, function, biotic composition and associated ecosystem services.
[General Authorisation DWS Notice 509 of 2016].

Riparian habitat
includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.
[National Water Act (Act No. 36 of 1998)].

Watercourse
a) a river or spring;
b) a natural channel or depression in which water flows regularly or intermittently;
c) a wetland, lake or dam into which, or from which, water flows; and
d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse.
[National Water Act (Act No. 36 of 1998)].

Extent of a Watercourse	*(a) The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; and* *(b) Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan.* [General Authorisation DWS Notice 509 of 2016].
Wetland	*Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.* [National Water Act (Act No. 36 of 1998)].

1. INTRODUCTION

1.1 Background

Nepid Consultants CC was appointed by FJ Joubert en Seuns (Pty) Ltd to conduct a specialist assessment of aquatic ecosystems to form part on an environmental rectification application to be submitted in terms of Section 24G National Environmental Management Act (Act No. 107 of 1998). The application concerns unauthorised clearing of indigenous vegetation on eighteen fields in or near Schoemanskloof in 2016 and 2017. This report focusses on the rehabilitation of aquatic ecosystems impacted by unauthorised clearing for cultivation, particularly in relation to the impeding or diverting the flow of water in a watercourse (Water Use Section 21c), altering the bed, banks, course or characteristics of a watercourse (Water Use Section 21i), and control of alien invasive vegetation. The report provides baseline information on aquatic ecosystems associated with the unauthorised clearing, assesses the impacts on aquatic ecosystems, recommends a rehabilitation plan to restore key ecological functions, and suggests mitigation and monitoring measures, where appropriate. The report is based on a review of available ecological data and field surveys undertaken in May and July 2018.

1.2 Approach

The approach to this report was to provide a practical plan to restore key ecological functions of aquatic ecosystems impacted by unauthorised clearing of natural vegetation, but without jeopardising the wider socio-economic benefits associated with the agricultural development that has taken place. The plan therefore focusses on rehabilitation of areas that were not yet in production in 2018 and does not recommend removal of orchards that were already established and in production at the time.

1.3 Aims of This Report

The aims of this report are summarised as follows:

- **Baseline.** To assess the Present Ecological State; Ecological Importance and Sensitivity; and Ecological Functions and of aquatic ecosystems associated with unauthorised clearing of indigenous vegetation on eighteen fields;

- **Impacts**. Identify and assess the impacts and associated risks of unauthorised clearing of vegetation on aquatic ecosystems;

- **Rehabilitation.** Develop a practical plan to rehabilitate ecological functions of aquatic ecosystems impacted by unauthorised clearing; and

- **Monitoring.** Suggest a plan to monitor the implementation of the proposed mitigation measures.

1.4 Expertise of the Specialist

This report was prepared by Rob Palmer, PhD (Zoology). Rob has over 20 years' experience in aquatic systems and specialist knowledge of river regulation and river ecology. He has undertaken numerous environmental assessments throughout Africa, mostly concerning water resource developments and mining. He is a registered Environmental Assessment Practitioner (No 0080/06), a member of the SA Council for Natural Scientific Professions (No 400108/95), an accredited SASS5 biomonitoring practitioner. and he has attended the South African Green Industries Council (SAGIC) Invasive Species Training (Modules 1 to 4). His CV is included in Appendix A, and a Declaration of Independence is included in Appendix B.

1.5 Legislation

Legislation	Requirement
National Environmental Management Act (Act No 107 of 1998)	
GNR 983 Listing Notice 1 of 2014 4th Dec 2014	***Activity 12.*** *The development of -* *(i) canals exceeding 100 square metres in size;* *(ii) channels exceeding 100 square metres in size;* *(iii) bridges exceeding 100 square metres in size;* *(iv) dams, where the dam, including infrastructure and water surface area, exceeds 100 square metres in size;* *(v) weirs, where the weir, including infrastructure and water surface area, exceeds 100 square metres in size;* *(vi) bulk storm water outlet structures exceeding 100 square metres in size;* *(vii) marinas exceeding 100 square metres in size;* *(viii) jetties exceeding 100 square metres in size;* *(ix) slipways exceeding 100 square metres in size;* *(x) buildings exceeding 100 square metres in size;* *(xi) boardwalks exceeding 100 square metres in size; or* *(xii) infrastructure or structures with a physical footprint of 100 square metres or more;* *where such development occurs-* *(a) within a watercourse;* *(b) in front of a development setback; or* *(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse; -*
	Activity 19. *The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from-* *(i) a watercourse;* *(ii) the seashore; or* *(iii) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater* *but excluding where such infilling, depositing, dredging, excavation, removal or moving-* *(a) will occur behind a development setback;* *(b) is for maintenance purposes undertaken in accordance with a maintenance* *management plan; or* *(c) falls within the ambit of activity 21 in this Notice, in which case that activity applies.*
	Activity 27. *The clearance of an area of 1 hectare or more, but less than 20 hectares of indigenous vegetation, except where such clearance of indigenous vegetation is required for-* *(i) the undertaking of a linear activity; or* *(ii) maintenance purposes undertaken in accordance with a maintenance management plan.*
GNR 984 Listing Notice 2 of 2014 4th Dec 2014	***Activity 13.*** *The physical alteration of virgin soil to agriculture, or afforestation for the purposes of commercial tree, timber or wood production of 100 hectares or more.*
	Activity 15. *The clearance of an area of 20 hectares or more of indigenous vegetation, excluding where such clearance of indigenous vegetation is required for-* *(i) the undertaking of a linear activity; or*

Legislation	Requirement
	(ii) maintenance purposes undertaken in accordance with a maintenance management plan.
GNR 985 Listing Notice 3 of 2014 4th Dec 2014	***Activity 12****. The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan.* ***In Mpumalanga:*** *i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004;* *ii. Within critical biodiversity areas identified in bioregional plans;* *iii. Within the littoral active zone or 100 metres inland from high water mark of the sea or an estuarine functional zone, whichever distance is the greater, excluding where such removal will occur behind the development setback line on erven in urban areas; or* *iv. On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning or proclamation in terms of NEMPAA.*
National Environmental Management Biodiversity Act (Act No 10 of 2004)	
GNR 151 23rd February 2007, and as amended in GNR 1187 14th December 2007.	List of Critically Endangered, Endangered, Vulnerable, and Protected Species.
GNR 864 Alien invasive species lists 2016 29th July 2016	**Notice 3: National List of Invasive Species in terms of section 70(1)** **List No 1**: National List of Invasive Terrestrial and Freshwater Plant Species. **Notice 4: Prohibited Alien Species in terms of section 67(1)** **List No 1**: Prohibited Terrestrial and Freshwater Plant Species.
Legislation	**Requirement**
Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No 36 of 1947)	
GNR 13424 26 July 1992	*No person shall for reward or on the course of any industry, trade or business:* *Use or recommend the use of, any agricultural remedy or stock remedy for a purpose or in a manner other than that specified in the label on a container thereof or described on such a container;* *Use any agricultural remedy unless he is a pest control operator registered in terms of this Act or otherwise than in the presence and under the supervision of a pest control operator so registered.*
Conservation of Agricultural Resources Act (Act No. 43 of 1983	
Government Gazette No. 37885 Alien and Invasive Species Regulations in 2011	Declared weeds and alien invaders in South Africa, which are classified as follows; • Category 1 plants: are prohibited and must be controlled. • Category 2 plants: (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread.

Legislation	Requirement
	• Category 3 plants: (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading
GN R1048 7(3)(a) Wetland Protection from Cultivation	CARA specifies that no land user may cultivate of any vlei, marsh, or portion thereof on the farm unit (unless this was prior to 1 June 1984, date of commencement of the Regulations, or with written permission).
GN R1048 7(3)(a) Wetland Protection from Draining	CARA specifies that no land user may drain of any vlei, marsh, or portion thereof on the farm unit (unless this was prior to 1 June 1984, date of commencement of the Regulations, or with written permission).
GN R1048 7(3)(b) Buffer Zone size for Crops	Land users may not cultivate any land on the farm unit within the flood area of a watercourse or within 10 m horizontally outside the flood area of a watercourse (unless this was prior to 1 June 1984, date of commencement of the Regulations, or with written permission). The flood area is defined as the 1:10 year flood line by the Act.
GN R1048 7(2) Debris in Watercourses	Every land user shall remove vegetation / debris in a watercourse so that it will not cause an obstruction during a flood that could cause excessive soil loss as a result of erosion through the action of water.
National Water Act (Act No 36 of 1998)	
Chapter 4 Use of Water **Section 21**	*21. For the purposes of this Act, water use includes* *(a) taking water from a water resource;* *(b) storing water;* *(c) impeding or diverting the flow of water in a watercourse;* *(d) engaging in a stream flow reduction activity contemplated in section 36;* *(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);* *(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;* *(g) disposing of waste in a manner which may detrimentally impact on a water resource;* *(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;* *(i) altering the bed, banks, course or characteristics of a watercourse;* *(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and* (k) using water for recreational purposes.
Government Gazette No 1616 30th December 2016	Classes of water resources and resource quality objectives for the catchments of the Inkomati
GN 509 General Authorisation for Water Uses Water Use in terms of Section 21(c) or Section 21(i) 26th August 2016	**Exclusions to General Authorisation** *This Notice does not apply—* *(a) to the use of water in terms of section 21 (c) and/or (i) of the Act for the rehabilitation of a wetland as contemplated in General Authorisation 1198 published in Government Gazette 32805 dated 18 December 2009,* *(b) to the use of water in terms of section 21 (c) and/or (i) of the Act within the regulated area of a watercourse where the Risk Class is Medium or High as determined by the Risk Matrix (Appendix A). This Risk Matrix must be completed by a suitably qualified SACNASP professional member;* *(c) in instances where an application must be made for a water use license for the authorisation of any other water use as defined in section 21 of the Act that may be associated with a new activity;* *(d) where storage of water results from the impeding or diverting of flow and/or altering the bed, banks, course or characteristics of a watercourse; and* *(e) to any section 21 (c) and/or (i) water use associated with construction/installation or maintenance of any sewerage pipelines, pipelines*

Legislation	Requirement
	carrying hazardous materials and to raw water and wastewater treatment works. Where the water use falls within paragraph 3 (b)-(e) a water use license will be required.
	<u>Rehabilitation</u> *10. (1) Rehabilitation as contemplated in paragraph 6(1)(v) above must be conducted in terms of a rehabilitation plan and the implementation of the plan must be overseen by a suitably qualified SACNASP professional member.* *(2) Upon completion of the construction activities related to the water use -* *(a) a systematic rehabilitation programme must be undertaken to restore the watercourse to its condition prior to the commencement of the water use;* *(b) all disturbed areas must be re- vegetated with indigenous vegetation suitable to the area; and* *(c) active alien invasive plant control measures must be implemented to prevent invasion by exotic and alien vegetation within the disturbed area.* *(3) Following the completion of any works, and during any annual inspection to determine the need for maintenance at any impeding or diverting structure, the water user must ensure that all disturbed areas are* *(i) cleared of construction debris and other blockages;* *(ii) cleared of alien invasive vegetation;* *(iii) reshaped to free -draining and non erosive contours, and* *(iv) re- vegetated with indigenous and endemic vegetation suitable to the area.* *(4) Upon completion of any works, the water user must ensure that the hydrological functionality and integrity of the watercourse, including its bed, banks, riparian habitat and aquatic biota is equivalent to or exceeds that what existed before commencing with the works.*
	<u>Monitoring</u> *11. (1) The water user must ensure the establishment and implementation of monitoring programmes to measure the impacts on the resource quality to ensure water use remains within the parameters of paragraph 8(3)(m) to (o) and results are stored;* *(2) Upon the written request of the responsible authority the water user must -* *(a) ensure the establishment of any additional monitoring programmes; and* *(b) appoint a competent person to assess the water use measurements made in terms of this General Authorisation and submit the findings to the responsible authority for evaluation.* *(3) The water user shall monitor and determine present day values for water resource quality before commencement of water uses in terms of section 21(c) or (i) of the Act.* *(4) Upon completion of construction activities related to the water use, the water user must undertake an Environmental Audit annually for three years to ensure that the rehabilitation is stable, failing which, remedial action must be taken to rectify any impacts.* *(5) Rehabilitation structures must be inspected regularly for the accumulation of debris, blockages, instabilities and erosion with concomitant remedial and maintenance actions.* *(6) Copies of all designs, method statements, risk assessments as done according to the Risk Matrix, rehabilitation plans and any other reports required must be made available to the responsible authority when requested to do so.*

National Forest Act (Act No 84 of 1998)	
GNR 908 List of Protected Tree Species 21 November 2014	Schedule A.
Mpumalanga Nature Conservation Act (Act No 10 of 1998)	
Section 60	prohibits the "obstruction or drainage of waters", including "*cutting through, breaking down or otherwise damaging a wall, bank of barrier thereof*".
Section 67	prohibits the pollution of waters and penalties apply to any person who "dumps or deposits in, allows to be dumped or to be deposited in, or in any other manner allows to enter or percolate into water any substance or thing, whether solid, liquid or gaseous, that is or is likely to be or to become injurious to aquatic and associated biota".
Section 68	regulates aquatic weed species, listed in Schedule 10.
Section 69	regulates protected plants and specially protected plants.
Section 80	regulates invader plant species.

2. STUDY AREA

2.1 General

Details of the fields that were cleared and developed for cultivation by FJ Joubert en Seuns (Pty) Ltd without relevant authorisations are presented in Table 2-1. The fields run alongside the N4 highway and Crocodile River west of Nelspruit (Figure 2-1). The fields cover a combined area of 996.8 hectares (9.97 km^2), and span nine farms between Sterkspruit 296JT and Barclays Vale 288 JT (Table 2-1). For the purposes of this report the fields were numbered in order downstream, starting at Sterkspruit (Table 2-1). The Study Area for this report considered all aquatic ecosystems within 500 m of the cultivated fields, as required in terms of Government Notice 509 (26th August 2016). The Study Area for this report covered an area of 3,748 hectares (37.48 km^2) (Figure 2-1).

Table 2-1. Details of fields in Schoemanskloof that were cleared and developed for cultivation by FJ Joubert en Seuns (Pty) Ltd without relevant authorisations.

No	Field Name	Farm Name	Erf No	Size (ha)
1	Sterkspruit	Sterkspruit 296 JT Sterkstroom 118 JT	T0JT00000000029600001 T0JT00000000011800001	16.9
2	Deon	Sterkspruit 296 JT	T0JT00000000029600040	38.6
3	Hiennuman	Rietvly 295 JT	T0JT00000000029500001	20.8
4	Turnbull	Rietvly 295 JT	T0JT00000000029500008	28.0
5	Dubai 1	Rietvly 295 JT	T0JT00000000029500011	5.0
6	Dubai 2	Rietvly 295 JT	T0JT00000000029500011	3.5
7	Rohan	Rietvly 295 JT	T0JT00000000029500010	1.3
8	I Swart	Rietvly 295 JT	T0JT00000000029500010	30.8
9	Spilpunt	Rietvly 295 JT	T0JT00000000029500005	25.2
10	Shabeen	Rietvly 295 JT	T0JT00000000029500004 T0JT00000000029500010	38.7
11	Rietvlei	Rietvly 295 JT	T0JT00000000029500003 T0JT00000000029500005	121.0
12	Rietvlei Macs	Rietvly 295 JT	T0JT00000000029500006 T0JT00000000029900003 T0JT00000000029900004	99.9
13	Loxley	Mooiland 294 JT	T0JT00000000029400003	31.3
14	In Die Middel	Geluk 299 JT	T0JT00000000029900001	61.3
15	Mooiland	Mooiland 294 JT In-De-Middel 293 JT	T0JT00000000029400000 T0JT00000000029300001 T0JT00000000029300002	121.0
16	Koedoeshoek	Koedoeshoek 301 JT	T0JT00000000030100009	294.0
17	Montrose 1	Montrose 290 JT	T0JT00000000029000000	24.2
18	Montrose 2	Barclays Vale 288 JT	T0JT00000000028800000	35.3
			Total Area (ha)	**996.8**

2.2 Aquatic Sampling Sites

Water quality, aquatic macroinvertebrates and fish were sampled at thirteen sites within the Study Area (Table 2-2). The sites were selected in relation to the eighteen fields that had been cultivated, and existing ecological monitoring sites were used where feasible. Five sites comprised upstream control sites, and eight were downstream of the unauthorised developments and therefore potentially impacted (Table 2-2). Three sites were on the Sterkspruit (SP01 to SP03); four sites were on tributaries of the Crocodile River (TR01 to TR04), and six sites were on the Crocodile River (CR01 to CR06) (Figure 2-5). The distribution of aquatic sampling sites is shown in Figure 2-2.

Table 2-2. Details of Aquatic Sampling Sites.

Code	Alias	Type	River	Field	River Type	Elevation (m amsl)	Lat	Long
Sterkspruit								
SP01	X2STER-R539B	Control	Sterkspruit	Sterkspruit	Transitional Stream	1100	-25.415360	30.493920
SP02		Impact	Sterkspruit	Sterkspruit	Transitional Stream	1056	-25.402760	30.503900
SP03		Impact	Sterkspruit	Deon	Transitional Stream	969	-25.383200	30.525090
Tributaries								
TR01	X2JUNG-MOOIP	Control	Jungle	Sterkspruit	Mountain Stream	1086	-25.412470	30.497190
TR02		Control	Trib	Rietvlei Macs	Mountain Stream	922	-25.394220	30.573370
TR03		Impact	Devils Creek	Koedoeshoek	Transitional Stream	877	-25.403920	30.622530
TR04		Impact	Houtbosloop	Montrose	Upper Foothill	739	-25.433890	30.751040
Crocodile River								
CR01		Control	Crocodile	Deon	Upper Foothill	864	-25.381890	30.526000
CR02	X2CROC-RIETV	Impact	Crocodile	Splitpunt	Upper Foothill	928	-25.388140	30.565690
CR03		Impact	Crocodile	Koedoeshoek	Upper Foothill	877	-25.403270	30.624210
CR04		Impact	Crocodile	Koedoeshoek	Upper Foothill	870	-25.411959	30.638160
CR05		Control	Crocodile	Montrose 1	Lower Foothill	734	-25.437480	30.740240
CR06		Impact	Crocodile	Montrose 2	Lower Foothill	726	-25.426670	30.764420

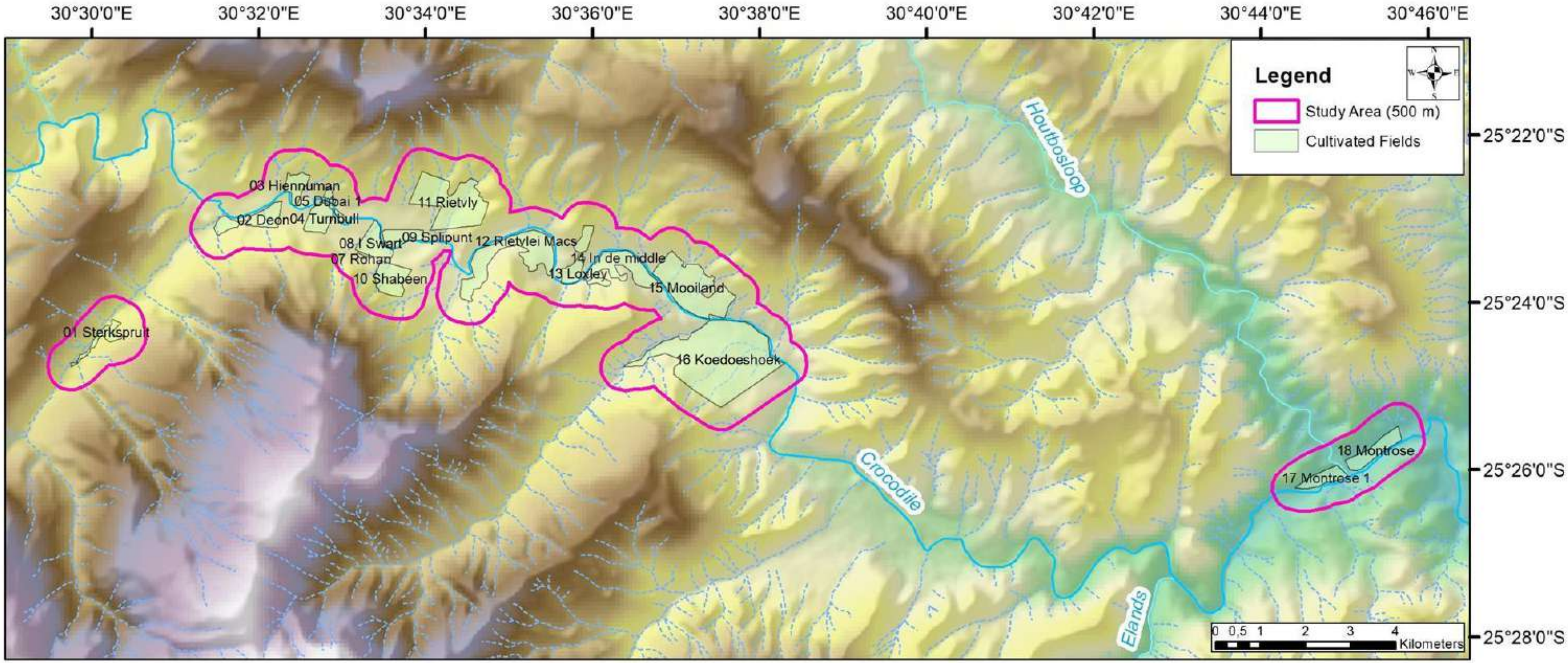


Figure 2-1. General Locality Map.

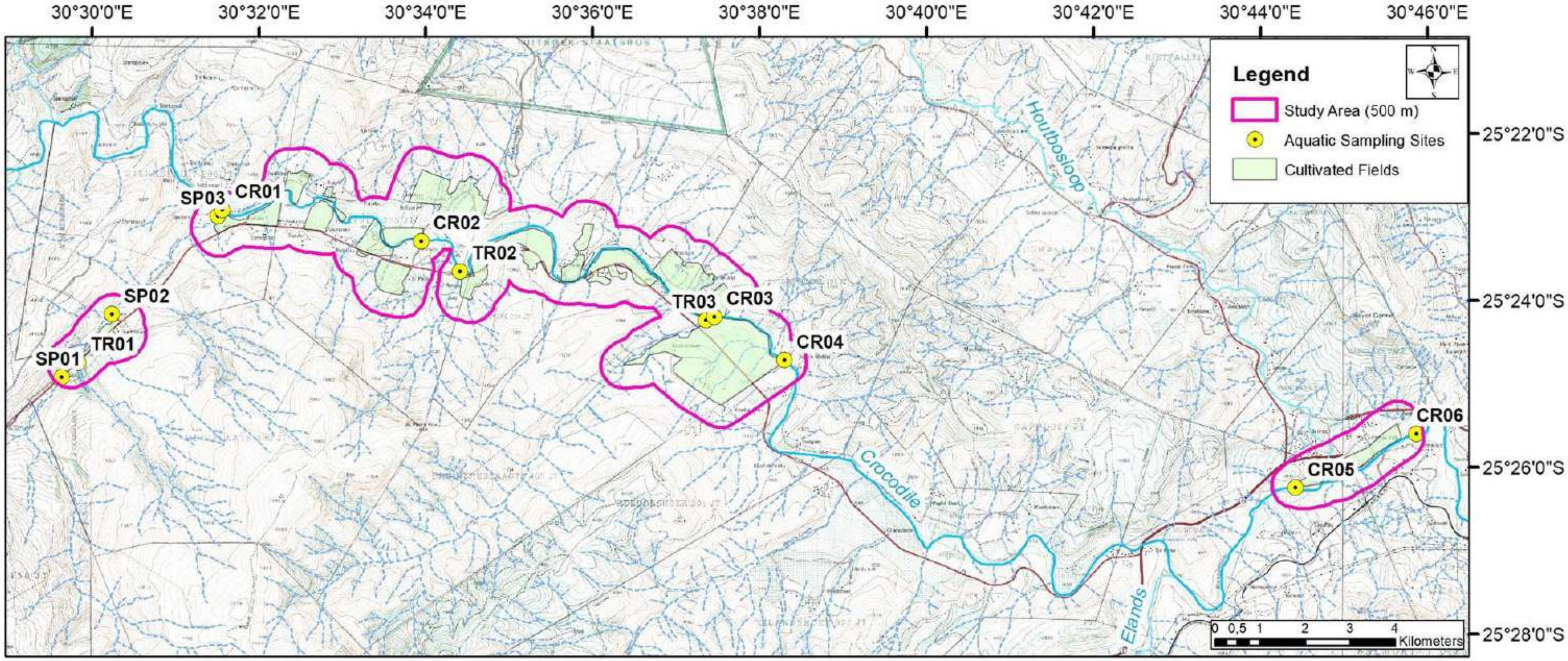


Figure 2-2. Topographical map. [Data extracted from 1: 50 000 scale maps 2530AD, BC & BD]

Sterkspruit

a) SP01 (upstream control) on the farm Sterkspruit. [2018-05-14].

b) SP02 (impact site) on the farm Sterkspruit. [2018-05-14].

c) SP03 (impact site) on the farm Deon. [2018-05-20].

Figure 2-3. Aquatic Sampling Sites – Sterkspruit (SP01 to SP03).

Tributaries

a) TR01. Jungle Stream (upstream control) on the farm Sterkspruit. [2018-05-20].

b) TR02. Un-named Mountain Stream (upstream control) on the farm Rietvlei Macs. [2018-05-20].

c) TR03. Devils Creek (impact site) on the farm Koedoeshoek. [2018-05-20].

d) TR04. Houtbosloop (impact site) on the farm Montrose. [2018-05-28].

Figure 2-4. Aquatic Sampling Sites – Tributaries (TR01 to TR04).

Crocodile River

a) CR01 (upstream control) on the farm Deon. [2018-05-16].

b) CR02 (impact site) on the farm Spilpunt. [2018-05-15].

c) CR03 (impact site) on the farm Koedoeshoek. [2018-05-14].

d) CR04 (impact site) on the farm Koedoeshoek. [2018-05-28].

e) CR05 (control site) on the farm Montrose 1. [2018-05-28].

f) CR06 (impact site), downstream of Montrose 2. [2018-05-28].

Figure 2-5. Aquatic Sampling Sites – Crocodile River (CR01 to CR06).

3. METHODS

3.1 Review

Important sources of information used in this report include the following:

- Aerial images from Chief Directorate of Surveys and Mapping (2015); Google Earth™ (various dates), and Digital Globe (various dates);
- Mpumalanga Biodiversity Sector Plan (MTPA 2013);
- National Freshwater Ecosystem Priority Areas (Nel *et al*. 2011);
- Present Ecological State, Ecological Importance and Ecological Sensitivity per sub Quaternary reaches in South Africa (DWS 2014);
- Fish distribution data sourced from personal records, the South African Institute for Aquatic Biodiversity (SAIAB), the Mpumalanga Tourism and Parks Agency (MTPA), and a study of the distribution and abundance of southern *Kneria* in the upper Crocodile River Catchment between 1984 and 1987 (Kleynhans 1988); and
- Various ecological studies of the Crocodile River, including:
  - assessment of the ecological impacts of a spill from a paper factory (Kleynhans *et al.* 1992);
  - specialist report on aquatic fauna associated with a proposed hydro-power station at Montrose Falls (Clean Stream 2009);
  - Ecostatus assessment conducted in 2012 (Roux and Selepe 2013);
  - water quality report (Hinsch 2014);
  - ecological impacts of anthropogenic activities on the Crocodile River (Soko 2014); and
  - specialist report on aquatic ecosystems associated with a proposed dam in Devil's Creek (Nepid 2017).

3.2 Field Surveys

Three field surveys were undertaken for this report as follows:

- autumn (14th -16th May 2018): instream assessment;
- autumn (21 & 28th May 2018); wetland and riparian delineation; and
- winter (3-5th July 2018): alien vegetation assessment.

3.3 Aquatic Ecosystems Classification

Aquatic ecosystems were classified according to hydrogeomorphic units, as described by Ollis *et al*. (2013).

3.4 Wetland and Riparian Delineation

Wetlands and riparian zones were delineated according to the method detailed by the Department of Water Affairs and Forestry (DWAF 2005). The method is based on a combination of plant species composition and soil features within 50 cm of the soil surface. A soil auger was used to locate the outer boundaries of the wetlands.

3.5 Flow

Daily average flow data for the Crocodile River at Montrose (X2H013), upstream of the confluence with the Elands River, were obtained from the South African Department of Water Affairs and Sanitation (www.dwa.gov.za/hydrology).

3.6 Present Ecological State

The Present Ecological State of aquatic ecosystems was assessed in terms of surface water quality, aquatic macroinvertebrates, fish, riparian health and extent of alien invasive vegetation.

3.6.1 Water Quality

Field measurements were made of basic water quality variables (conductivity, turbidity, pH, water temperature) at the thirteen aquatic monitoring sites. In addition, surface water samples were taken at these sites on 14th March 2018 and analysed by Labserve (Pty) Ltd for key variables including pH, conductivity, nutrients and major ions. The results were compared to Resource Quality Objectives specified for various reaches of the Inkomati Catchment (Government Gazette No 1616, 30th December 2016).

3.6.2 Aquatic Macroinvertebrates

Aquatic macroinvertebrates were sampled at the twelve of the thirteen aquatic monitoring sites using the standard SASS5 biomonitoring method (Dickens and Graham 2002). Aquatic macroinvertebrates were not sampled at Site TR02 because of inadequate suitability of instream habitats. The SASS5 results were classified into one of six Present Ecological State categories, ranging from *Natural* (Category A), to very *Critically Modified* (Category F). The limits for each category varied depending the Level I Ecoregion and the geomorphological zone, according to the method of Dallas (2007) (Figures 3-1 to 3-3).

Habitat Assessment

The quality of each instream habitat where macroinvertebrates were sampled was assessed in terms of the suitability for aquatic macroinvertebrates using a simple, five-point scale (0 = absent; 1=very poor; 5=highly suitable). Each habitat category was assigned weighted importance value that varied according to the geomorphological stream type. The weighted values were multiplied by the suitability rating (0-5), and the results were expressed as a percentage, where 100% = all habitats highly suitable. The percentage values were converted to a category (A to F), to allow easy comparison among sites or sampling events.

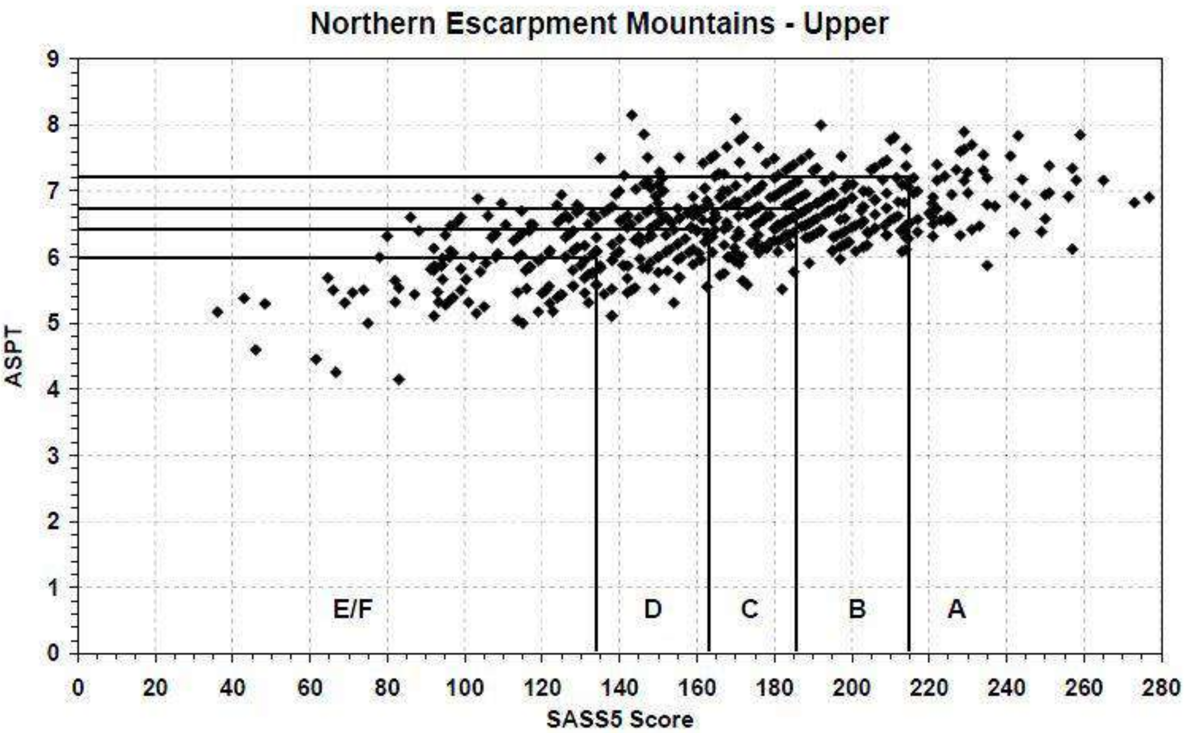


Figure 3-1. Guideline used to delineate the Present Ecological State Categories in terms of SASS5 biomonitoring results in the upper portion of the Northern Escarpment Mountains Ecoregion (Dallas 2007).

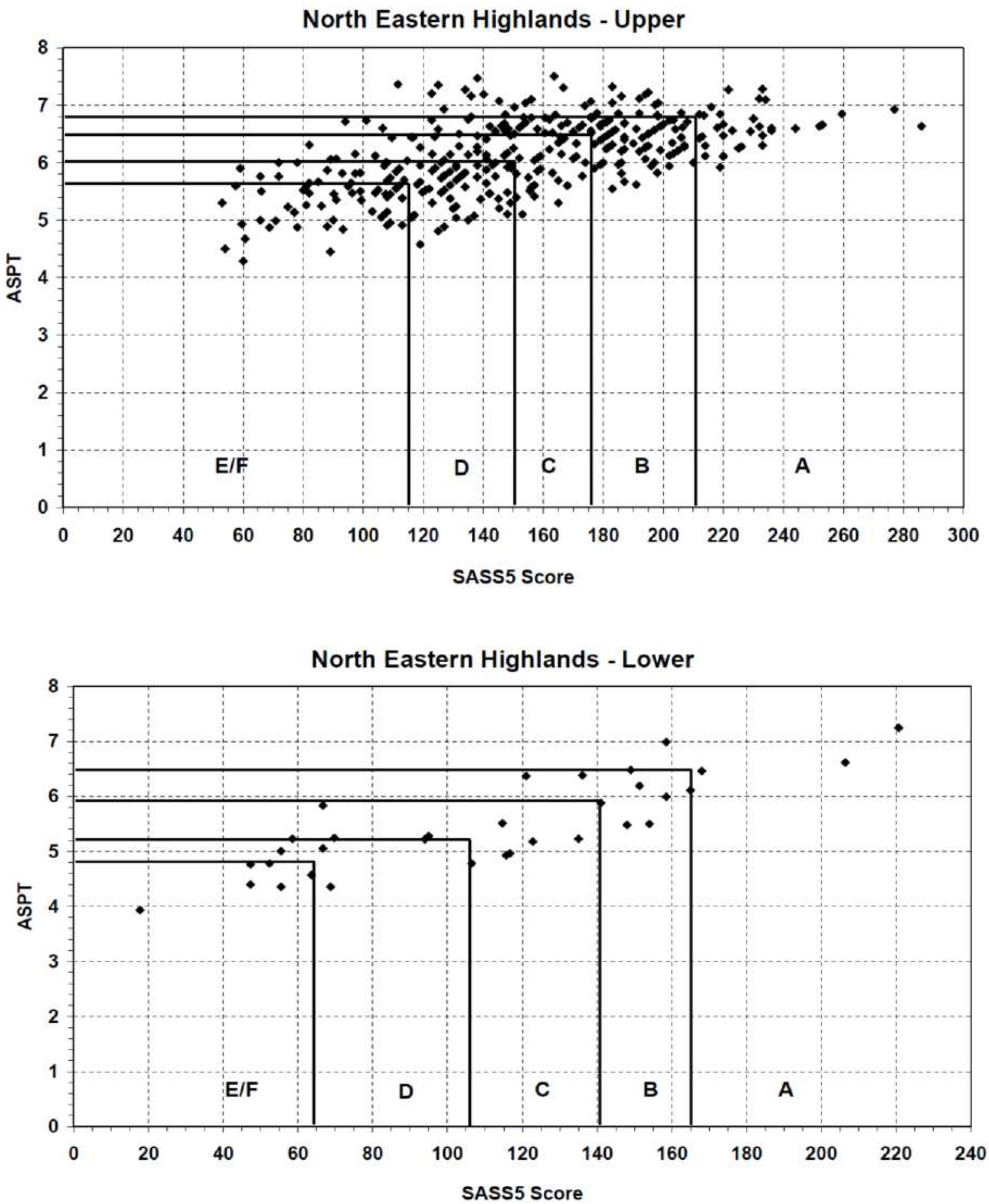


Figure 3-2. Guidelines used to delineate the Present Ecological State Categories in terms of SASS5 biomonitoring results in the upper and lower portions of the North Eastern Highlands Ecoregion (Dallas 2007).

3.6.3 Fish

Fish were sampled at the thirteen aquatic sampling sites using a battery operated portable electro-fisher (Samus 725M), with a fine-meshed net attached to a 30 cm anode ring. Sampling effort was about 30 minutes at each site. The Present Ecological category of fish at was assessed using the Fish Assemblage Integrity Index (Kleynhans 2003). The index classifies results into one of six Present State Categories, from Category A (*Natural*), to Category F (*Critically Modified*).

3.6.4 Riparian Health Index

The Present Ecological State of the riparian zone within each Management Unit was assessed using the Riparian Health Index (Ground Truth 2016). The method involves rating eight criteria on a numerical scale between 0 (*No Impact)* and 5 (*Critical Impact*). The scores are added and expressed as percentage change and classified into one of six categories, ranging from *Natural* (Category A), to *Critical* (Category F) (Table 3-1).

Table 3-1. Classification of Present Ecological State. [Ground Truth 2016.]

Category	Ecological Condition	Score	Percentage Change
A	*Natural.*	<5	<11
B	*Good*	5 – 11.5	11 – 29
C	*Fair*	12 – 19.5	30 – 49
D	*Poor*	20 – 27.5	50 – 69
E	*Very Poor*	28 – 35.5	70 – 89
F	*Critical*	>35.5	>89

3.6.5 Alien Invasive Vegetation

The abundance of declared alien invasive plant species within each Management Unit was assessed on a numerical scale between 0 (Absent) and 5 (100% cover).

3.7 Ecological and Functional Assessment

The Ecological and Functional Importance of aquatic ecosystems within the Study Area were assessed using a rapid method that considers: 1) Ecological Importance, 2) Hydro-functional Importance and 3) Direct Human Benefits (Rountree 2012). The method involved rating 25 parameters on a numerical scale between 0 (*Zero)* and 4 (*Very High*). The assessment was based on present conditions as observed during the field surveys in 2018.

3.8 Risk Assessment

Risks of the developments on aquatic ecosystems were assessed using the Department of Water Affairs and Sanitation Risk Assessment Matrix, dated September 2016. The method complies with General Authorisations for impeding or diverting the flow of water in a watercourse (National Water Act Section 21c), and/or altering the bed, banks, course or characteristics of a watercourse (National Water Act Section 21i) (DWA 2016).

3.9 Buffer Zones

Wetland and riparian buffer zones were based on assessment of various considerations including Present Ecological State, Ecological Importance and Sensitivity, potential risks, slope, vegetation cover, and soil permeability, *inter alia*, as detailed by Macfarlane *et al*. (2015).

3.10 Assumptions and Limitations

3.10.1 Exclusions

This report focuses on unauthorised clearing of natural vegetation and does not address various other activities within the Study Area that could impact on aquatic ecosystems, such as:

- water abstraction;
- water storage;
- water discharge;
- ablution facilities; and
- waste disposal.

The report does not address various aspects related to aquatic ecosystems, such as flood lines, hydrology, hydraulics, geomorphology, benthic diatoms, amphibians, reptiles and waterbirds. However, the level of detail collected and presented is considered appropriate for the purposes of this report.

3.10.2 Spatial Resolution

The wetland boundaries are considered accurate to about 15 m, as they were based on available Google Earth imagery and a standard, hand-held GPS. Higher resolution delineation would need more detailed assessment of soils, differential GPS and boundaries pegged in the field.

4. REGIONAL CONTEXT

4.1 Geology

The Study Area is underlain by four major geological formations:

- **Pretoria Formation**, comprising arenites, shales, siltstones, conglomerates and andesites;
- **Hekpoort Formation,** comprising basaltic andesites and other pyroclastic rocks;
- **Timeball Hill**, comprising porous sedimentary shales, quartzites and arenites; and
- **Nelspruit Granites**.

(Figure 4-1).

4.2 Erosion Risk

Erosion risk in most of the Study Area is low, except in the lower reaches at Montrose and Barclay Vale, where erosion risk is high (Figure 4-2).

4.3 Drainage

The Study Area is located alongside the Crocodile River and associated tributaries, including the Sterkspruit, Junglespruit, Devil's Creek and Houtbosloop. Most of the Study Area is within Quaternary Catchment X21E, except in the lower reaches at Montrose, which are located in Quaternary Catchment X22B (Figure 4-3).

4.4 Rainfall

Mean annual rainfall is moderate and ranges between and 813 to 897 mm (Figure 4-4). Most of the Study Area is located within a Strategic Water Source Area, which are defined as areas that contribute at least 50% of Mpumalanga's runoff in only 10.2% of surface area (www.bgis.sanbi.org). These areas are recognised as ecologically important.

4.5 Terrestrial Vegetation

Terrestrial vegetation within the Study Area comprises mostly Legogote Sour Bushveld (SVl 9), but there are a few peripheral areas of Northern Mistbelt Forest (FOz 4), and Barberton Serpentine Sourveld (SVl 13) (Figure 4-5).

4.6 Aquatic Ecoregions

The Study Area straddles two Level I aquatic ecoregions *sensu* Kleynhans *et al.* (2005):

- **North Escarpment Mountains.** This ecoregion is described as comprising closed hills and mountains with a well-defined escarpment and vegetation dominated by North-eastern Mountain Grassland and Sour Lowveld Bushveld towards the east; and

- **North Eastern Highlands.** This ecoregion is described as a hot and dry region characterised by plains with a low to moderate relief, and vegetation consisting mostly of Lowveld Bushveld types.

4.7 Critical Biodiversity Areas

The Mpumalanga Biodiversity Sector Plan Freshwater Assessment classifies most of the Study Area as *Important Ecological Support Area*, but two areas are classified as *Critical Biodiversity Areas*, namely:

- Houtbosloop at Montrose (MU 17d)
- Lower Crocodile River at Montrose (MU 17a-c; 18a, b)

(Figure 4-6).

4.8 Fish Support Areas

The Houtbosloop and Crocodile Rivers are classified as Fish Support Areas and Freshwater Ecosystem Priority Areas on account of the following conservation important fish species:

- Incomati suckermouth *Chiloglanis bifurcus* (*Critically Endangered*); and
- Natal Mountain Catfish *Amphilius natalensis* (*Data Deficient*)

(Nel *et al.* 2011).

4.9 Ecological Importance & Sensitivity

Ecological Importance and Sensitivity of main river reaches were rated by the Department of Water Affairs and Sanitation on a 5-point scale between *Very Low* (<1), and *Very High* (4-5) (DWAS 2014). Smaller tributaries, such as the Sterkspruit and Devil's Creek, were not assessed, but ratings assigned to the main river reaches in the Study Area were as follows:

Reach Code	Description	MU	**Importance**	**Sensitivity**
X21E-00943	Crocodile: Buffelskloofspruit to Elands	2b – 16o	**High**	**Very High**
X22B-00987	Crocodile: Elands to Houtbosloop	17a – 17c	**High**	**High**
X22B-00888	Crocodile: Houtbosloop to Visspruit	17d	**High**	**High**
X22A-00913	Lower Houtbosloop	18a & b	**High**	**Very High**

4.10 Present Ecological State

The Present Ecological States of main river reaches in the Study Area were rated based on desktop information by the Department of Water Affairs and Sanitation in 2012 (DWAS 2014) as follows:

Reach Code	Description	MU	**Present Ecological State**
X21E-00943	Crocodile: Buffelskloofspruit to Elands	2b – 16o	**C**
X22B-00987	Crocodile: Elands to Houtbosloop	17a – 17c	**C**
X22B-00888	Crocodile: Houtbosloop to Visspruit	17d	**C**
X22A-00913	Lower Houtbosloop	18a & b	**C**

A biomonitoring survey conducted in 2012, commissioned the Inkomati Catchment Management Agency (Roux and Selepe 2013), rated the Present Ecological State of the main river reaches in the Study Areas as follows:

Reach Code	**Present Ecological State**	**Key Issues**
X21E-00943	**C**	**River regulation (Kwena Dam)**
X22B-00987	**(B/C)**[1]	**-**
X22B-00888	**C**	**Cultivation, Siltation, Weirs and Alien Vegetation**
X22A-00913	**B/C**	**Siltation**

A subsequent biomonitoring survey of the Crocodile River Catchment was commissioned by the Inkomat Usuthu Catchment Management Agency and field surveys for this were conducted in July 2017, but the report was not available when this report was written (Frans Roux, pers. comm.).

[1] The assessment of Present Ecological State in this reach was extrapolated from "previous surveys and expert judgment" (Roux and Selepe 2013).

4.11 Land Use

Land use in the Study Area in 2018 comprised:

- undisturbed natural bushveld;
- cultivation (mostly citrus);
- homesteads and buildings;
- impoundments; and
- road network, including N4 highway, old highway, secondary roads and farm roads.

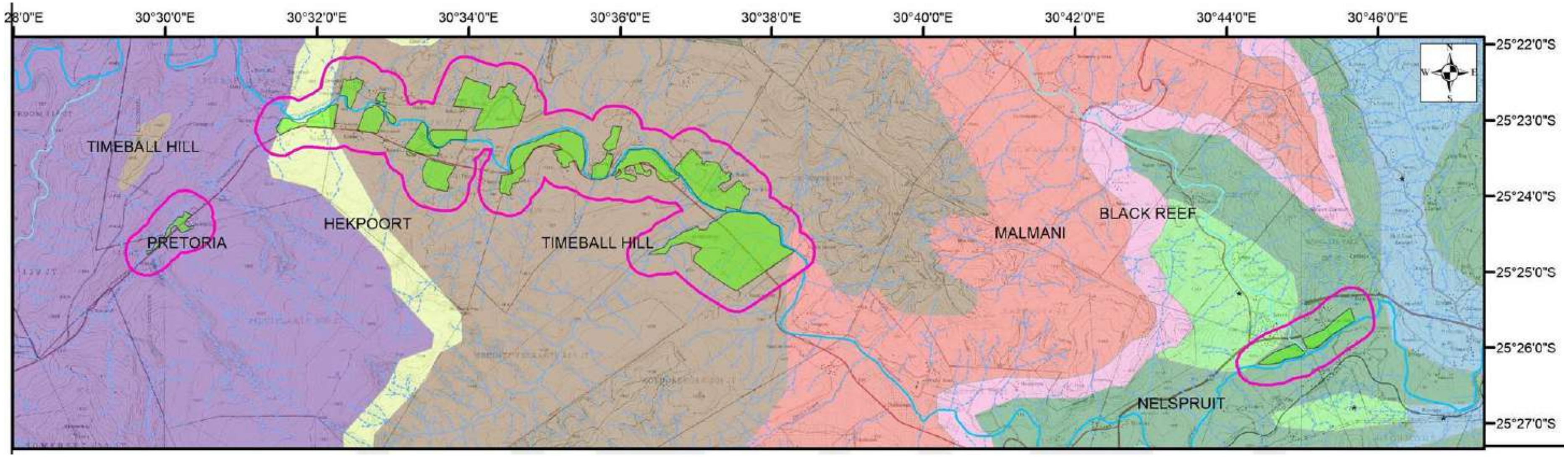


Figure 4-1. Geology.

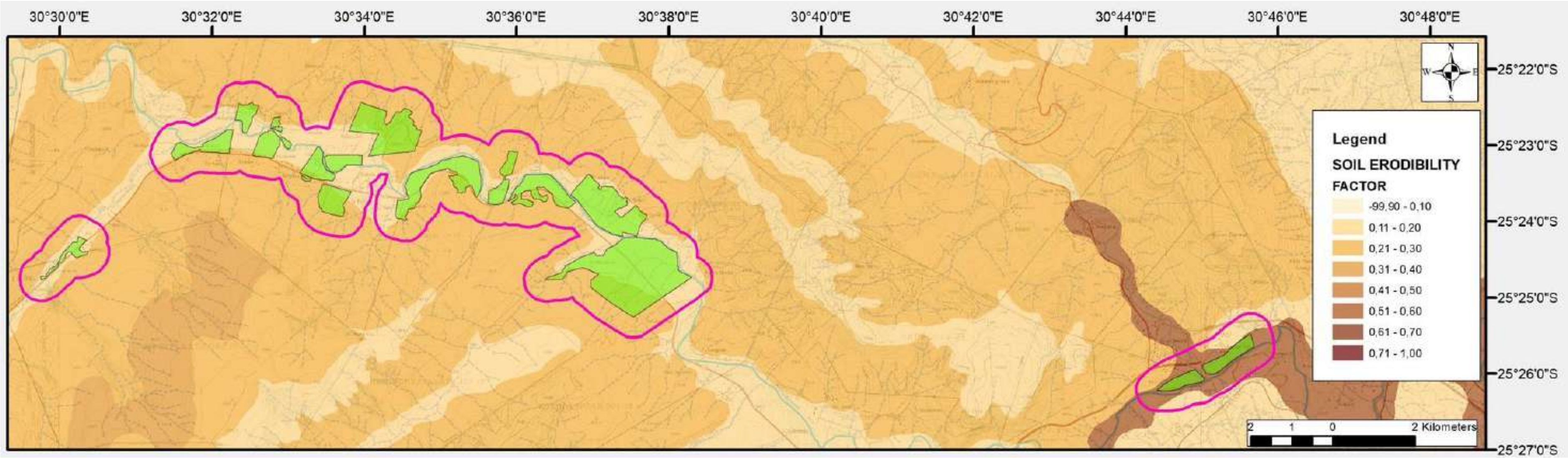


Figure 4-2. Soil erodibility (extracted from Schulze and Horan 2006).

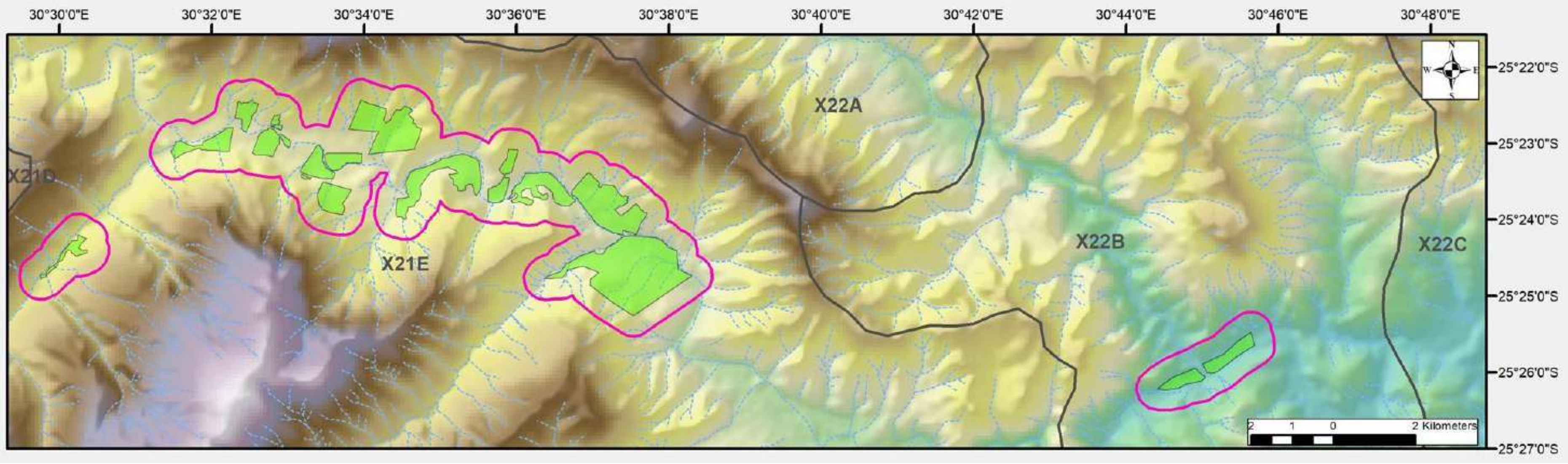


Figure 4-3. Quaternary Catchments.

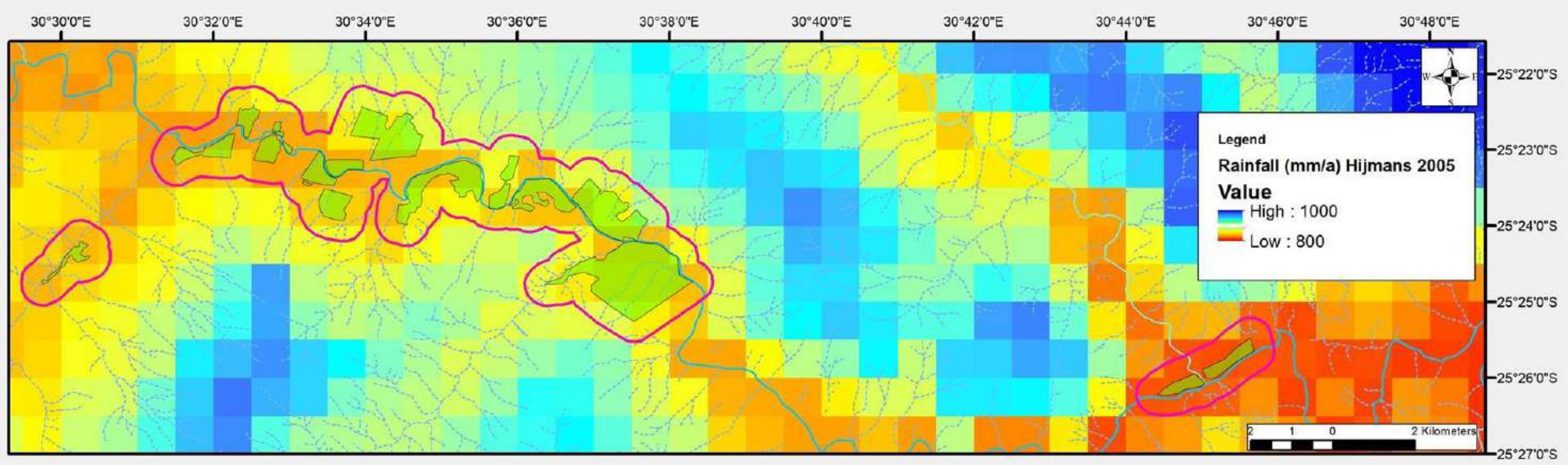


Figure 4-4. Rainfall (from Hijmans *et al*. 2005).

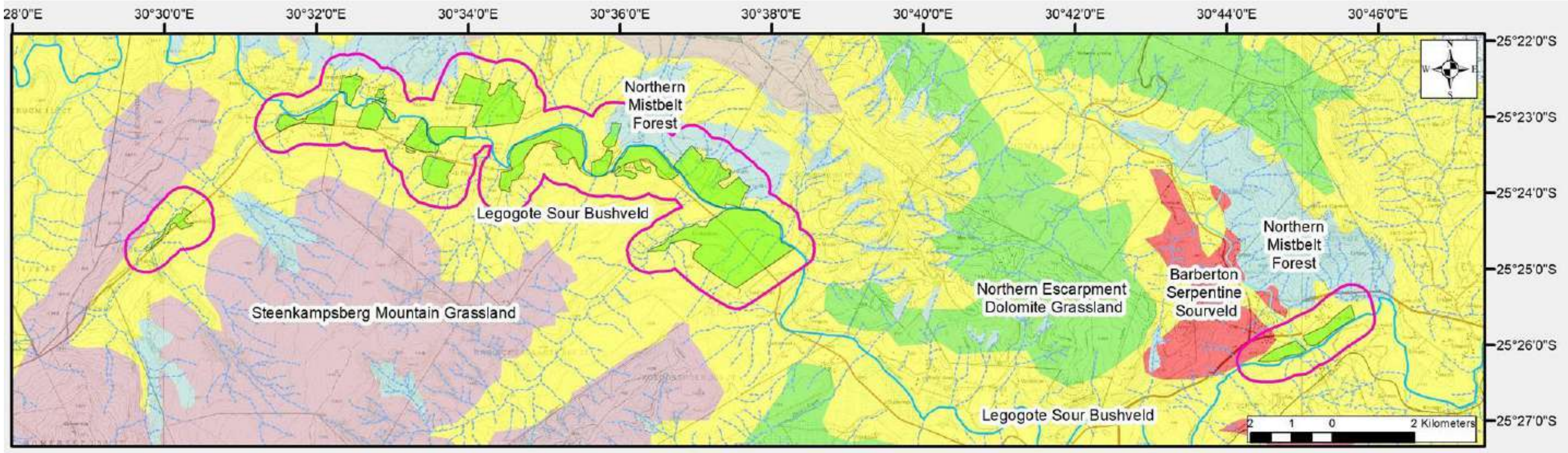


Figure 4-5. Terrestrial Vegetation (from Mucina and Rutherford, 2006).

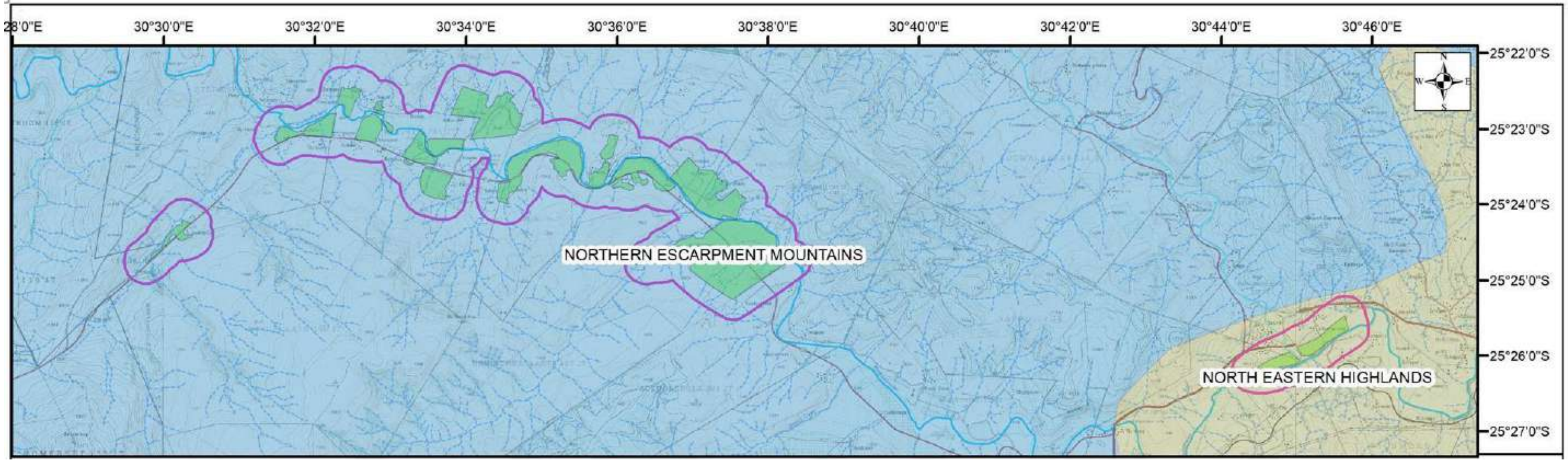


Figure 4-6. Aquatic Ecoregions (from Kleynhans *et al.* 2005).

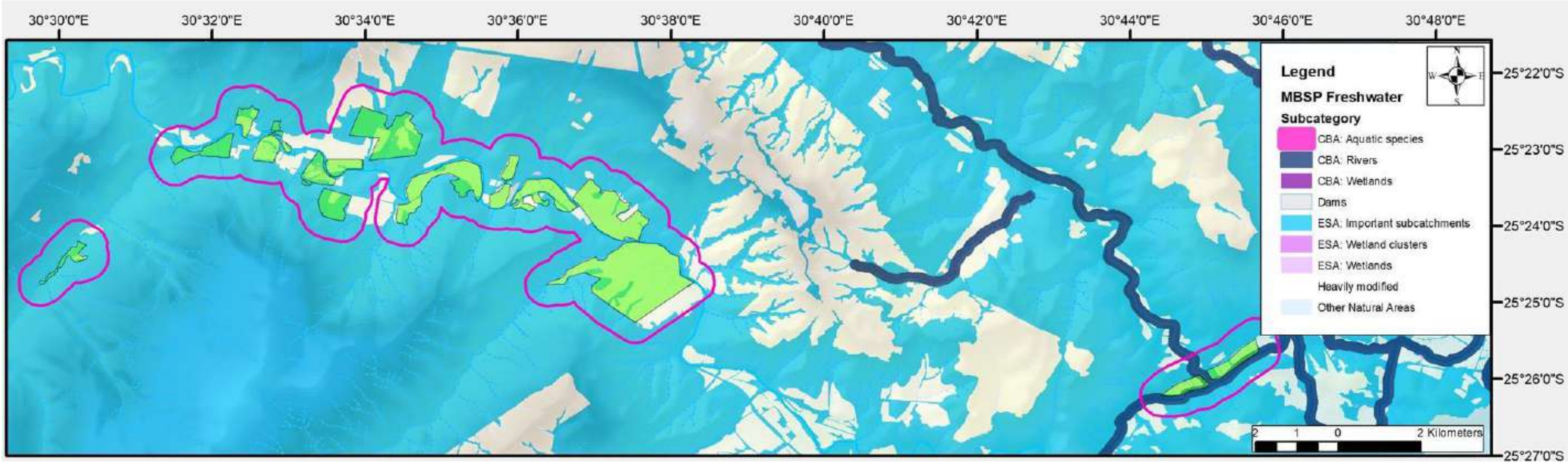


Figure 4-7. Freshwater Assessment (*sensu* MTPA 2011).

5. BASELINE ASSESSMENT

5.1 Aquatic Ecosystem Classification

Aquatic Ecosystems Impacted

Five natural hydro-geomorphic aquatic ecosystem types were impacted by the unauthorised clearing of natural vegetation on eighteen fields in the Study Area as follows:

- **Hillslope Seeps.** Hillslope Seepage Wetlands were impacted at several locations, notably on the farms Sterkspruit, Dubai 1 and I Swart. Many of the seepage wetlands have been drained and cultivated (Figure 5-1a).

- **Mountain Stream**. Clearing of natural vegetation on the farm Sterkspruit impacted the lower reaches of Junglespruit before its confluence with the Sterkspruit (Figure 5-1b).

- **Transitional.** Three stretches of stream classified as Transitional were impacted by clearing of vegetation as follows:
    - middle reaches of Sterkspruit on the farm Sterkspruit;
    - lower reaches of Sterkspruit on the farm Deon (Figure 5-1c); and
    - Devil's Creek downstream of Koedoeshoek Dam.

- **Upper Foothill**. Two stretches of river were classified as Upper Foothills as follows:
    - Crocodile River upstream of the farm Mooiland (Figure 5-1d); and
    - lower reaches of Houtbosloop.

- **Lower Foothill**. Two stretches of river were classified as Lower Foothills as follows:
    - Crocodile River between Mooiland and Koedoeshoek, upstream of Montrose Falls;
    - Crocodile River on the farms Montrose 1 and 2, downstream of Montrose Falls (Figure 5-1e).

Unauthorised clearing of natural vegetation also impacted on a number of Episodic Drainage Lines (Figure 5-1f). These were not assessed in detail for this report because they do not support aquatic biota and are not a priority for rehabilitation of ecosystem functions, although they are classified as watercourses in terms of the National Water Act.

a) Hillslope Seep on I Swart.

b) Mountain Stream: Junglespruit at TR01.

c) Transitional Stream: Sterkspruit on the farm Deon at SP03.

d) Upper Foothill: Crocodile River at CR01.

e) Lower Foothill: Crocodile River at CR06.

f) Episodic Drainage Line on Koedoeshoek.

Figure 5-1. Aquatic Ecosystems Impacted by Unauthorised Clearing of Natural Vegetation in Schoemanskloof. Photographed in May 2018.

Aquatic Ecosystems Not Impacted

Other aquatic ecosystem types identified within the Study Area, but not impacted directly by unauthorised clearing of natural vegetation and therefore not considered further for this report, comprised the following:

- **Valley-Bottom**. One Valley Bottom wetland covering an area of some 3.7 hectares was present in the Study Area on the farm Koedoeshoek (Figure 5-2a). This wetland is currently channelled, but is likely to have been naturally un-channelled;

- **Dams (in-channel).** The Study Area included a number of in-channel farm dams, notably Koedoeshoek Dam, two dams on the farm Rietvlei, and two dams on the farm Mooiland (Figure 5-2b);

- **Fish Farm Dams**. The Study Area included one fish farm on the left bank of the Crocodile River on the farm Mooiland, adjacent to MU 14a (Figure 5-2c); and

- **Canals.** Two irrigation canals that divert water from the Sterkspruit and Crocodile River on the farm Sterkspruit were identified within the Study Area (Figure 5-2d).

a) Valley Bottom Wetland on Koedoeshoek.

b) Farm Dam on Mooiland.

c) Fish Farm on the left bank of the Crocodile River, on the farm Mooiland.

d) Irrigation canal diverting water from the Sterkspruit on the farm Sterkspruit (MU 1e).

Figure 5-2. Aquatic Ecosystems Types within the Study Area not Impacted Directly by Unauthorised Clearing, Photographed in May 2018.

5.2 Aquatic Ecosystem Delineation

Unauthorised clearing of natural vegetation on the eighteen fields investigated for this report impacted directly on a total 66.54 hectares of riparian habitat, and 32.02 hectares of seepage wetland (Table 5-1). Details of the delineation of aquatic ecosystems are shown in Appendix C. Riparian habitats impacted the most were Upper and Lower Foothills of the Crocodile River, and Episodic Drainage Lines (Table 5-1). Other types of riparian ecosystem that were impacted were a short section of Mountain Stream (Junglespruit), and portions of a Transitional Stream (Sterkspruit and Devil's Creek). The field with the largest impact on riparian habitats was Koedoeshoek, where 30.96 hectares of riparian habitat was impacted (Table 5-1). The field with the largest impact on wetland habitat was I Swart, where 11.78 hectares of seepage wetland was drained and cultivated (Table 5-1). No aquatic ecosystems were impacted by vegetation clearing on Rohan, while clearing on Shabeen and Rietvlei impacted Episodic Drainage Lines but no other aquatic ecosystem types (Table 5-1).

Table 5-1. Aquatic ecosystem types impacted by vegetation clearing of eighteen fields.

No	Field	Drainage Line (m)	Mountain Stream (m)	Transitional (m)	Upper Foothill (m)	Lower Foothill (m)	Riparian (ha)	Drain (m)	Seep (ha)
1	Sterkspruit	98	80	1 480	-	-	2.98	340	2.85
2	Deon	325	-	376	1 180	-	4.00	1 105	0.91
3	Hiennuman	320	-	-	520	-	0.28	860	0.00
4	Turnbull	-	-	-	795	-	1.30	870	6.66
5	Dubai 1	310	-	-		-	0.26	78	1.12
6	Dubai 2	-	-	-	360	-	0.35	-	0.00
7	Rohan	-	-	-	-	-	0.00	-	0.00
8	I Swart	186	-	-	885	-	0.59	2 127	11.78
9	Spilpunt	-	-	-	660	-	0.00	1 000	0.79
10	Shabeen	570	-	-	-	-	0.00	-	0.00
11	Rietvlei	2 725	-	-	-	-	0.00	460	0.00
12	Rietvlei Macs	622	-	-	3 322	-	3.56	3 168	6.32
13	Loxley	-	-	-	370	-	0.00	-	0.00
14	In Die Middel	-	-	-	2 190	-	17.44	-	0.00
15	Mooiland	1 885	-	-	215	1 525	0.61	-	1.03
16	Koedoeshoek	3 310	-	2 355	-	1 825	30.96	2 863	0.00
17	Montrose 1	-	-	-	420	1 385	3.27	-	0.00
18	Montrose 2	-	-	-		1 265	0.94	-	0.56
	Total	**10 351**	**80**	**4 211**	**10 917**	**6 000**	**66.54**	**12 871**	**32.02**

5.3 Flows

Flows during the field surveys for this report were low and ideal for biomonitoring at all sites surveyed. Daily average flow data recorded in the Crocodile River at Montrose show that flows during the 2017/2018 wet season were low and declined steadily as the season progressed, and no significant high flow events were recorded for the season (Figure 5-3). Flows during and prior to the field surveys for this report were below the 20th percentile of historical data at Montrose before the completion of Kwena Dam, between 1959 and 1983 (i.e. 24 years). Flows in the Crocodile River during the 2017/2018 season are therefore classified as drought flows (Figure 5-3).

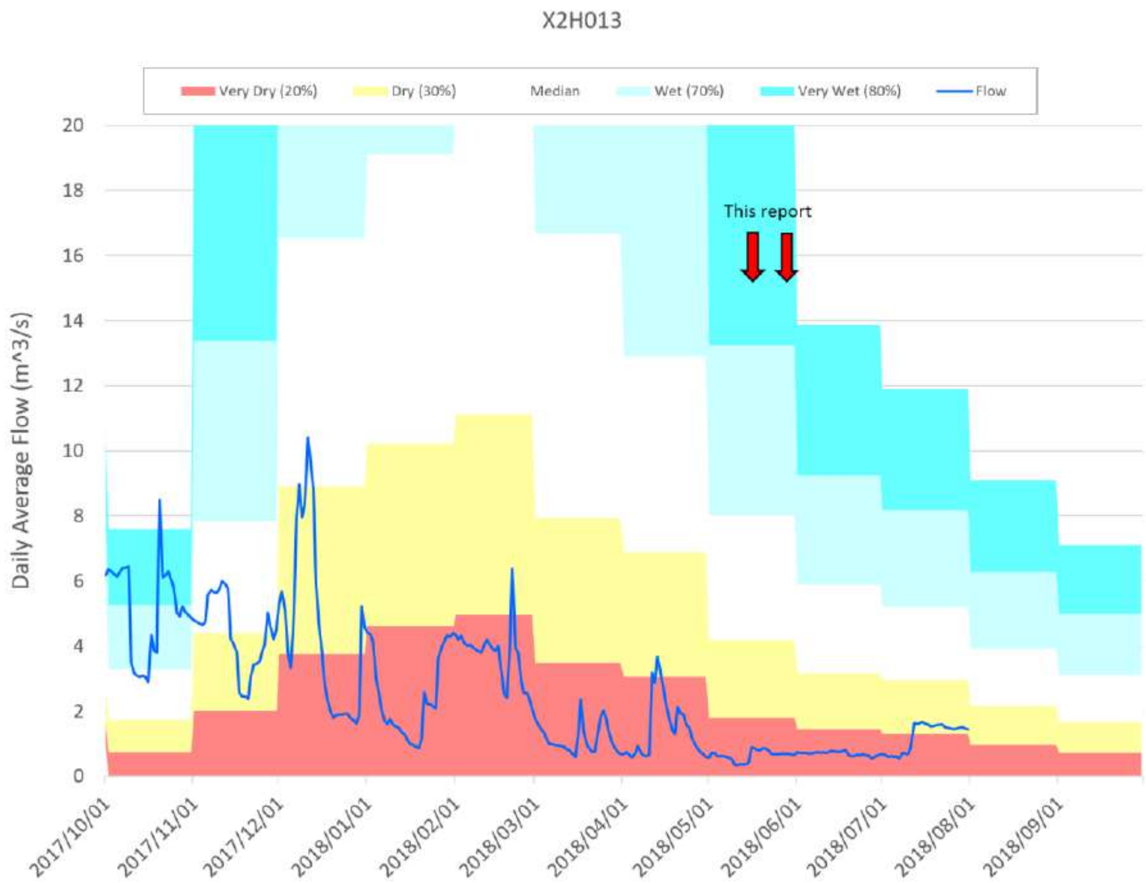


Figure 5-3. Daily average flow in the Crocodile River at Montrose (X2H013), starting in October 2017. Shading indicates daily average flow percentiles between 1959 and 1983 (24 years), before the completion of Kwena Dam. Red arrow indicates timing of the biomonitoring surveys for this report.

5.4 Water Quality

This section summaries the results of water quality samples taken at the thirteen sampling sites in May 2018. Detailed results are presented in Appendix D1.

a) *Conductivity*

Conductivities at all sites surveyed were low and well within the Resource Quality Objectives (Figure 5-4). Conductivities in the Sterkspruit and other tributaries of the Crocodile River ranged between 5 mS/m in the lower reaches of Devil's Creek (TR03), to 13 mS/m in the lower reaches of Houtbosloop (TR04) (Figure 5-4). Conductivities in the Crocodile River upstream of the confluence with the Elands River declined steadily with distance downstream, from 17 mS/m at CR01 to 12 mS/m at CR04 (Figure 5-4). The decline is attributed to the contributions of low conductivity water from tributaries. The results show that agricultural developments along the Sterkspruit and middle reaches of the Crocodile River did not impact negatively on salt concentrations in the two rivers. This conclusion was also supported by *ad hoc* sampling of conductivity in agricultural drains in the Study Area, which showed that salt concentrations in agricultural drains were no different to those found in tributaries. Conductivities in the Crocodile River at Montrose 1 (CR05), downstream of the Elands River confluence, increased significantly (31 mS/m) compared to upstream (12 mS/m). The increase is attributed to the inflow of poor-quality water from the Elands River. Conductivity dropped slightly to 27 mS/m at CR06, and this decline is attributed to the contribution of low conductivity water from the Houtbosloop, which joins the Crocodile River between CR05 and CR06.

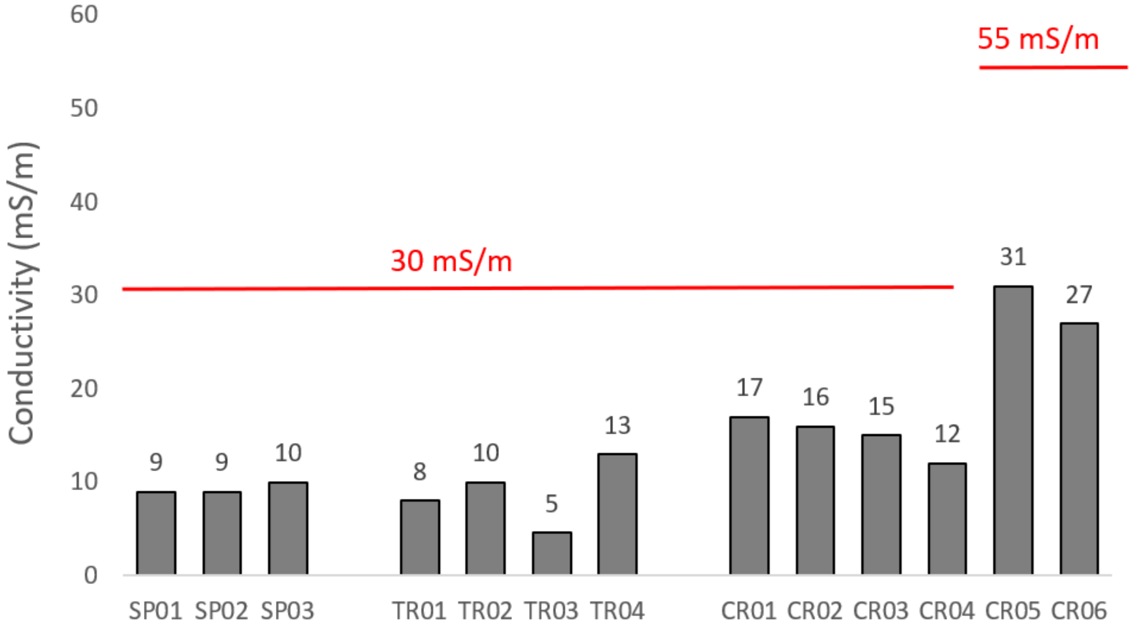


Figure 5-4. Conductivity (mS/m) recorded in the Study Area in May 2018. Resource Quality Objectives are shown in red.

b) *Turbidity*

Turbidity at all sites surveyed for this report in May 2018 were low to very low (≤8NTU), and this reflected the low (drought) flows at the time of the survey.

c) Phosphate

Concentrations of phosphate in May 2018 were generally low and well within the Resource Quality Objectives, except for the upper Sterkspruit (SP01 and SP02), and Junglespruit (TR01), where Resource Quality Objectives were exceeded (Figure 5-5). The reason for elevated concentrations of phosphate at these sites is unknown for certain, but most likely associated with low (drought) flows and decomposition of leaf litter from closed-canopy riparian forests. The results show that unauthorised clearing of natural vegetation at the eighteen fields investigated for this report did not impact negatively on phosphate concentrations in receiving watercourses at the time of the survey.

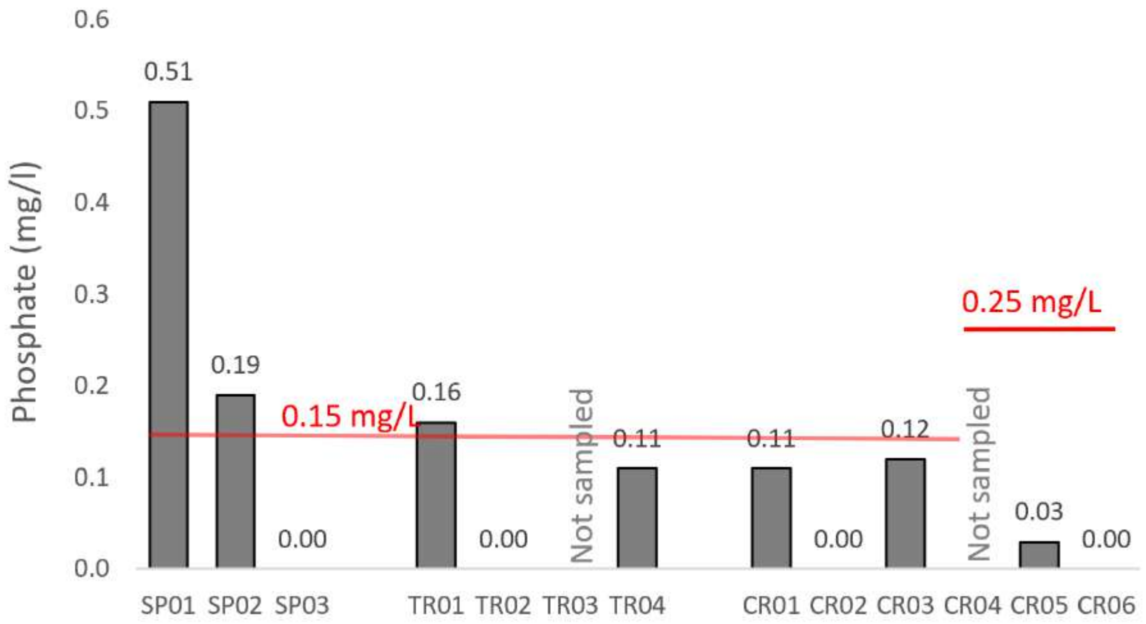


Figure 5-5. Phosphate (mg/ℓ) concentrations recorded in the Study Area in May 2018. Resource Quality Objectives are shown in red.

d) Nitrogen

Concentrations of nitrogen (nitrate and nitrite) in May 2018 were generally at or below the Resource Quality Objectives, except for the upper Sterkspruit (SP01), Junglespruit (TR01), and Crocodile River upstream of Montrose 1 (CR05), where Resource Quality Objectives were exceeded (Figure 5-6). The reason for elevated concentrations of nitrogen at these sites is unknown for certain, but most likely associated with low flows and decomposition of leaf litter from closed-canopy riparian forests. The results show that unauthorised clearing of natural vegetation on the eighteen fields investigated for this report did not impact negatively on nitrogen concentrations in receiving watercourses at the time of the survey.

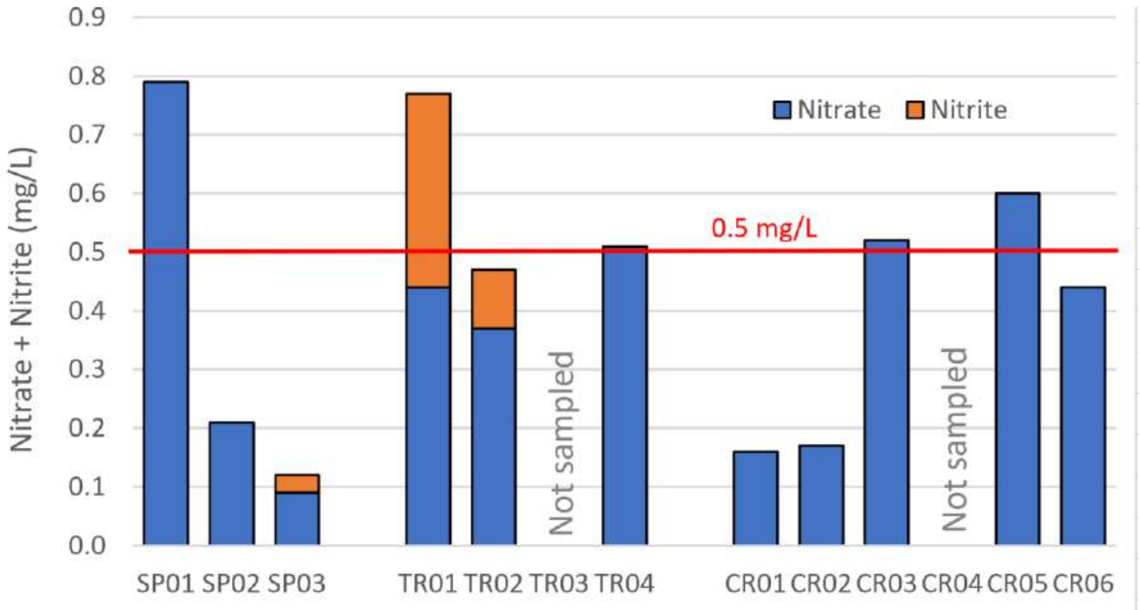


Figure 5-6. Nitrate + nitrate (mg/ℓ) concentrations recorded in the Study Area in May 2018.

e) Ionic Composition

Diagrams that show the relative contributions of major ions are presented in Appendix D2. Ionic composition at most sites was dominated by total alkalinity (TAL) and to a less extent magnesium, and this reflects unimpacted, good quality water at the time of the survey. However, ionic composition in the Crocodile River at Montrose (CR05 and CR06) was significantly different to the other sites analysed, and characterised by elevated concentrations of sodium and sulphate, and this is attributed to the influence poor quality water from the Elands River. The results show that unauthorised clearing of natural vegetation on the eighteen fields investigated for this report did not impact negatively on ionic composition of receiving watercourses at the time of the survey.

f) Benthic Algae

Benthic algae were not noticeably present at aquatic sampling sites in May 2018, except for the Crocodile River at Montrose (CR05 and CR06), where the filamentous alga *Cladophora glomerata* was present in low abundance estimated at 5% cover in riffle and rapid habitats at CR05 and CR06 (Figure 5-7). The presence of this alga is attributed to the influence of poor-quality water from the Elands River. The results show that unauthorised clearing of natural vegetation on the eighteen fields investigated for this report did not influence the abundance of benthic algae in receiving watercourses at the time of the survey.

a) Benthic alga *Cladophora glomerata* recorded on rocks in the Crocodile River at Montrose 1. [CR05, 2018-05-28].

b) Cladophora glomerata.

Figure 5-7. Benthic Algae.

5.5 Aquatic Macroinvertebrates

a) Present Ecological State

The Present Ecological State of aquatic macroinvertebrates in the Study Area in May 2018 ranged between *Largely Modified* (Category D), and borderline *Largely Natural to Unmodified* (Category A/B) (Figure 5-8). Detailed data on aquatic macroinvertebrates on are presented in Appendix E. The results show that unauthorised clearing of natural vegetation on the eighteen fields investigated for this report had no measurable negative impacts on the composition of aquatic macroinvertebrates at the time of the survey.

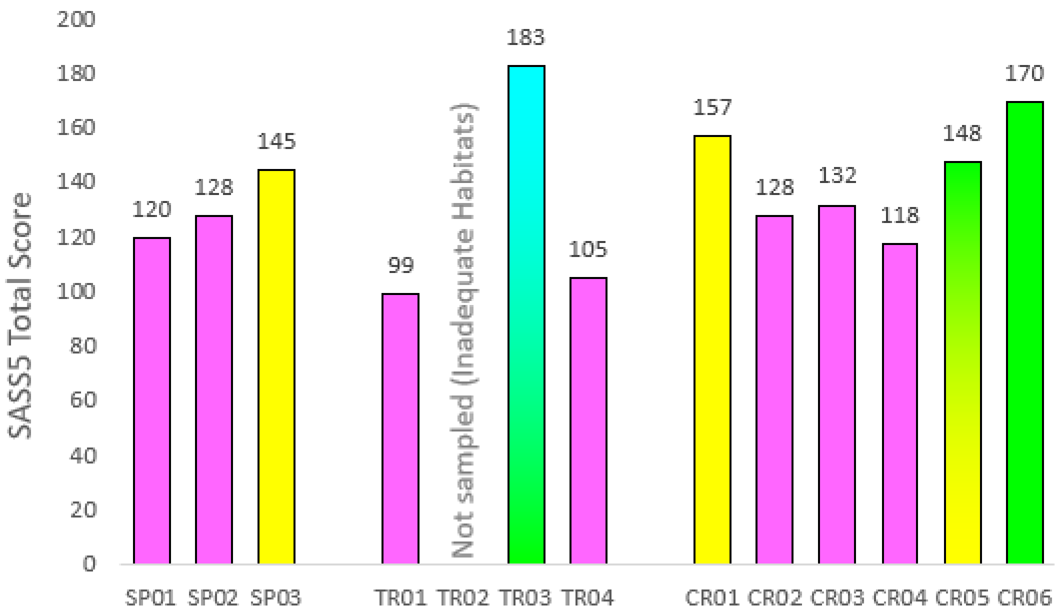


Figure 5-8. Present Ecological State of Aquatic Macroinvertebrates in May 2018.

Colour Codes:

Category	Description
A	***Unmodified***, or approximate natural conditions closely.
B	***Largely natural*** with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modification.
C	***Moderately Modified.*** A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at the lower limit of this class.
D	***Largely Modified***. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderately intolerant species. Impairment of health may become more evident at the lower limit of this class.
E	***Seriously Modified***. A strikingly lower than expected species richness and general absence of intolerant and moderately intolerant species. Impairment of health may become very evident.
F	***Critically Modified***. An extremely lowered species richness and absence of intolerant and moderately intolerant species. Only tolerant species may be present with a complete loss of species at the lower limit of the class. Impairment of health generally very evident.

b) Sensitive Taxa[2]

A total of 22 sensitive macroinvertebrate taxa were recorded within the Study Area in May 2018 (Table 5-2). The lowest number of sensitive taxa was five, which was recorded in the Sterkspruit at SP02 (Table 5-2). The highest number of sensitive taxa was 12, which was recorded in the lower reaches of Devil's Creek at TR03 (Table 5-2). The results show that unauthorised clearing of natural vegetation on the eighteen fields investigated for this report had no measurable negative impacts on the composition or abundance of sensitive aquatic macroinvertebrates at the time of the survey.

Table 5-2. Sensitive macroinvertebrate taxa recorded at the biomonitoring sites in May 2018, arranged in order of decreasing sensitivity.

			Sterkspruit			Tributaries			Crocodile River					
		Site	SP01	SPO2	SPO3	TR01	TR03	TR04	CR01	CR02	CR03	CR04	CR05	CR06
	Sensitive Taxa (QV > 7)	QV												
1	Oligoneuridae	15	-	-	-	-	-	-	-	A	A	-	-	1
2	Amphipoda	13	-	-	A	-	-	-	-	-	-	-	-	-
3	Heptageniidae	13	-	-	-	-	A	B	B	A	-	B	A	B
4	Perlidae	12	-	-	-	-	A	-	-	-	-	-	-	A
5	Baetidae >2 sp	12	-	-	B	B	B	B	B	B	C	B	B	B
6	Hydropsychidae (>2 sp)	12	-	-	B	-	-	-	-	-	-	-	-	-
7	Scirtidae	12	A	-	-	A	1	-	-	-	-	-	-	-
8	Polymitarcyidae	10	-	-	-	-	-	-	A	-	-	-	-	-
9	Calopterygidae	10	-	-	-	-	-	-	-	-	-	-	1	
10	Chlorocyphidae	10	-	1	A	1	A	1	A	-	1	1	1	-
11	Philopotamidae	10	-	-	-	-	-	1	-	-	-	-	1	1
12	Psephenidae	10	A	1	-	-	1	-	1	A	A	-	A	-
13	Athericidae	10	1	A	B	A	1	-	-	-	B	A	1	1
14	Dixidae	10	-	-	-	-	1	-	-	-	-	-	-	-
15	Lepophlebiidae	9	A	A	1	B	1	-	A	A	B	1	A	A
16	Tricorythidae	9	1	B	B	A	-	-	A	A	A	B	A	A
17	Atyidae	8	-	-	-	-	-	B	-	-	-	-	B	B
18	Hydracarina	8	-	-	1	-	1	-	-	-	-	-	-	-
19	Aeshnidae	8	A	-	1	1	1	A	A	-	-	-	-	1
20	Ecnomidae	8	-	-	-	-	-	-	A	-	-	-	-	-
21	Elmidae	8	-	-	1	-	1	-	-	-	-	-	-	1
22	Naucoridae	7	-	-	-	-	-	-	-	-	1			
	Total Number		**6**	**5**	**10**	**7**	**12**	**6**	**9**	**6**	**8**	**6**	**10**	**11**

Abundance ratings: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000

QV= Quality Value (Sensitivity rating, where 15= highly sensitive)

[2] Sensitive taxa were defined here as taxa with a sensitivity value >7.

5.6 Fish

a) Reference Conditions

A total of 18 species of fish is expected to have occurred in the Study Area under natural conditions. A detailed list of species is expected at each site under natural conditions is presented in Appendix F1. The number of fish species expected at each aquatic sampling site in the Study Area ranged between three in the Sterkspruit at SP01 and SP02, to 14 in the Crocodile River at Montrose (CR05 and CR06) (Appendix F1).

b) Present Ecological State

The Present Ecological State of fish at the thirteen aquatic sampling sites in May 2018 ranged between *Seriously Modified* (Category E) at Sites SP03 and CR05, to *Natural* (Category A) at TR01 (Figure 5-9). A total of 15 species of indigenous fish and no alien fish species was recorded in the Study Area in May 2018. Photographs of fish species recorded are shown in Figures 5-10 and 5-11. Detailed data on fish habitats and fish recorded during the field survey are presented in Appendix F2. The results show that unauthorised clearing of indigenous vegetation had no measurable detrimental impacts on the composition or abundance of fish in the Crocodile River or Devil's Creek, but there was a high likelihood that clearing of natural vegetation had a measurable negative impact on the diversity and abundance of fish in two areas as follows:

- Sterkspruit at SP02 and SP03, which were classified as *Largely Modified* (Category D), and *Seriously Modified* (Category E) respectively; and
- lower reaches of the Houtbosloop at TR04, which was classified as *Largely Modified* (Category D).

(Figure 5-9).

Five species of fish were recorded in the Crocodile River at CR05, upstream of the vegetation clearing on Montrose 1, compared to 15 species of fish expected at the site under natural conditions, and the ecological state of the site was classified as *Seriously Modified* (Category E) (Figure 5-9). The degraded state of fish at the site could not be attributed to changes in the availability of habitat or cover, as these were much the same as other sites surveyed in the Crocodile River. The reason for the degraded state of fish in the Crocodile River at CR05 is unknown for certain but is most likely attributed to the inflows of poor-quality water from the Elands River.

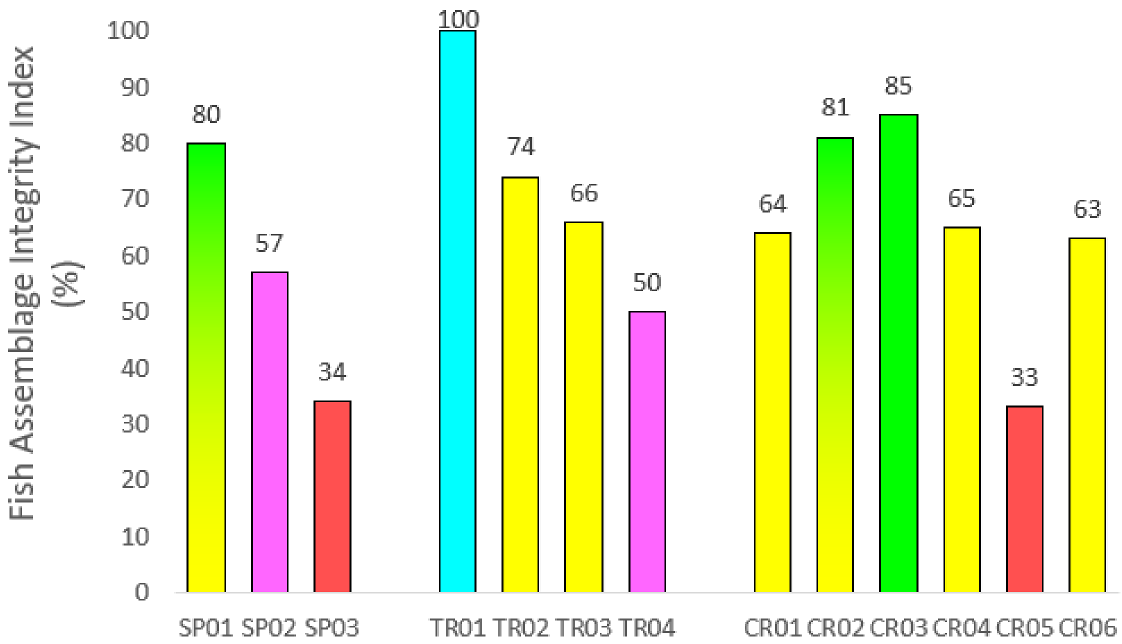


Figure 5-9. Present Ecological State of Fish in May 2018.

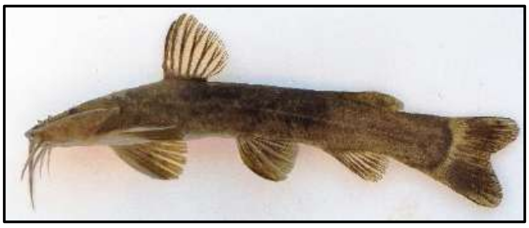
[Colour Codes are shown in Figure 5-8.]

c) Fish Species of Conservation Concern

Four species of fish of conservation concern were expected and confirmed in the Study Area in May 2018 as follows:

- *Amphilius natalensis,* referred to as "*Data Deficient*" by Nel *et al.* (2011), but listed as "*Least Concern*" by the IUCN (www.iucnredlist.org). This species was recorded in the upper Sterkspruit at SP01 and SP02, and Junglespruit at TR01 in May 2018;
- *Chiloglanis bifurcus*, classified as "*Critically Endangered"* by the IUCN. This species was recorded in low abundance at four sites in May 2018;
- *Kneria* sp. nov. 'South Africa", classified as "*Endangered"* by the IUCN. This species was recorded in moderate abundance in the Jungelspruit at TR01 in May 2018; and
- *Oreochromis mossambicus,* classified as "*Near-Threatened*" by the IUCN. This species was recorded in low abundance in the Crocodile at CR03 only in May 2018.

a) *Amphilius natalensis* (Amphiliidae).



b) *Amphilius uranoscopus* (Amphiliidae).

c) *Chiloglanis bifurcus* (Mochokidae).

d) *Chiloglanis pretoriae* (Mochokidae).

e) *Clarias gariepinus* (Clariidae).

Figure 5-10. Photographs of fish recorded in the Study Area in May 2018 (in part)).

a) *Micralestes acutidens* (Alestidae).

b) *Enteromius anoplus* (Cyprinidae).

c) *Enteromius crocodilensis* (Cyprinidae).

d) *Enteromius neefi* (Cyprinidae).

e) *Labeobarbus marequensis* (Cyprinidae).

f) *Kneria sp. "Kwena"* (Kneriidae).

g) *Coptodon rendalii* (Cichlidae).

h) *Oreochromis mossambicus* (Cichlidae).

i) *Pseudocrenilabrus philander*.

j) *Tilapia sparrmanii* (Cichlidae).

Figure 5-11. Photographs of fish recorded in the Study Area in May 2018 (continued).

5.7 Alien Invasive Plant Species

Disturbed areas are typically colonised initially by annual herbs, followed by alien shrubs and eventually a climax community of alien woody species. The successional phases of alien vegetation colonisation observed in the Study Area are shown in Figure 5-12. A total of 40 species of nationally declared alien invasive plant species was recorded within the Study Area during field surveys in 2018 (Table 5-3). Most of the alien species recorded are likely to have been present in the Study Area before clearing took place, but disturbance of soils associated with clearing has created ideal conditions for excessive proliferation of alien invasive species. For the proposed management plan the declared alien plant species are prioritised here into three categories (Table 5-3) as follows:

- **High Priority.** These are mostly woody species that are likely to have a significant impact on water use, and populations are discrete, so they could be eradicated from the area. The list includes one highly invasive and toxic herb (Famine Weed), that has not yet widely established in the area and could therefore be eradicated if controlled early. Common bamboo (*Bambusa balcoa*), is currently localised in distribution and therefore could also be eradicated from the area. Black wattle *Acacia mearnsii* are also listed as priority species although they were not recorded within riparian zones or wetlands, but were recorded on the farm Rietvlei, and are expected to colonise surrounding areas over time. Photographs of selected high priority species are shown in Figure 5-13.

- **Medium Priority.** These are mostly shrubs that are common and widely distributed in the Study Area, and impossible to eradicate, but important to control because they displace indigenous species and therefore have a negative impact on biodiversity. Photographs of selected medium priority species are shown in Figure 5-14.

- **Low Priority.** These are mostly annual herbs and early colonisers, many of which have become naturalised and are not a significant threat to water use or biodiversity.

a) Riparian vegetation clearing and soil disturbance. [MU 17d, 2018-07-06].

b) Initial colonisation of pioneer annual herbs. [MU 01, 2018-05-14].

c) Intermediate colonisation of annual shrubs. [MU 18b, 2018-07-04].

d) Climax colonisation of alien woody vegetation. [MU 14a, 2018-07-04].

Figure 5-12. Alien Vegetation – Successional Phases.

Table 5-3. NEMBA listed (July 2016) Alien Invasive Plant Species recorded in the Study Area in 2018.

Species	Common Name	Form	NEMBA Category
A) High Priority			
Acacia mearnsii	Black wattle	tree	2
Bambusa balcoa	Common bamboo	bamboo	1b
Casuarina equisetifolia	Beefwood / Horsetail tree	tree	2
Eucalyptus sp.	Gum	tree	various
Gleditsia triacanthos	Honey locust	tree	1b
Grevillea robusta	Australian silver oak	tree	3
Melia azedarach	Seringa	tree	1b
Parthenium hysterophorus	Famine weed	herb	1b
Pinus sp.	Pine	tree	various
Populus x canescens	Grey poplar	tree	2
B) Medium Priority			
Caesalpinia decapetala	Mauritius thorn	shrub	1b
Chromolaena odorata	Triffid weed	shrub	1b
Jacaranda mimosifolia	Jacaranda	tree	various
Lantana camara complex	Lantana	shrub	1b
Morus alba	White mulberry	tree	various
Psidium guajava	Guava	tree	2
Ricinus communis	Castor-oil plant	shrub	2
Senna didymobotrya	Peanut butter cassia	shrub	1b
Senna septemtrionalis	Arsenic bush	shrub	1b
Sesbania punicea	Red sesbania	shrub	1b
Solanum mauritianum	Bugweed	herb	1b
Tecoma stans	Yellow bells	shrub	1b
Tithonia diversifolia	Mexican sunflower	herb	1b
Tithonia rotundifolia	Red sunflower	herb	1b
C) Low Priority			
Ageratum conyzoides	Invading ageratum	herb	1b
Argemone ochroleuca	White-flowered mexican poppy	herb	1b
Bidens pilosa	Common blackjack	herb	1b
Cardiospermum grandiflorum	Balloon vine	climber	1b
Cirsium vulgare	Scotch thistle	herb	1b
Datura stramonium	Stinkblaar	herb	1b
Dolichandra unguis-cati	Cat's claw creeper	climber	1b
Ipomoea alba	Moonflower plant	climber	1b
Nicandra physalodes	Apple-of-Peru	herb	1b
Passiflora subpeltata	Granadina	climber	1b
Pennisetum purpureum	Elephant grass	grass	1b
Rubus sp.	Bramble	climber	1b
Solanum nigrum	Black nightshade	herb	1b
Solanum seaforthianum	Potato creeper	climber	1b
Solanum sisymbriifolium	Dense thorned bitter apple	herb	1b
Verbena bonariensis	Purple top	herb	1b

a) *Bambusa balcoa* *1b (Common bamboo). [MU 15c, 2018-07-03].

b) *Eucalyptus sp*.*(Gum). [MU 14b, 2018-07-04].

c) *Gleditsia triacanthos* *1b (Honey locust). [MU 17a, 2018-07-04].

d) *Melia azedarach* *1b (Seringa). [MU 09a, 2018-07-05].

e) *Parthenium hysterophorus* *1b (Famine weed). [MU 16o, 2018-05-14].

f) *Pinus sp*.* (Pine). [MU 1e, 2018-07-05].

Figure 5-13. Photographs of Selected High Priority Alien Invasive Plant Species.

a) *Jacaranda mimosifolia* * (Jacaranda).
[MU, 2018-07-00].

b) *Morus alba* * (White mulberry).
[MU, 2018-07-00].

c) *Ricinus communis* *2 (Castor-oil plant).
[MU 18b, 2018-07-04].

c) *Solanum mauritianum* (Bugweed).
[MU 3a, 2018-07-05].

e) *Tithonia diversifolia* (Mexican sunflower).
[MU 18b, 2018-07-04].

f) *Tithonia rotundifolia* (Red sunflower).
[MU 18b, 2018-07-04].

Figure 5-14. Photographs of Selected Medium Priority Alien Invasive Plant Species.

5.8 Ecological and Functional Importance

The Ecological and Functional Importance of the five natural aquatic ecosystem types impacted by unauthorised clearing on the eighteen fields investigated for this report is detailed in Appendix G, and summarised as follows:

- **Hillslope Seeps**: The overall Ecological and Functional Importance of Hillslope Seepage Wetlands impacted by unauthorised clearing was rated as ***Low*** in their current (modified) state (Table 5-4). There was no information available on these wetlands before development, but they are likely to have supported a few wetland plant species that are protected under provincial legislation, such as *Eulophia spp., Knifophia sp., Gladiolus* spp. and *Eucomus autumnalis.*

- **Mountain Stream**: The overall Ecological and Functional Importance of the Mountain Stream (Junglespruit) was rated as ***Low,*** but Ecological Importance was rated as ***High*** because of the confirmed presence of *Kneria sp nov. "South Africa",* which is highly restricted in distribution and has conservation status of *Endangered.*

- **Transitional**: The overall Ecological and Functional Importance of Transitional Streams, comprising Sterkspruit and lower reaches of Devi's Creek, was rated as ***Moderate***, but Ecological Importance was rated as ***High*** because of the confirmed presence of *Chiloglanis bifurcus,* which has conservation status of *Critically Endangered.*

- **Upper Foothills**: The overall Ecological and Functional Importance of Upper Foothills, comprising the Crocodile River upstream of the farm Mooiland and lower reaches of Houtbosloop, was rated as ***Moderate,*** but Ecological Importance was rated as ***High*** because of the confirmed presence of *Chiloglanis bifurcus,* which has conservation status of *Critically Endangered.*

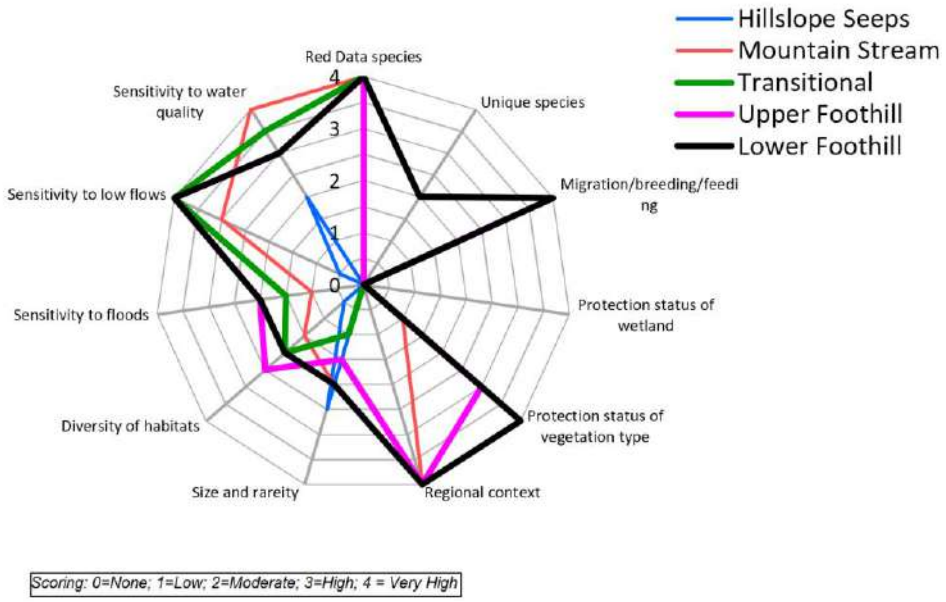
- **Lower Foothills**: The overall Ecological and Functional Importance of Lower Foothills, comprising the Crocodile River downstream of the farm Mooiland was rated as ***High.*** The river here is classified as a *Critical Biodiversity Area*. The river downstream of Montrose Falls provides an important corridor for the migration of fish species, particularly *Labeobarbus marequensis.*

Table 5-4. Summary Present Ecological and Functional Importance.

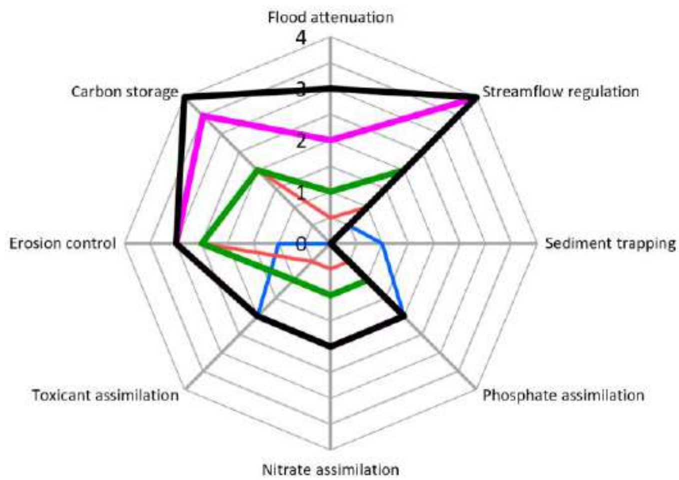
Parameter	Hillslope Seeps	Mountain Stream	Transitional	Upper Foothill	Lower Foothill
Ecological Importance	0.8	2.7	3.0	3.0	3.3
Hydro-Functional Importance	1.1	0.9	1.5	2.6	2.9
Direct Human Benefits	0.1	0.3	0.7	2.0	2.3
Average	**0.7**	**1.3**	**1.7**	**2.5**	**2.8**

Scoring: 0=None; 1=Low; 2=Moderate; 3=High; 4 = Very High

Ecological Importance



Functional Importance



Direct Human Benefits (Subsistence)

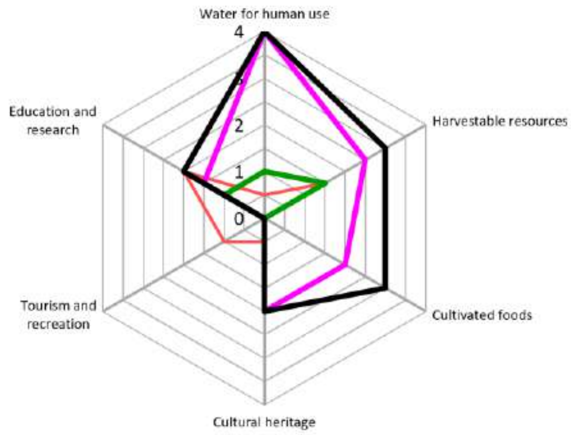


Figure 5-15. Ecological and Functional Importance.

6. IMPACT ASSESSMENT

This section summarises the impacts associated with clearing of natural vegetation on eighteen fields investigated for this report on aquatic ecosystems. Detailed scoring of the Risk Assessment is included in Appendix H. Risks were assessed after considering all listed mitigation measures.

6.1 Impact of Vegetation Clearing on Riparian and Seepage Wetland Habitats

Vegetation clearing impacted directly on 66.54 hectares of riparian habitat (Figure 6-1a), and 32.02 hectares of seepage wetland habitat (Figure 6-1b). Clearing is likely to have had a small impact on the flow regime, even for wetlands that have been drained, but clearing is likely to have mobilised sediments and therefore impacted on downstream water quality. Sediments are mobilised mainly during storm events, but the field surveys for this report were undertaken during clear weather and low flows, so there was no direct evidence of elevated sediments, apart from embedded stream substrates noted in the lower Sterkspruit, at SP03. The reduction in fish species composition and abundance recorded in the Sterkspruit at SP03 in July 2018, is attributed to elevated concentration of suspended sediments carried in stormwater runoff from areas in the catchment where vegetation had been cleared. Mobilisation of sediments is expected to stabilise once orchards are established, so this is a short-term consequence of vegetation clearing. The biggest impact of vegetation clearing has been destruction and fragmentation of riparian and wetland habitats, and the associated loss of wildlife habitat and terrestrial migration corridors; increased carbon emissions from burning of large trees; reduced buffering capacity and bank stability provided by riparian habitats; and proliferation of alien invasive vegetation. The impact of vegetation clearing on instream biota was shown by the biomonitorjng survey conducted for this report to be low, except for fish in the Sterkspruit and Houtbosloop. However, the impact on riparian biota was high, particularly for conservation important plants, most notably *Breonadia salicina.* The spatial scale of the impact of vegetation clearing on riparian and wetlands habitats was regional, and the duration of impact is permanent. The risk of vegetation clearing on riparian and wetland habitats was rated according to the Risk Matrix as **Moderate**.

a) Cleared Riparian Zone on the farm Deon. [MU 02b, S25.38278 E30.53111, 2018-07-05].

b) Cultivated Seepage Wetland on the farm I Swart. [S25.38791 E30.55552; 2018-05-21].

Figure 6-1. Riparian and Seepage Wetland Habitats Impacted by Vegetation Clearing.

6.2 Impact of Agricultural Drains on Seepage Wetland Habitats

Trenching has drained an estimated total of 32.02 hectares of seepage wetland habitat that was intended for agricultural development (Figure 6-2). Most of these former wetland areas in the lower portions of the Study Area were productive orchards in 2018. Operation of orchards is likely to need periodic maintenance and control of weeds, particularly in agricultural drains, so the application of herbicides to drains is likely, and this is expected to impact the quality of water draining from these areas. Agricultural development in the upper portions of the Study Area, particularly Sterkspruit and Deon, was stopped in 2018 by a directive from the Department of Environmental Affairs and Tourism. Here, wetlands were drained but no further development took place, and so these wetlands as they stand are prone to encroachment of terrestrial plant species. The spatial scale of the impact of agricultural drains on wetlands habitats was regional, and the duration of impact is permanent. The risk of agricultural drains on wetland habitats was rated according to the Risk Matrix as **Moderate**.

a) Drain through seepage wetland on the farm Sterkspruit. [MU 01e, 2018-07-05].

b) Drain through seepage wetland on the farm Rietvlei. [S25.38332 E30.56299, 2018-07-14].

Figure 6-2. Seepage Wetlands Impacted by Agricultural Drains.

6.3 Impact of Access Roads and Unprotected Stream Crossings on Surface Water Quality

Agricultural development of the eighteen fields investigated for this report has led to the development of access roads within riparian zones and increased vehicle traffic over existing culverts and stream crossings, as well as new stream crossings. A total of 11 unprotected stream crossings were identified as follows:

- Sterkspruit x 2 (MU 01a, MU1b)
- Deon x 1 (MU 02a)
- Hiennuman x 1 (MU 03a)
- Turnbull x 1 (MU 04a)
- Loxley x 1 (MU13a)
- Mooiland x 2 (MU 15a, MU15e)
- Koedoeshoek x2 (MU 16g, MU 16o)
- Montrose x1 (MU 17d)

Access roads close to watercourses and unprotected stream crossings increase the drainage network and this increases sediment transport in downstream watercourses. Access roads and unprotected stream crossings also increase the magnitude of high flow events, and this has the potential to destabilise stream banks and lead to bank erosion. The impact of unprotected streams crossings on turbidity in the Houtbosloop was shown when runoff from washing of equipment ran for some distance along the road before entering the Houtbosloop, as shown in Figure 6-3. Vehicle traffic also increases the risks of hydrocarbon contamination of surface waters, particularly at stream crossings where water levels are elevated. The spatial scale of the impact of access roads and unprotected stream crossings on downstream surface water quality is localised, and the duration of impact is usually short. The risk of access roads and unprotected stream crossings on surface water quality was rated according to the Risk Matrix as **Moderate**.

a) Culvert over Houtbosloop on the farm Montrose, near TR04. [MU 17d, S25.43197 E30.74875, 2018-05-28].

b) Suspended sediments mobilised by equipment washing upslope of culvert over Houtbosloop near TR04. [MU17d, 2018-05-28].

Figure 6-3. Surface Water Quality Impacted by Unprotected Stream Crossing.

6.4 Impact of Woody Debris on Stream Flow

Clearing of riparian vegetation for agricultural development on the eighteen fields investigated for this report has led to piles of woody debris in riparian zone and in some places the main river channels (Figure 6-4). Many of the wood piles have been burnt and the hot fires produced have removed organic material from the underlying soils and this has localised but long-term impacts on local soil quality. The wood piles that remain within flood lines are likely to restrict high flows, and this could have long-term detrimental impacts on bank stability and erosion at a local scale. Woody snags in river channels are likely to restrict low and high flows, and this could also have long-term detrimental impacts on bank stability and erosion at a local scale. The risk of woody debris on stream flows was rated according to the Risk Matrix as **Low**.

a) Woody Debris in the Riparian Zone on the farm Dubai 2. [MU 06a, S25.38305 E30.54906, 2018-05-21].

b) Woody Debris in Crocodile River at Montrose 1. [MR17c, S25.43467 E30.75096; 2018-07-04].

Figure 6-4. Woody Debris that Restrict Stream Flow.

6.5 Impact of Stone Packs and Rubble on Riparian Habitats

Clearing of riparian vegetation for agricultural development on the eighteen fields investigated for this report has led to large piles of stones and in some places building rubble being deposited in the riparian zone (Figure 6-5). The stone packs and rubble impede vegetation growth and alter the characteristics of the riparian zone and may reduce the diversity of plant species. Furthermore, the stone packs and rubble within flood lines are likely to restrict high flows, and this could have long-term detrimental impacts on bank stability and erosion at a local scale. The risk of stone packs and rubble on riparian habitats was rated according to the Risk Matrix as **Low**.

a) Stone packs in riparian zone of Crocodile River on the farm Rietvlei Macs. [MU12a, S25.39008 E30.57632, 2018-07-05].

b) Sone packs in riparian zone of Crocodile River on the farm Montrose 1. [MU 17b, S25.43780 E30.74397, 2018-07-04].

Figure 6-5. Riparian Habitats impacted by Stone Packs and Rubble.

6.6 Impact of Solid Waste Disposal on Riparian Habitats

Agricultural development on the eighteen fields investigated for this report has led to the disposal of excess materials in the riparian zone, particularly fencing materials, metal offcuts, timber offcuts, plastic irrigation pipes, potting bags and other plastics (Figure 6-6a). The riparian zone has also been used for the disposal of tyres (Figure 6-6b). Furthermore, riparian zones in areas with productive orchards were used for disposing branches from pruning of orchards. Dead branches left within the riparian zone increase the risks of fire, and this could have detrimental impacts on biodiversity, particularly larger, indigenous riparian trees. The solid waste impedes vegetation growth and alters the characteristics of the riparian zone and may reduce the diversity of plant species. The risk of solid waste disposal on riparian habitats was rated according to the Risk Matrix as **Moderate**.

a) Solid waste on Hiennuman. [MU 03a, S25.37793 E30.53908, 2018-05-21].

b) Tyres in riparian zone at Koedoeshoek. [MU 16e, S25.40991 E30.63539, 2018-07-03].

Figure 6-6. Riparian Habitats Impacted by Solid Wastes.

7. REHABILITATION PLAN

7.1 Objectives

The overall objective of the proposed rehabilitation plan is to restore ecological functions of aquatic ecosystems impacted by unauthorised clearing of natural vegetation in the eighteen fields investigated for this report, but without jeopardising socio-economic opportunities that have been created by agricultural development. The specific aims of the plan are:

- to rehabilitate 27.15 hectares of riparian habitat[3], including planting nearly 17 000 fast-growing indigenous trees to facilitate recovery time;
- to rehabilitate 1.88 hectares of seepage wetland[4]; and
- to provide buffer zones totalling 63.38 hectares to protect watercourses.

(Table 7-1).

7.2 Management Units

The proposed rehabilitation plan focusses on the restoration of riparian and wetland ecosystems within Management Units (MUs) that comprise discrete areas where specific actions are required. The MUs function as buffer zones, which are defined as "*strips of land surrounding a wetland or riparian zone in which activities are controlled or restricted to reduce the impact of adjacent land use on the wetland or riparian area".* The MUs are no different to buffer zones in areas that were not productive orchards in 2018, but MUs were narrower than buffer zones in areas that were productive orchards in 2018 and here the MUs comprised mostly a narrow strip of riparian habitat between the river channel (MU inner boundary) and the edge of the existing orchards (MU outer boundary). The upper and lower boundaries of each MU comprise features that are easy to identify in the field, such a tributary junction, stream crossing, access road or property boundaries. The reason for selecting such features is to make it easier to manage field teams and allocate tasks. However, the MU outer boundaries will still need to be demarcated in fields where orchards have not yet been developed. The proposed plan comprises 45 MUs, and these are identified by the field number plus one or more letters assigned in order downstream (Table 7-2). Three fields, namely Rohan, Shabeen and Rietvlei, had no riparian zones or wetlands and therefore no MUs. Baseline photographs were taken in each MU, including one fixed-point location intended for long-term monitoring of riparian vegetation (Table 7-2).

[3] This represents 41% of the 66.54 hectares that was impacted by unauthorised clearing.
[4] This represents about 1% of the 32.02 hectares of seepage wetland that was impacted by unauthorised clearing.

Table 7-1. Details of Management Units, Including the Extent of Aquatic Ecosystems and Number of Indigenous Trees that Need to be Planted.

Field	MU	Total Area (ha)	Seeps (ha)	Riparian Zone (ha)	Rehab Area (ha)	River Length (m)	Distance between (m)	Trees needed (number)
Sterkspruit	01a	2.17	0.18	1.03	1.14	290	4	644
	01b	0.35	0.12	0.16	0.19	62	4	100
	01c	1.20	-	0.48	0.72	490	4	300
	01d	1.27	-	0.48	0.79	420	4	300
	01e	0.89	0.13	0.00	0.89	320	4	0
Deon	02a	4.06	-	2.30	1.76	600	4	1 438
	02b	2.50	-	1.00	1.50	450	4	625
	02c	3.38	-	2.26	1.12	540	4	1 413
Hiennuman	03a	2.80	-	1.05	1.75	474	4	656
Turnbull	04a	3.29	-	0.00	3.29	791	4	0
Dubai 1	05a	1.04	0.10	0.68	0.36	252	4	425
Dubai 2	06a	2.53	-	0.45	2.08	627	4	281
I Swart	08a	1.74	-	0.72	1.02	373	4	450
	08b	2.27	0.75	1.16	1.11	461	4	725
Spilpunt	09a	3.17	-	0.00	3.17	920	4	0
	09b	0.86	-	0.10	0.76	339	4	63
Rievlei Macs	12a	2.50	-	0.96	1.54	760	4	600
	12b	1.67	-	0.55	1.12	471	4	344
	12c	2.14	-	1.02	1.12	459	4	638
	12d	3.80	-	1.54	2.26	802	4	963
	12e	2.07	0.38	0.22	1.85	691	4	138
Loxley	13a	1.23	-	0.12	1.11	192	4	75
In Die Middel	14a	1.15	-	0.62	0.53	444	4	388
	14b	1.83	-	0.27	1.56	568	4	169
	14c	1.77	-	0.37	1.40	480	4	231
	14d	2.89	-	0.00	2.89	753	4	0
Mooiland	15a	0.95	-	0.00	0.95	394	4	0
	15b	1.15	-	0.00	1.15	458	4	0
	15c	0.64	-	0.00	0.64	344	4	0
	15d	0.57	-	0.00	0.57	302	4	0
	15e	2.43	-	0.77	1.66	453	4	481
Koedoeshoek	16a	1.50	-	0.00	1.50	489	4	0
	16b	1.11	-	0.24	0.87	382	4	150
	16c	0.80	-	0.30	0.50	308	4	188
	16d	1.14	-	0.00	1.14	339	4	0
	16e	0.58	-	0.00	0.58	253	4	0
	16f	1.31	-	0.00	1.31	381	4	0
	16g	0.98	-	0.22	0.76	554	4	138
	16o	4.45	0.22	0.00	4.45	0	4	0
Montrose 1	17a	2.98	-	1.11	1.87	429	4	694
	17b	2.74	-	0.62	2.12	541	4	388
	17c	2.48	-	1.00	1.48	412	4	625
	17d	4.63	-	3.27	1.36	722	4	2 044
Montrose 2	18a	2.99	-	1.20	1.79	750	4	750
	18b	2.53	-	0.88	1.65	540	4	550
	Total	**90.53**	**1.88**	**27.15**	**63.38**	**21 080**		**16 969**

Table 7-2. Details of Management Units and Proposed Vegetation Monitoring Sites.

No	Field Name	Management Unit	River	Total Area (Hectares)	River Length (m)	Riparian Monitoring Site Lat	Long
1	Sterkspruit	01a	Sterkspruit	2.17	290	-25.411825	30.495708
		01b	Junglespruit	0.35	62	-25.412036	30.496760
		01c	Sterkspruit	1.20	490	-25.409679	30.498575
		01d	Sterkspruit	1.27	420	-25.406455	30.500941
		01e	Sterkspruit	0.89	320	-25.403894	30.502917
2	Deon	02a	Sterkspruit	4.06	600	-25.383117	30.525512
		02b	Crocodile	2.50	450	-25.382814	30.531327
		02c	Crocodile	3.38	540	-25.381028	30.534775
3	Hiennuman	03a	Crocodile	2.80	474	-25.379668	30.539986
4	Turnbull	04a	Crocodile	3.29	791	-25.380068	30.546421
5	Dubai 1	05a	Crocodile	1.04	252	-25.379891	30.547204
6	Dubai 2	06a	Crocodile	2.53	627	-25.383446	30.549159
8	I Swart	08a	Crocodile	1.74	373	-25.384656	30.557455
		08b	Crocodile	2.27	461	-25.387361	30.557615
9	Spilpunt	09a	Crocodile	3.17	920	-25.387514	30.558209
		09b	Crocodile	0.86	339	-25.387650	30.562843
12	Rievlei Macs	12a	Crocodile	2.50	760	-25.391958	30.575295
		12b	Crocodile	1.67	471	-25.387982	30.580251
		12c	Crocodile	2.14	459	-25.386021	30.584907
		12d	Crocodile	3.80	802	-25.386116	30.590406
		12e	Crocodile	2.07	691	-25.390819	30.592237
13	Loxley	13a	Crocodile	1.23	192	-25.396293	30.595263
14	In Die Middel	14a	Crocodile	1.15	444	-25.393925	30.598883
		14b	Crocodile	1.83	568	-25.389627	30.602169
		14c	Crocodile	1.77	480	-25.389879	30.607960
		14d	Crocodile	2.89	753	-25.393058	30.610408
15	Mooiland	15a	Crocodile	0.95	394	-25.395266	30.613088
		15b	Crocodile	1.15	458	-25.398559	30.615410
		15c	Crocodile	0.64	344	-25.401110	30.617971
		15d	Crocodile	0.57	302	-25.402655	30.620567
		15e	Crocodile	2.43	453	-25.403105	30.623259
16	Koedoeshoek	16a	Crocodile	1.50	489	-25.403481	30.625910
		16b	Crocodile	1.11	382	-25.403748	30.629746
		16c	Crocodile	0.80	308	-25.404970	30.632334
		16d	Crocodile	1.14	339	-25.406885	30.634881
		16e	Crocodile	0.58	253	-25.408585	30.635241
		16f	Crocodile	1.31	381	-25.411269	30.636210
		16g	Devil's Creek	0.98	554	-25.404160	30.622381
		16o	Wetland	4.45	0	-25.409776	30.632162
17	Montrose 1	17a	Crocodile	2.98	429	-25.437686	30.741882
		17b	Crocodile	2.74	541	-25.436798	30.745217
		17c	Crocodile	2.48	412	-25.435406	30.749751
		17d	Houtbosloop	4.63	722	-25.433025	30.750180
18	Montrose 2	18a	Crocodile	2.99	750	-25.432444	30.755241
		18b	Crocodile	2.53	540	-25.428413	30.759611
				90.53	**21 080**		

7.3 Rehabilitation Plan

The proposed rehabilitation plan is presented Table 7-3. Baseline data on specific actions per MU are present Appendix I.

Table 7-3. Rehabilitation Plan.

Impact	Objective	Actions	Schedule
-	● Demarcate MUs in the field so there is no doubt about management boundaries. This should be completed by the end of 2018.	**0a) Demarcate MUs**. Poles that are clearly visible should be placed on inner boundaries of all MUs at intervals of about 30 m.	Once-off
1) Impact of Vegetation Clearing on Riparian and Seepage Wetland Habitats	● Eradicate all High Priority alien species from all MUs by 2023. ● Control all Medium Priority alien plant in all MUs ● Restore natural composition of riparian and wetland plant species in each MU by 2028.	**1a) Manage Alien Plants.** Eradicate High Priority alien invasive plant species and control Medium Priority alien invasive plant species in all MUs. Personnel tasked to control alien vegetation must have appropriate training in the following: methods and control measures; equipment and techniques; types of herbicides and dosages applied; mixing techniques; storage of chemicals and equipment; health and safety issues; plant identification; procedures for equipment washing and equipment maintenance. Clearing methods should include cutting, felling and treating the stumps with registered herbicides by appropriately skilled herbicide applicators. The use of a flail mower should be considered, where appropriate. Follow-up methods should include a combination of manual and herbicide control. **1b) Plant Indigenous Trees**. Plant indigenous trees in riparian zones within each MU. The following fast-growing tree species are recommended: *Acacia robusta subsp. clavigera, Trema orientalis, Ficus sycomorus, Combretum erythrophyllum, and Syzygium cordatum.* Trees may need watering until they are established.	Initial clearing followed by annual follow-up.
2) Impact of Agricultural Drains on Seepage Wetland Habitats	● Restore natural drainage patterns of seepage wetlands that have been drained within each MU by 2023.	**2a) Seepage Wetlands.** Agricultural drains in Seepage Wetlands within MUs should be backfilled to restore natural flow patterns. The surface must be level with the surrounding land surface to minimise soil erosion from the areas when the backfilling is complete.	Once-off.

Impact	Objective	Actions	Schedule
3) Impact of Access Roads and Unprotected Stream Crossings on Surface Water Quality	● Ensure that all access roads and stream crossings do not increase the risks of surface water contamination by 2023. ● Ensure that surface runoff from orchards and access roads meets the relevant Resource Quality Objectives for suspended solids	**3a) Stream Crossings.** Remove unnecessary stream crossings and rehabilitate, or formalise as culverts, where appropriate (and with the relevant Water Use License(s)). Drifts are only suitable for low usage roads, as they have high environmental impacts (sedimentation and pollution from crossing vehicles) and do not enable crossing during flood events. **b) Stormwater.** Road approaches to all stream crossings must have humps to divert stormwater into vegetation buffer zones and in doing so, prevent stormwater entering directly into watercourses. Stormwater on access roads should also be diverted to minimise the amount of water running directly from the road into the watercourses. Having more frequent drains on the approach to a water body ensures that the least amount of water is discharged directly into the water body and reduced sediment loading. **3c) Access Roads.** Access roads should be removed from all MUs. Access roads that are not necessary should be recontoured (rehabilitated) and revegetated.	Once-off, and with any civils works to be undertaken during the dry season only (April to October).
4) Impact of Woody Debris on Stream Flow	● Ensure that woody debris are removed from river channels in all MUs by mid-2019. ● Ensure that all woody debris are removed from riparian zones in all MUs by mid-2020.	**4a) Woody Debris in River Channels.** Woody debris in river channels must be removed and either burnt in one area that is dedicated for incineration of woody debris, with permit for burning if needed, or otherwise stacked in piles outside watercourses and left as "insect hotels". Large woody debris should not be burnt in situ because of the detrimental impacts this has on soil properties and associated runoff of ash. **4b) Woody Debris in Riparian and Wetland Habitat**. Woody debris in all MUs must be removed and treated the same as described above.	Once-off
5) Impact of Stone Packs and Rubble on Riparian Habitats	● Ensure that stone packs do not impact on high flows or riparian or wetland habitats.	**5a) Stone Packs and Rubble.** Stone packs and rubble must be removed from all MUs and placed in areas where they do not impact watercourses or riparian habits. Disturbed areas should be recontoured, where necessary, and rehabilitated.	Once-off
6) Impact of Solid Waste Disposal on Riparian Habitats	● Ensure that solid wastes do not pose a threat to surrounding environment.	**6a) Solid Waste Removal.** Remove solid wastes from riparian and wetland habitats and dispose of appropriately. No burning, except for smaller branches and twigs. **6b) Solid Waste management.** Provide adequate waste bins at strategic locations. Bins must be covered to prevent movement of wind-blown waste. **6c) Environmental Awareness.** All staff and contractors must be made aware of the environmental standards and the waste management strategy during induction. The induction process must include rules and regulations regarding disposal of wastes.	Initial clearing followed by annual follow-up.

7.4 Monitoring and Reporting

Annual monitoring and reporting on compliance of the Rehabilitation Plan (Table 7-3), is recommended for at least three years, as detailed in Section 11, Government Notice 509 of 2016 (26 Aug 2016). Biological monitoring should focus on:

- the composition and abundance alien invasive plant species;
- riparian health index; and
- fixed-point photographs.

Monitoring of instream ecological conditions (water quality, aquatic macroinvertebrates and fish), is not recommended because they are unlikely to provide reliable responses to the proposed interventions.

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9. APPENDICES

FJ JOUBERT EN SEUNS (PTY) LTD

Aquatic Ecosystem Assessment and Rehabilitation Plan Associated with Unauthorised Cultivation of Eighteen Fields in Schoemanskloof

In compliance with:

National Environmental Management Act Section 24G (Act 107 of 1998);
National Environmental Management Biodiversity Act, 2004, (Act 10, of 2004); and
Invasive Species Regulations (July 2016).

Draft 1.0
2nd October 2018

Appendices

Houtbosloop on Montrose. [4th July 2018].

Prepared for:

Lionel Eva
General Manager
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PO Box 29
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1207
Tel: 071 892 5245

Email: gm@joubertenseuns.co.za

Prepared by:

Rob Palmer
Nepid Consultants CC
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SOUTH AFRICA

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e-mail: rob@nepid.co.za
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TABLE OF CONTENTS

Appendix A1: Curriculum Vitae

ROBERT WILLIAM PALMER

Profession:	Aquatic Ecologist
Date of Birth	15 Dec 1961
Name of Firm	Nepid Consultants CC
Position in Firm	Director
Years with Firm	11
Nationality	South African

Qualifications:

• PhD [River Ecology]	Rhodes University, Grahamstown, RSA	1992
• BSc (Hons) [Mammalogy]	Pretoria University, RSA	1985
• BSc [Zoology]	University of Cape Town, RSA	1984

Professional Societies:

- SA Council for Natural Scientific Professions (Biological Science): No 400108/95
- SA Environmental Assessment Practitioner: No 0080/06
- International Association for Theoretical and Applied Limnology
- International Association for Impact Assessment (South Africa)
- Southern African Society of Aquatic Scientists

Languages:

	Speaking	Reading	Writing
English (home):	*Excellent*	*Excellent*	*Excellent*
Afrikaans:	*Good*	*Good*	*Poor*
Xhosa:	*Fair*	*Poor*	*Poor*
Portuguese:	*Poor*	*Fair*	*Poor*

Countries of Work Experience (short-term consultancies)	Angola, Burkina Faso, Cameroon, Democratic Republic of the Congo, Eritrea, Ethiopia, Lesotho, Malawi, Mozambique, Namibia, Sierra Leone, South Africa, Swaziland, Tanzania and Zambia.

KEY QUALIFICATIONS

- Over 20 years' experience of river research and management, baseline aquatic surveys, data analysis and report writing;
- Over 15 years' experience in environmental consulting, project management, including the design of environmental monitoring and mitigation programmes and water resource planning studies;
- Over 15 years' experience in general company administration, including proposal writing, marketing, contract administration and bookkeeping;
- Specialist knowledge of identification and control of pest blackflies (Diptera: Simuliidae);
- Specialist knowledge of river ecology, river regulation, aquatic invertebrates, instream flow requirements and downstream environmental impacts of dams and mines;
- Team leader for various water resource development projects and environmental impact assessments, involving coordination of multi-disciplinary teams.

EMPLOYMENT RECORD

2005 - present	Nepid Consultants CC	Founder Director
1997 – 2004	AfriDev Consultants (Pty) Ltd	Associate from 1997; Director from 2000
1991 – 1997	Onderstepoort Veterinary Institute	Research Fellow
1986 – 1991	Rhodes University	PhD Student

Appendix A2: SASS Certificate

NATIONAL AQUATIC ECOSYSTEM HEALTH MONITORING PROGRAMME

Water and Sanitation

Environment Affairs

Water Research Commission

CERTIFICATE OF ACCREDITATION

This is to certify that

Rob Palmer

has met the requirements of the River Health Programme as a SASS5 Practitioner

COMPETENCY IN THE FOLLOWING AREAS HAVE BEEN DEMONSTRATED:

UNDERSTANDING OF THE SCOPE AND APPLICATION OF THE SASS5 METHOD.

DEMONSTRATION OF THE CORRECT SAMPLING PROTOCOLS

DEMONSTRATION OF THE CORRECT SAMPLE PREPARATION PROTOCOLS

IDENTIFICATION OF AQUATIC MACROINVERTEBRATES

COMPETENCY IS VALID FOR 3 YEARS FROM CERTIFICATE DATE

NATIONAL SASS5 AUDITOR

15 March 2016

DATE

Appendix A3: Alien Invasive Training


No: SAGP 9106

SAGIC Invasive Species Training

This serves to notify that

Rob Palmer

has attended the South African Green Industries Council (SAGIC)
Invasive Species Training: Module 1: Identification & Legislation

Training date: 19/06/18
Expiry date: 19/06/21

Chairman: Ida-Marie Strydom

Trainer

Appendix B: Declaration of Independence

10.4 The Specialist

Note: Duplicate this section where there is more than one specialist.

I, Robert William Palmer, as the appointed specialist hereby declare/affirm the correctness of the information provided as part of the application, and that I:

- in terms of the general requirement to be independent (tick which is applicable):

✓	other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity; or

	am not independent, but another EAP that is independent and meets the general requirements set out in Regulation 13 has been appointed to review my work (Note: a declaration by the review specialist must be submitted);

- have expertise in conducting specialist work as required, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- will ensure compliance with the EIA Regulations 2014;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the application;
- will take into account, to the extent possible, the matters listed in regulation 18 of the regulations when preparing the application and any report, plan or document relating to the application;
- will disclose to the proponent or applicant, registered interested and affected parties and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority or the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority (unless access to that information is protected by law, in which case I will indicate that such protected information exists and is only provided to the competent authority);
- declare that all the particulars furnished by me in this form are true and correct;
- am aware that it is an offence in terms of Regulation 48 to provide incorrect or misleading information and that a person convicted of such an offence is liable to the penalties as contemplated in section 49B(2) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist

Nepid Consultants CC

Name of company

2016-06-07

Date

SUID-AFRIKAANSE POLISIEDIENS
STASIE KOMMISSARIS
2016 -06- 07
STATION COMMISSIONER
WITRIVIER / WHITE RIVER
SOUTH AFRICAN POLICE SERVICE

WHITE RIVER 2016-06-07 09 00

(HANDTEKENING) KOMMISSARIS VAN EDE
(SIGNATURE) COMMISSIONER OF OATHS

VOLLE VOORNAME EN VAN IN DRUKSKRIF
FULL FIRST NAMES AND SURNAME IN BLOCK LETTERS

27 CHIEF MGIYANE

BESIGHEIDSADRES (STRAATADRES)
BUSINESS ADDRESS (STREET ADDRESS)

WHITE RIVER

RANG/RANK

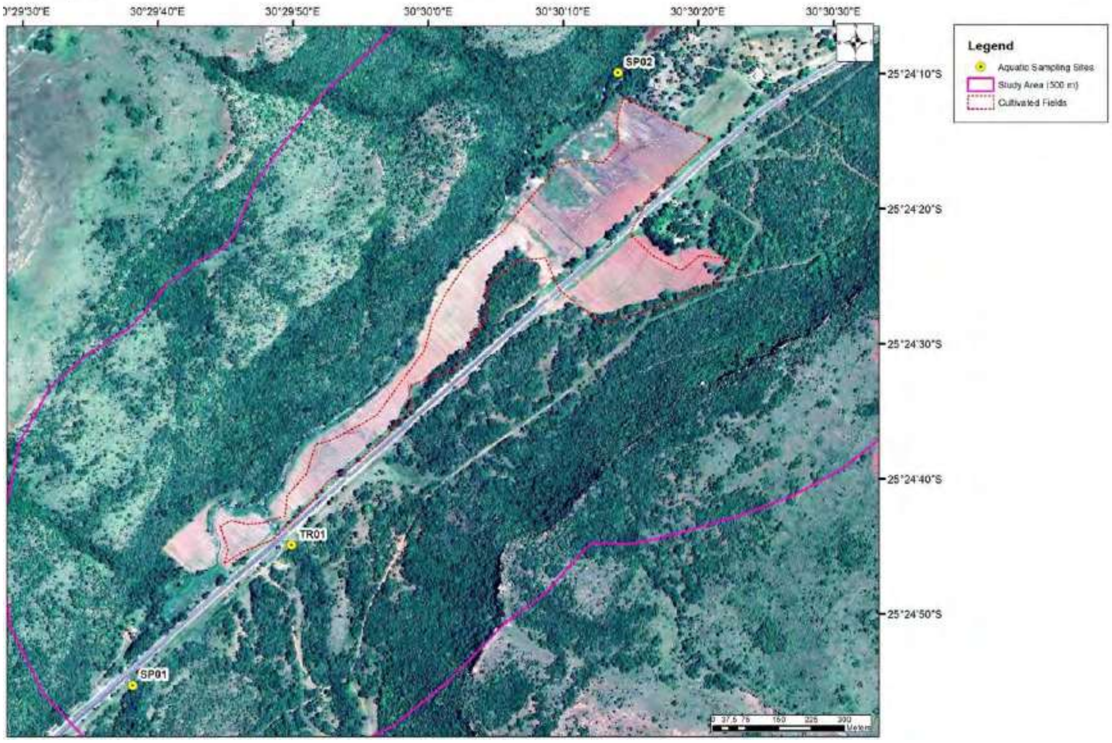
SA POLISIEDIENS
SA POLICE SERVICE

Version 1.0, 8 December 2014 Application for

MPUMALANGA

Appendix C: Aquatic Ecosystem Delineation

Sterkspruit



Sterkspruit

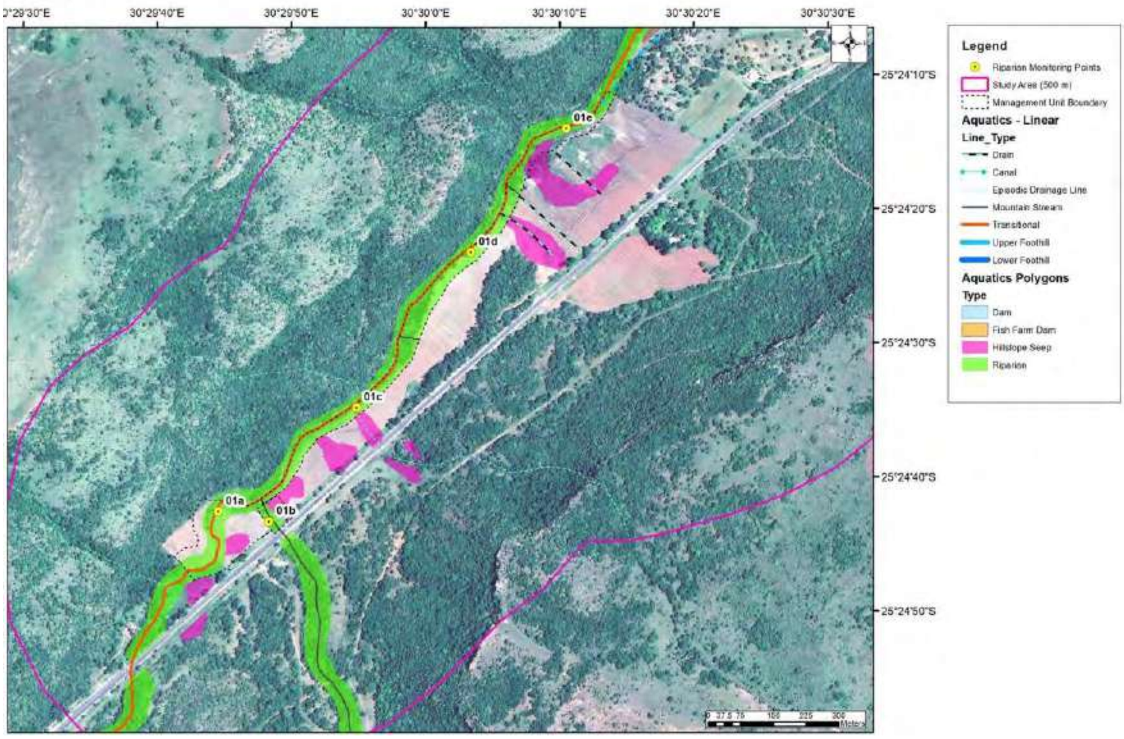
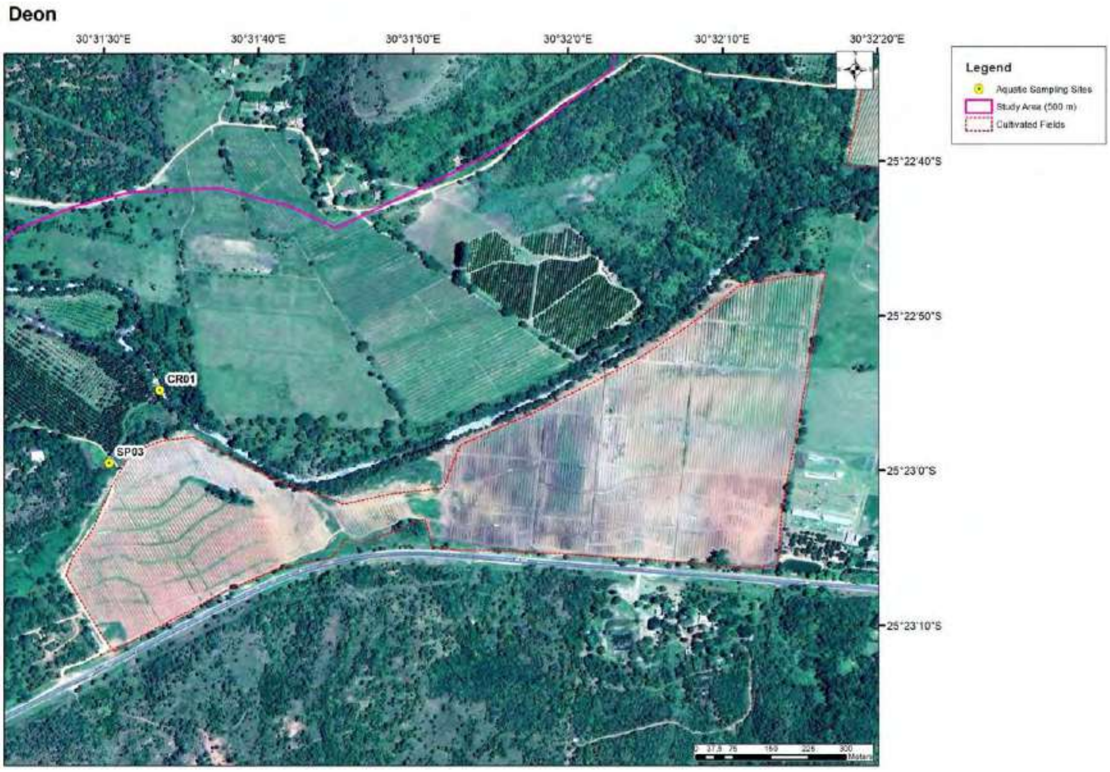
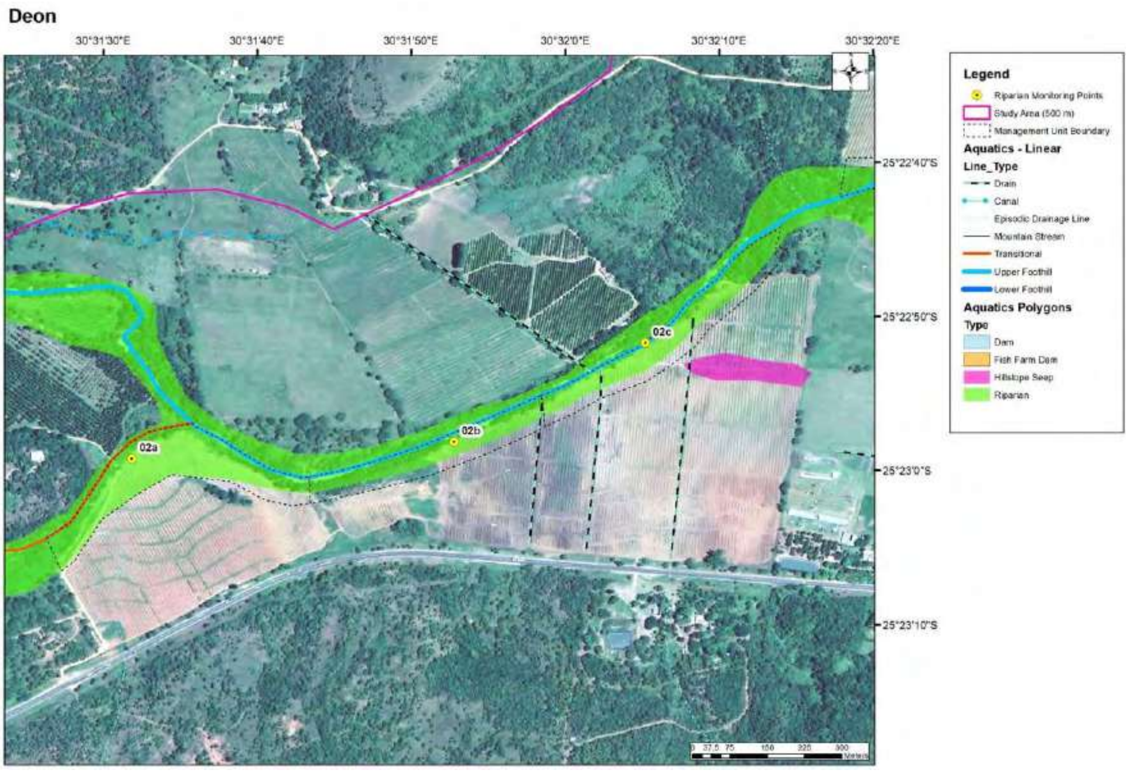


Figure 0-1. Google Earth™ image dated 2018-01-06 at Sterkspruit.





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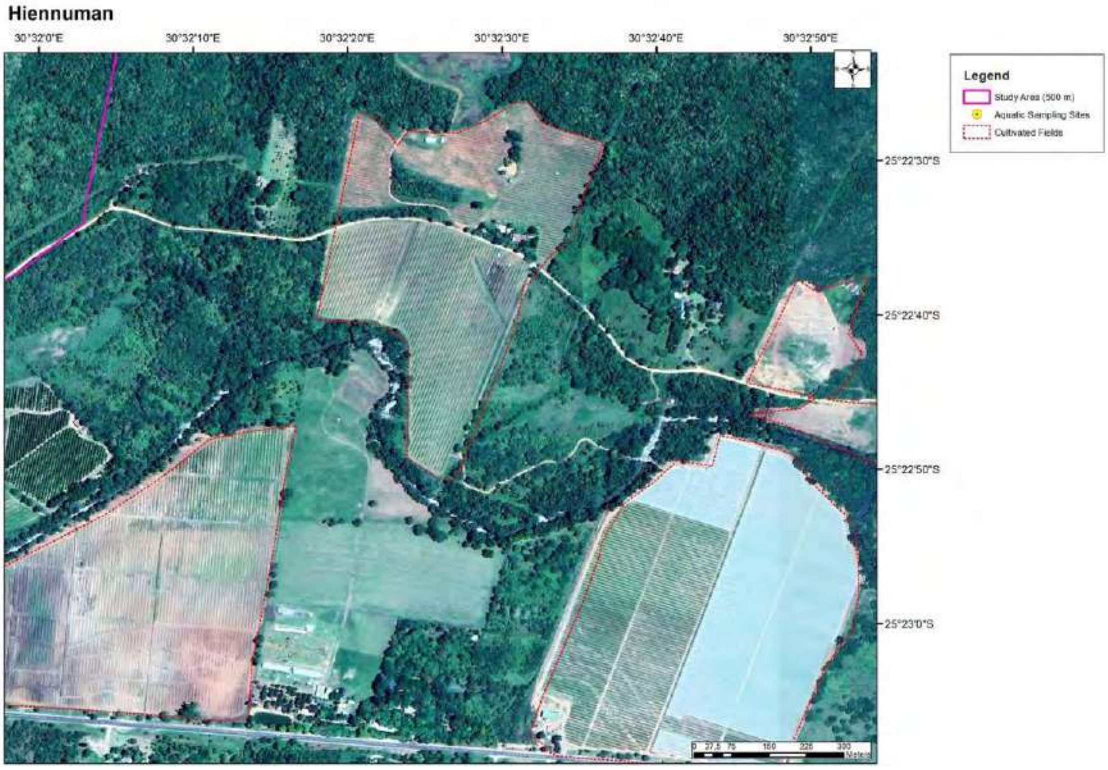

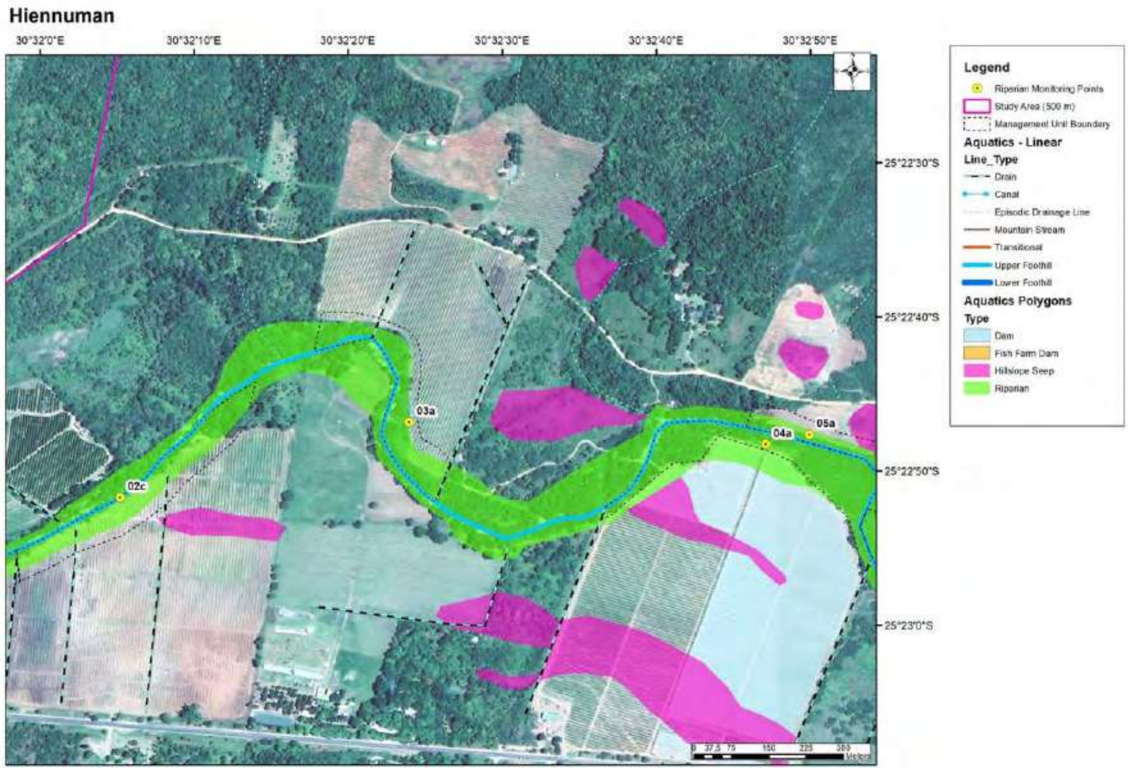

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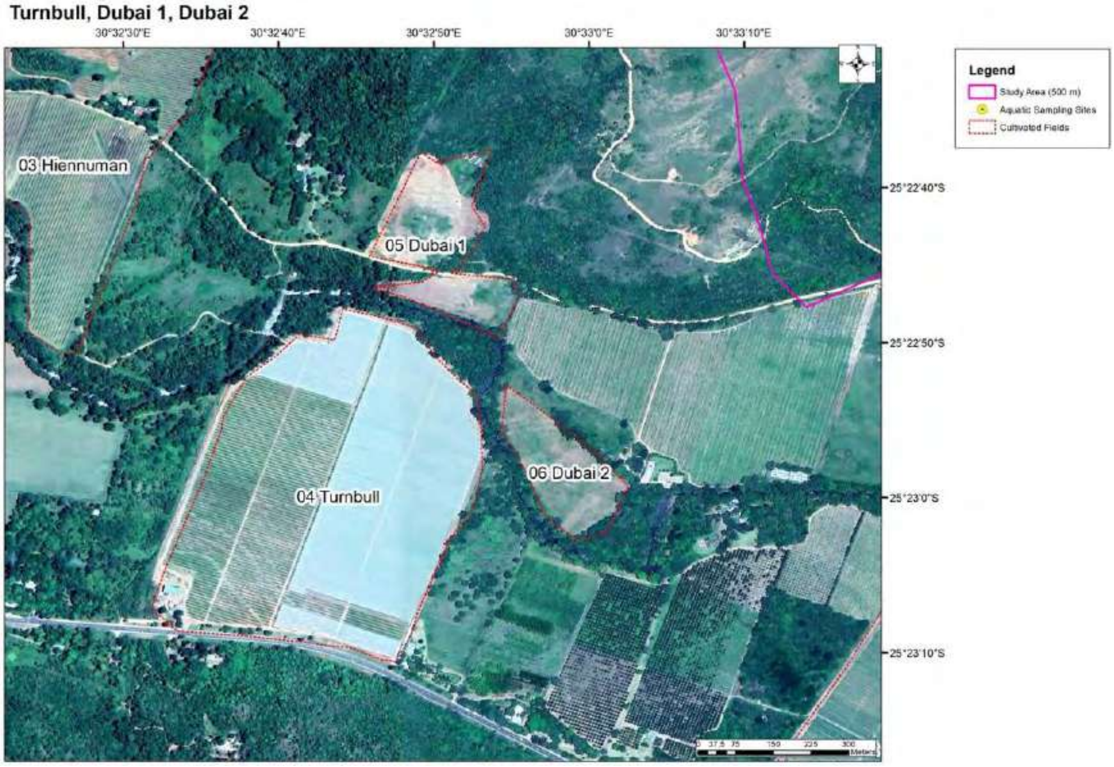

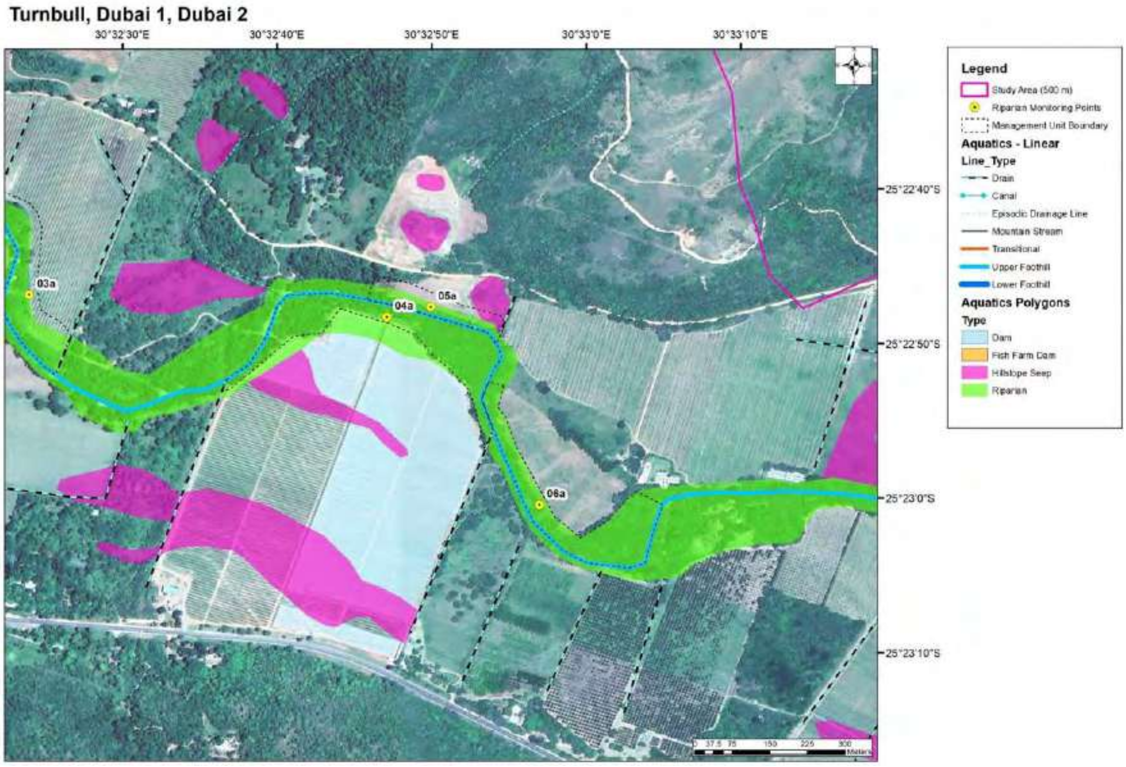

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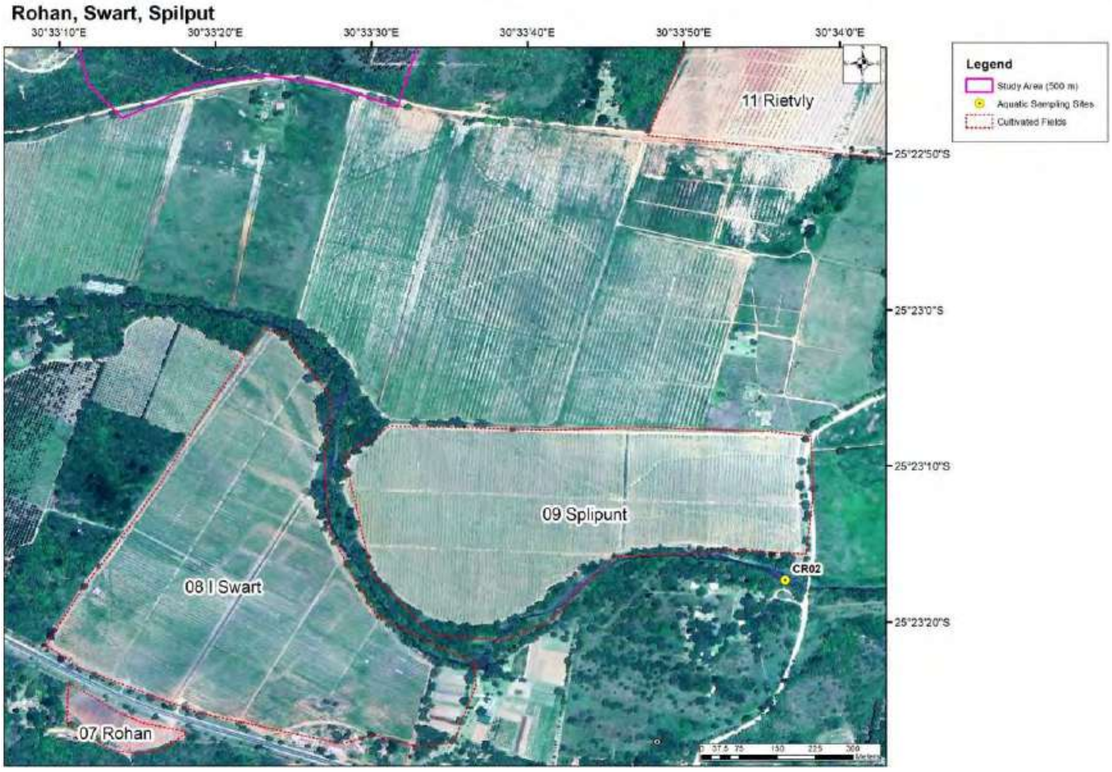

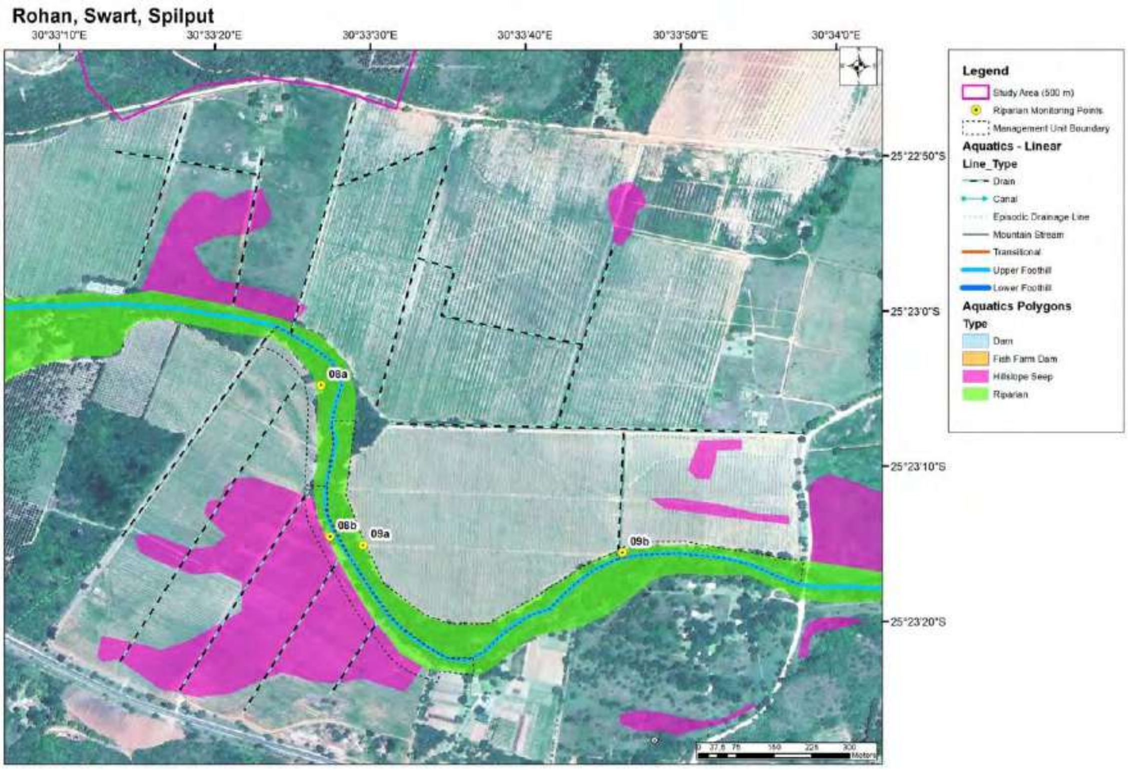

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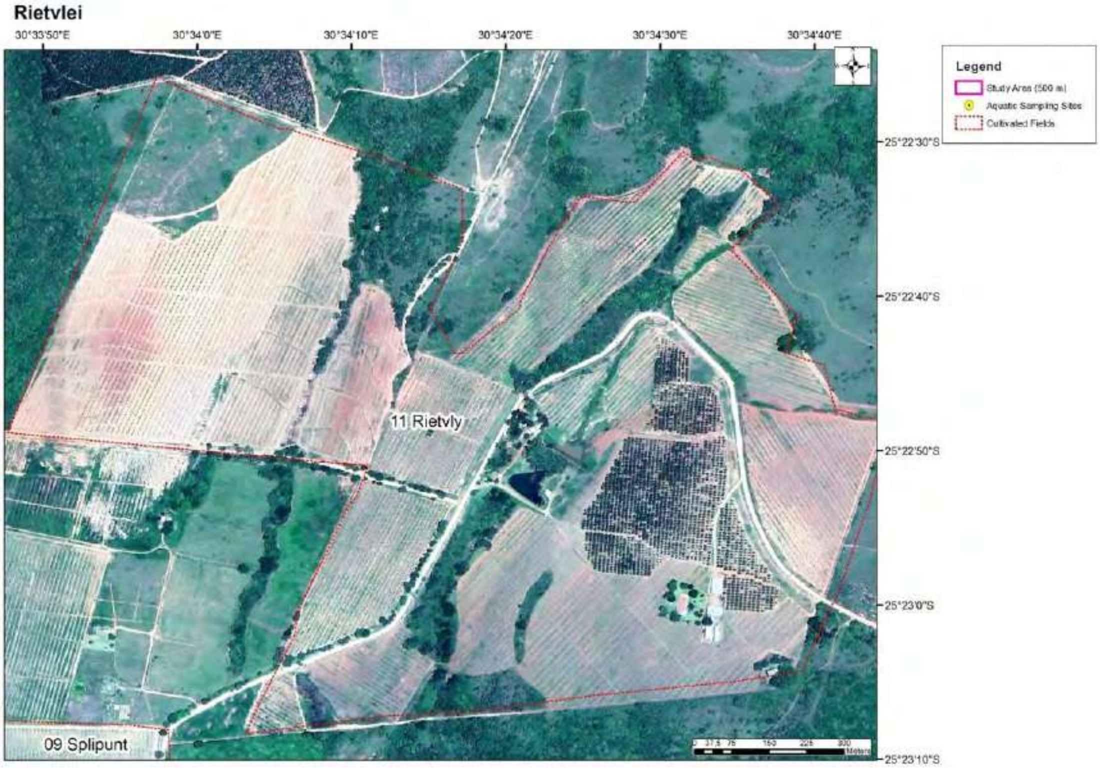

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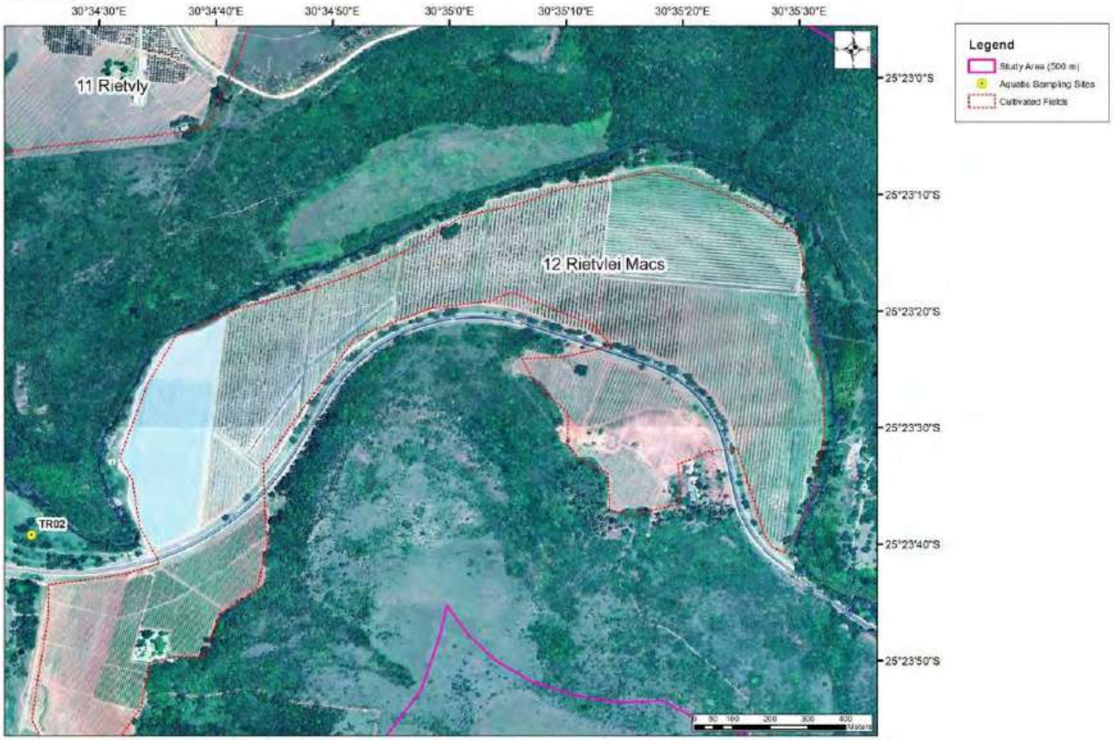
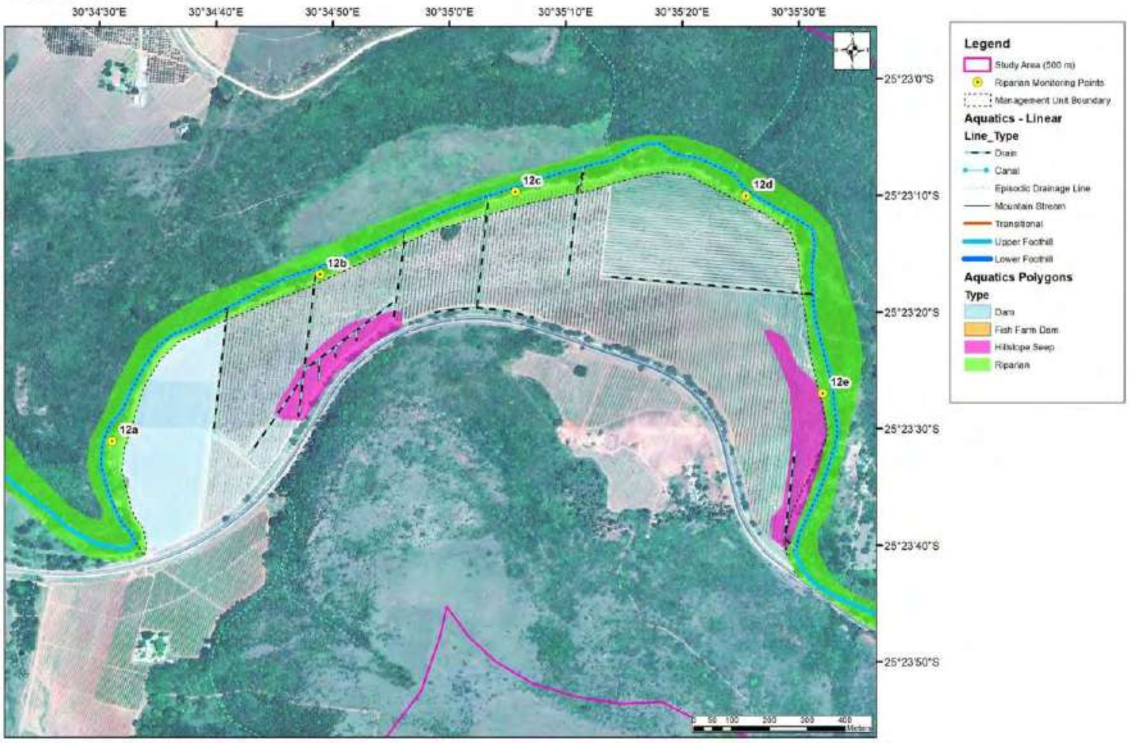
Rietvlei Macs



Rietvlei Macs



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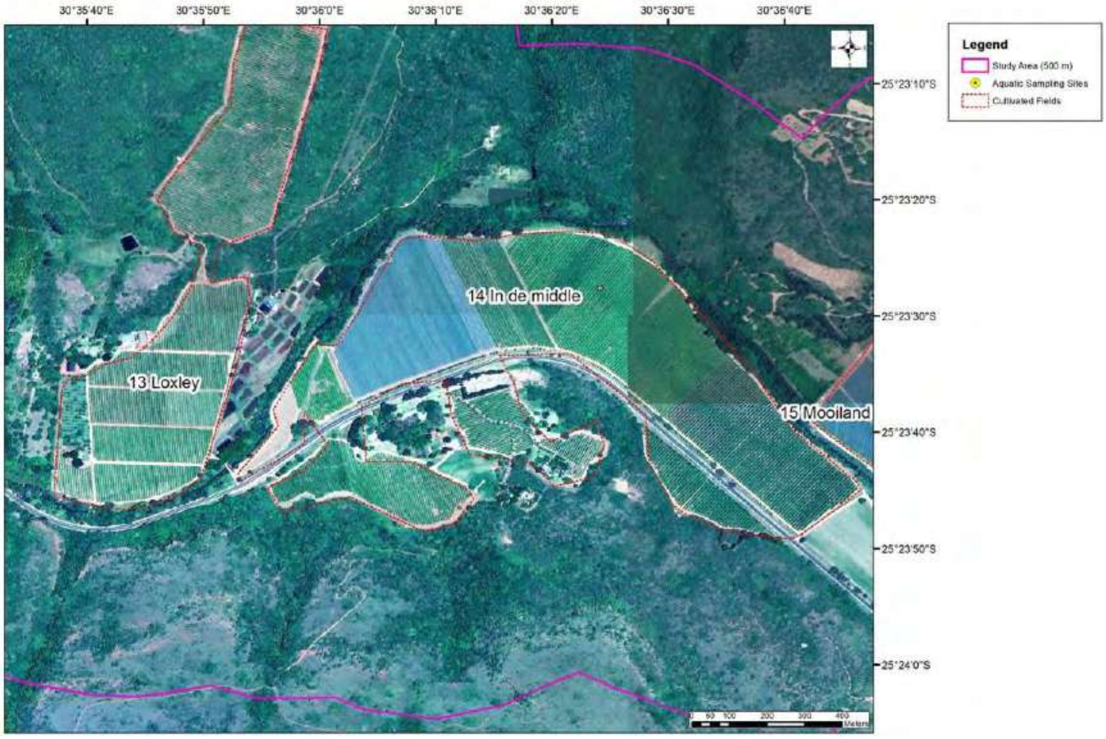
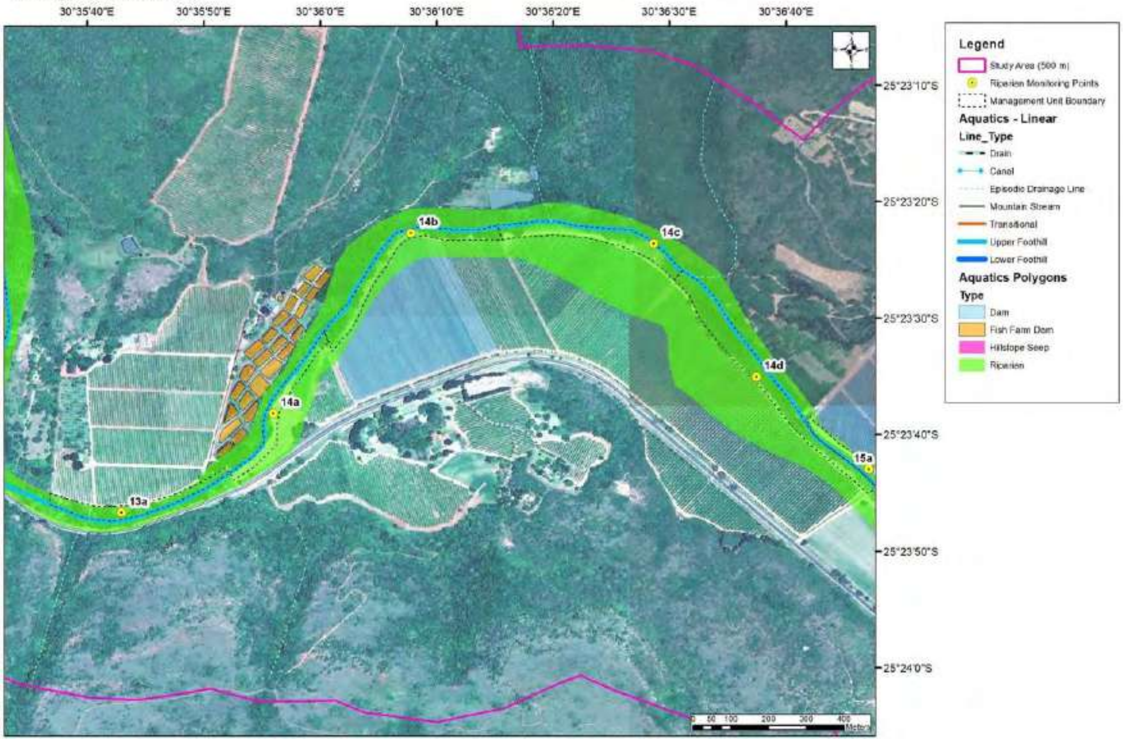
Loxley, In Die Middel



Loxley, In Die Middel



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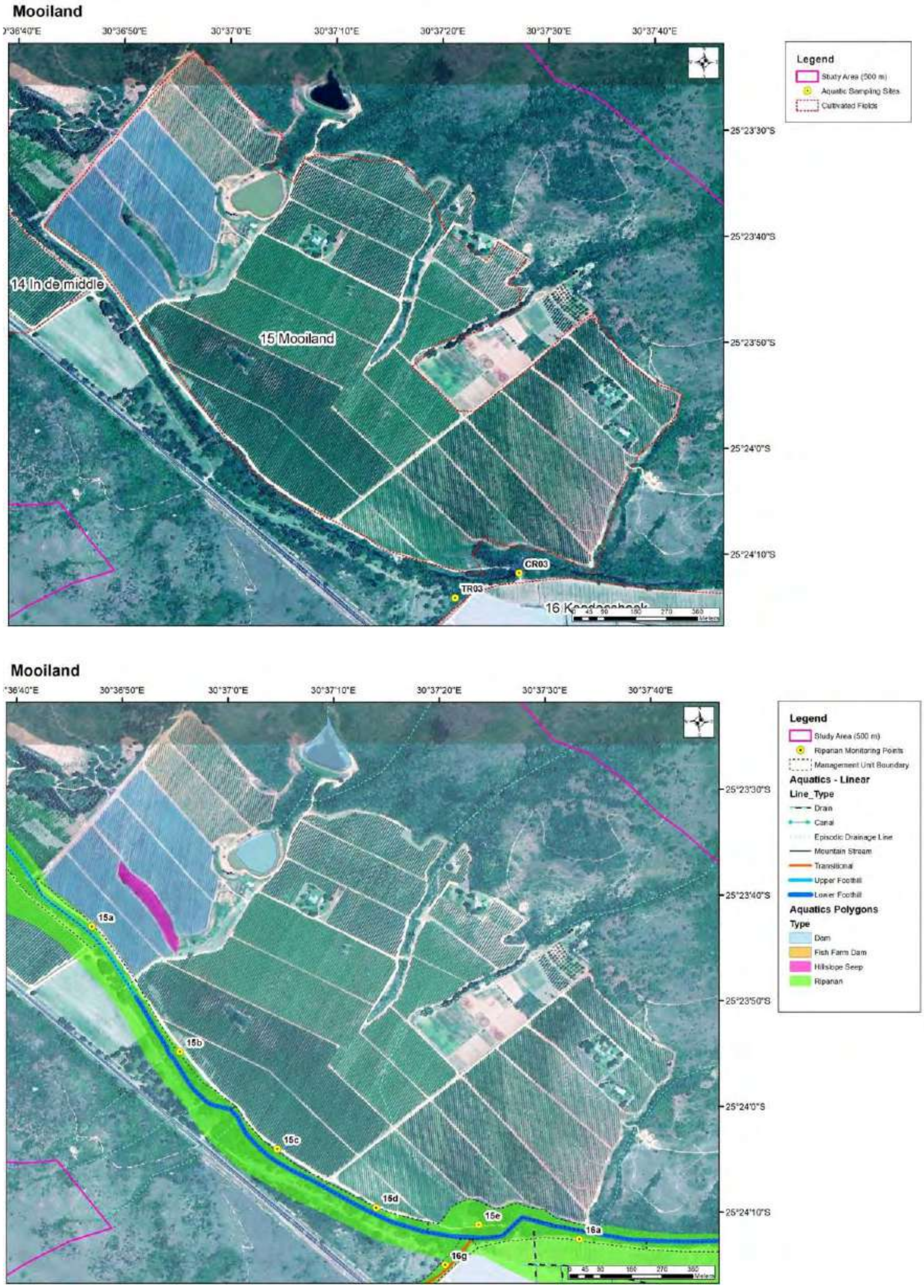

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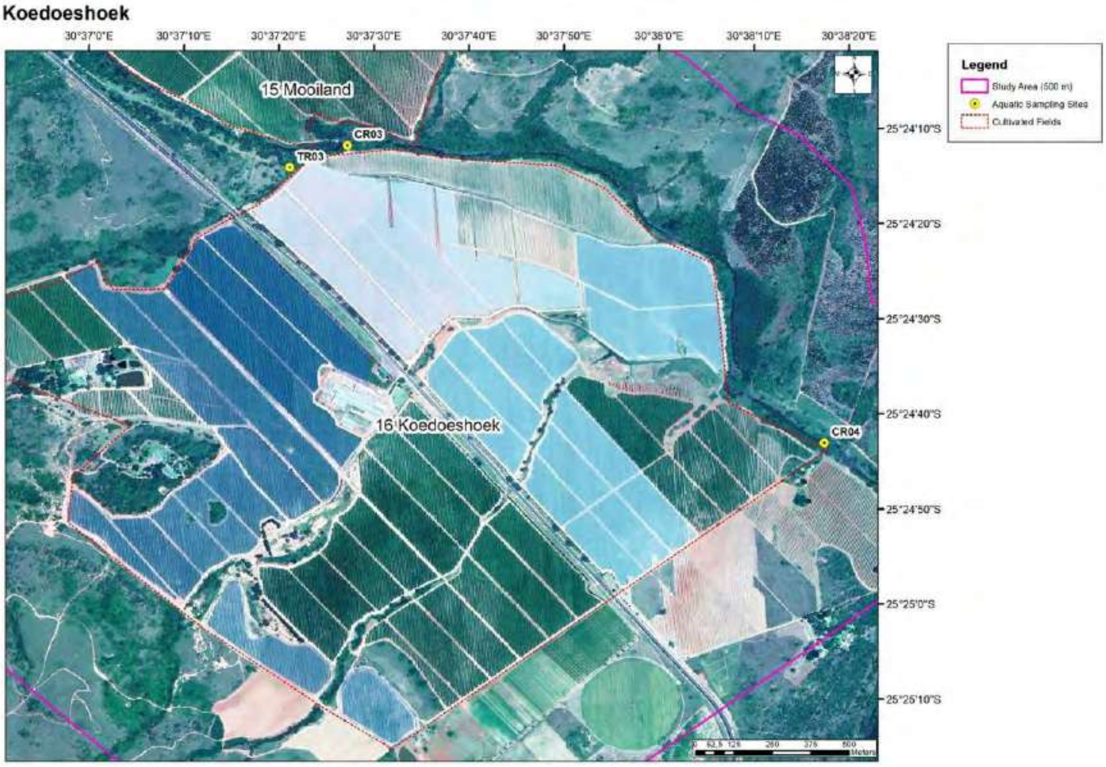

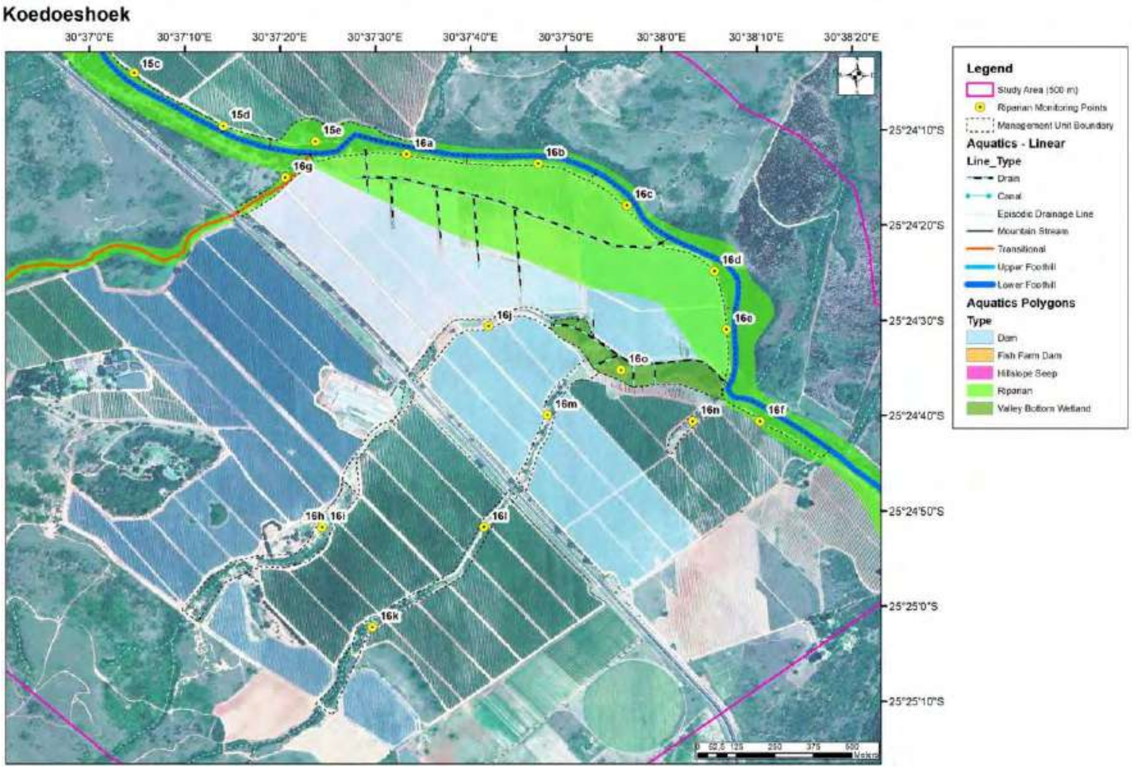

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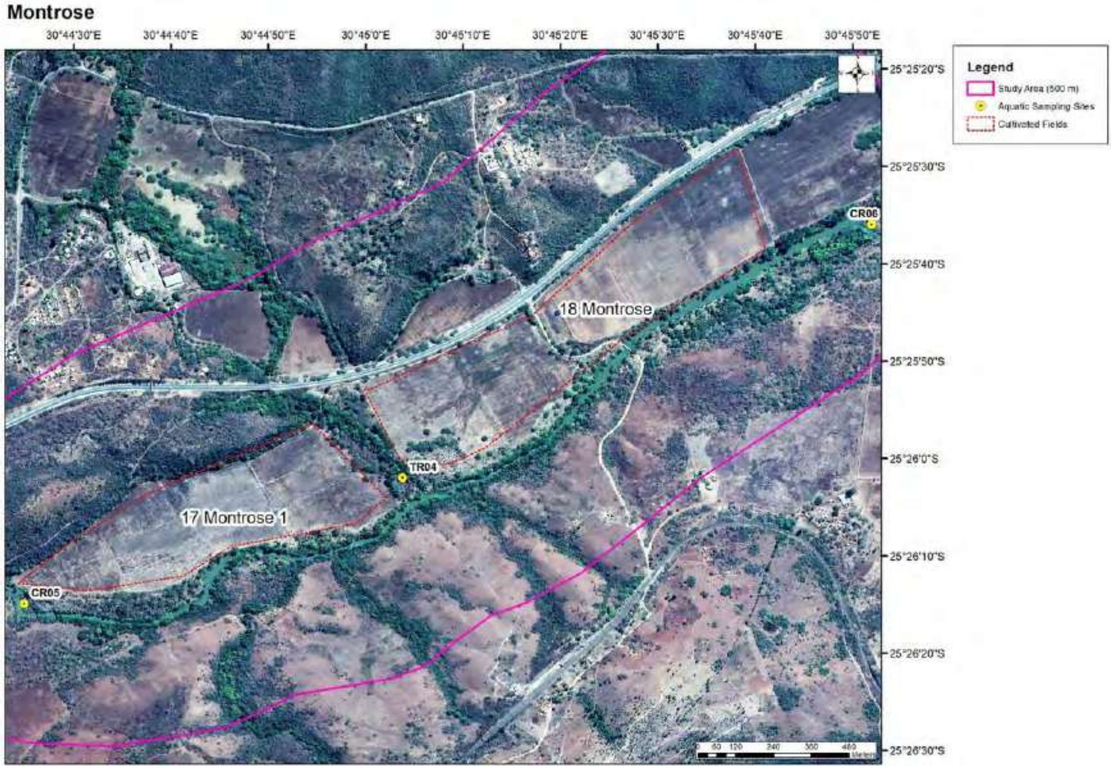

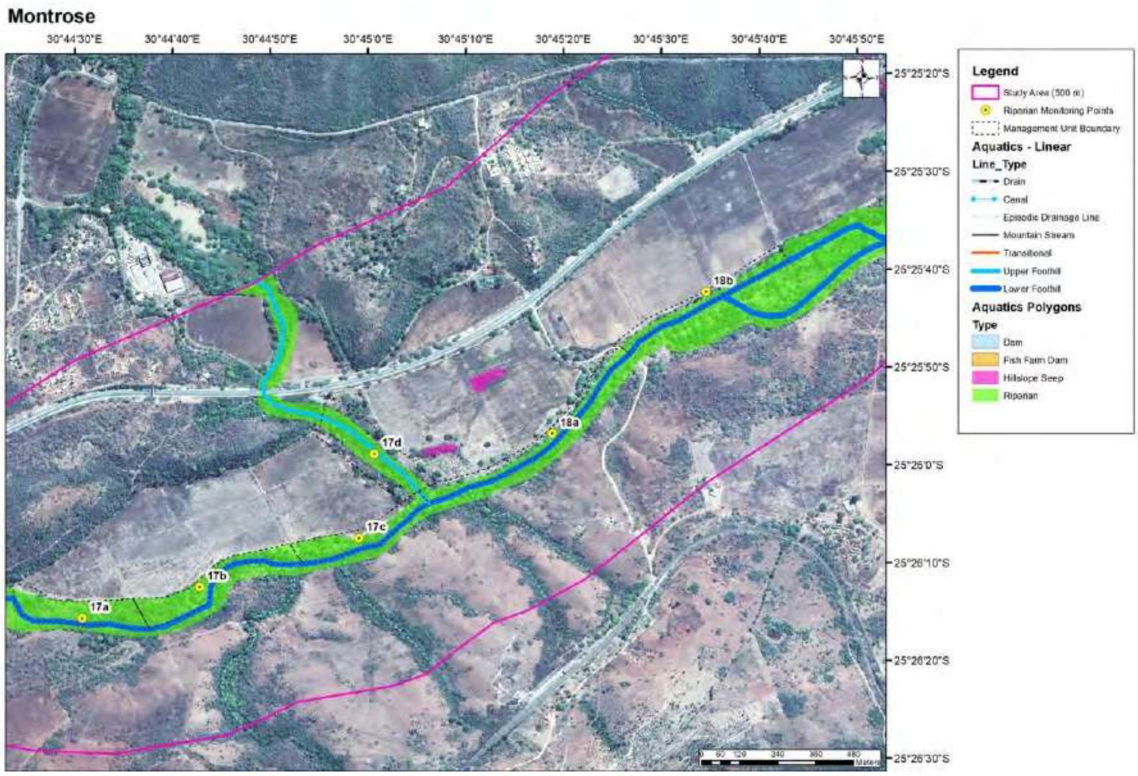

Figure 0-11. Google Earth[TM] image dated 2017-04-01 at Montrose.

Appendix D1: Water Quality – Data

Mr R. Palmer

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Box 4349
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1240
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ARC: INSTITUTE FOR SOIL, CLIMATE AND WATER
LNR: INSTITUUT VIR GROND, KLIMAAT EN WATER
Private Bag X79, PRETORIA, 000
Tel: (012) 310 2500
Fax:: (012) 310 2500

Date / Datum: 2018/05/24

REPORT NO:
VERSLAG NR: WATER 201819 11655

Sender ID: SP01 13/05/2018 **Lab. No:** W174

pH	pHs	SAR	Electric Conductivity
7.82	9.22	0.33	9.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l	CATIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.08	0.00	Sodium (400)	2.80	0.12
Nitrite (4.0)	0.00	0.00	Potassium (400)	0.77	0.02
Nitrate (44.0)	0.79	0.01	Calcium (200)	2.31	0.12
Chloride (250)	1.47	0.04	Magnesium (100)	1.92	0.16
Sulphate (500)	0.98	0.02	Boron (1.5)	0.01	0.00
Phosphate	0.51	0.01			
Carbonate (20.0)	0.00	0.00			
Bicarbonate	71.37	1.17			
Subtotal	75.20	1.26	Subtotal	7.81	0.42

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	75.08	0.89
Alkalinity	58.50	1.17
Temp. Hardness	13.81	0.28
Perm. Hardness	0.00	0.00

Total	83.00
Less (*)	35.69
Total disolved Solids	47.32

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 1 of 11

Mr R. Palmer

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Tel: (012) 310 2500
Fax:: (012) 310 2500

Date / Datum: 2018/05/24
REPORT NO: VERSLAG NR: WATER 201819 11655

Sender ID: SP02 13/05/2018 **Lab. No:** W 175

pH	pHs	SAR	Electric Conductivity
7.66	9.34	0.31	9.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.03	0.00
Nitrite (4.0)	0.00	0.00
Nitrate (44.0)	0.21	0.00
Chloride (250)	1.06	0.03
Sulphate (500)	0.66	0.01
Phosphate	0.19	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	61.00	1.00
Subtotal	63.15	1.05

CATIONS	mg/l	mmol(c)/l
Sodium (400)	2.55	0.11
Potassium (400)	0.76	0.02
Calcium (200)	2.01	0.10
Magnesium (100)	1.92	0.16
Boron (1.5)	0.01	0.00
Subtotal	7.25	0.39

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	62.06	0.74
Alkalinity	50.00	1.00
Temp. Hardness	13.06	0.26
Perm. Hardness	0.00	0.00

Total	70.00
Less (*)	30.50
Total disolved Solids	39.50

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 2 of 11

Mr R. Palmer

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Fax:: (012) 310 2500

Date / Datum: 2018/05/24

REPORT NO: **VERSLAG NR:** WATER 201819 11655

Sender ID: TR01 13/05/2018 **Lab. No:** W 176

pH	pHs	SAR	Electric Conductivity
7.58	9.74	0.33	8.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.10	0.01
Nitrite (4.0)	0.33	0.01
Nitrate (44.0)	0.44	0.01
Chloride (250)	1.46	0.04
Sulphate (500)	0.33	0.01
Phosphate	0.16	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	61.00	1.00
Subtotal	63.82	1.07

CATIONS	mg/l	mmol(c)/l
Sodium (400)	2.04	0.09
Potassium (400)	0.73	0.02
Calcium (200)	0.80	0.04
Magnesium (100)	1.22	0.10
Boron (1.5)	0.01	0.00
Subtotal	4.80	0.25

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	71.98	0.86
Alkalinity	50.00	1.00
Temp. Hardness	7.16	0.14
Perm. Hardness	0.00	0.00

Total	68.00
Less (*)	30.50
Total disolved Solids	37.50

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 3 of 11

Mr R. Palmer

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Private Bag X79, PRETORIA, 000
Tel: (012) 310 2500
Fax:: (012) 310 2500
Date / Datum: 2018/05/24
REPORT NO: / VERSLAG NR: WATER 201819 11655

Sender ID: SP03 13/05/2018 **Lab. No:** W 177

pH	pHs	SAR	Electric Conductivity
7.71	9.27	0.33	10.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l	CATIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.04	0.00	Sodium (400)	2.86	0.12
Nitrite (4.0)	0.03	0.00	Potassium (400)	0.74	0.02
Nitrate (44.0)	0.09	0.00	Calcium (200)	2.27	0.11
Chloride (250)	1.45	0.04	Magnesium (100)	2.15	0.18
Sulphate (500)	0.62	0.01	Boron (1.5)	0.01	0.00
Phosphate	0.00	0.00			
Carbonate (20.0)	0.00	0.00			
Bicarbonate	64.66	1.06			
Subtotal	66.89	1.12	Subtotal	8.03	0.44

Sodium Carbonate	0.00	0.00	Total	74.00
Sodium Bicarbonate	64.42	0.77	Less (*)	32.33
Alkalinity	53.00	1.06	Total disolved Solids	41.67
Temp. Hardness	14.65	0.29		
Perm. Hardness	0.00	0.00		

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 4 of 11

Mr R. Palmer

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Tel: (012) 310 2500
Fax:: (012) 310 2500

Date / Datum: 2018/05/24

REPORT NO:
VERSLAG NR: WATER 201819 11655

Sender ID: CR01 13/05/2018 **Lab. No:** W 178

pH	pHs	SAR	Electric Conductivity
8.09	8.49	0.28	17.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.15	0.01
Nitrite (4.0)	0.00	0.00
Nitrate (44.0)	0.16	0.00
Chloride (250)	3.37	0.09
Sulphate (500)	3.19	0.07
Phosphate	0.11	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	109.80	1.80
Subtotal	116.78	1.97

CATIONS	mg/l	mmol(c)/l
Sodium (400)	4.79	0.21
Potassium (400)	1.28	0.03
Calcium (200)	8.65	0.43
Magnesium (100)	8.62	0.71
Boron (1.5)	0.01	0.00
Subtotal	23.35	1.39

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	55.09	0.66
Alkalinity	90.00	1.80
Temp. Hardness	57.21	1.14
Perm. Hardness	0.00	0.00

Total	140.00
Less (*)	54.90
Total disolved Solids	85.10

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 5 of 11

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Date / Datum: 2018/05/24

REPORT NO: / VERSLAG NR: WATER 201819 11655

Sender ID: CR02 13/05/2018 **Lab. No:** W 179

pH	pHs	SAR	Electric Conductivity
8.06	8.75	0.27	16.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l	CATIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.10	0.01	Sodium (400)	4.56	0.20
Nitrite (4.0)	0.00	0.00	Potassium (400)	1.22	0.03
Nitrate (44.0)	0.17	0.00	Calcium (200)	8.09	0.40
Chloride (250)	2.79	0.08	Magnesium (100)	7.82	0.64
Sulphate (500)	2.96	0.06	Boron (1.5)	0.01	0.00
Phosphate	0.00	0.00			
Carbonate (20.0)	0.00	0.00			
Bicarbonate	61.61	1.01			
Subtotal	67.63	1.16	Subtotal	21.70	1.28

Sodium Carbonate	0.00	0.00	Total	89.00
Sodium Bicarbonate	0.00	0.00	Less (*)	30.81
Alkalinity	50.50	1.01	Total disolved Solids	58.20
Temp. Hardness	50.50	1.01		
Perm. Hardness	2.02	0.04		

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 6 of 11

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Date / Datum: 2018/05/24

REPORT NO:
VERSLAG NR: WATER 201819 11655

Sender ID: TR02 13/05/2018 **Lab. No:** W 180

pH	pHs	SAR	Electric Conductivity
7.77	9.17	0.31	10.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.07	0.00
Nitrite (4.0)	0.10	0.00
Nitrate (44.0)	0.37	0.01
Chloride (250)	1.36	0.04
Sulphate (500)	0.69	0.01
Phosphate	0.00	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	68.93	1.13
Subtotal	71.52	1.19

CATIONS	mg/l	mmol(c)/l
Sodium (400)	2.89	0.13
Potassium (400)	0.78	0.02
Calcium (200)	2.67	0.13
Magnesium (100)	2.48	0.20
Boron (1.5)	0.01	0.00
Subtotal	8.83	0.49

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	66.34	0.79
Alkalinity	56.50	1.13
Temp. Hardness	17.01	0.34
Perm. Hardness	0.00	0.00

Total	80.00
Less (*)	34.47
Total disolved Solids	45.54

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 7 of 11

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Date / Datum: 2018/05/24

REPORT NO: **VERSLAG NR:** WATER 201819 11655

Sender ID: CR03 13/05/2018 **Lab. No:** W 181

pH	pHs	SAR	Electric Conductivity
7.89	8.60	0.28	15.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l	CATIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.11	0.01	Sodium (400)	4.43	0.19
Nitrite (4.0)	0.00	0.00	Potassium (400)	1.10	0.03
Nitrate (44.0)	0.52	0.01	Calcium (200)	7.31	0.37
Chloride (250)	3.07	0.09	Magnesium (100)	6.94	0.57
Sulphate (500)	2.49	0.05	Boron (1.5)	0.01	0.00
Phosphate	0.12	0.00			
Carbonate (20.0)	0.00	0.00			
Bicarbonate	100.04	1.64			
Subtotal	106.35	1.80	Subtotal	19.79	1.16

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	58.88	0.70
Alkalinity	82.00	1.64
Temp. Hardness	46.95	0.94
Perm. Hardness	0.00	0.00

Total	126.00
Less (*)	50.02
Total disolved Solids	75.98

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 8 of 11

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Date / Datum: 2018/05/24

REPORT NO:
VERSLAG NR: WATER 201819 11655

Sender ID: CR05 13/05/2018 **Lab. No:** W 182

pH	pHs	SAR	Electric Conductivity
8.15	8.38	1.05	31.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.09	0.00
Nitrite (4.0)	0.00	0.00
Nitrate (44.0)	0.60	0.01
Chloride (250)	21.24	0.60
Sulphate (500)	43.39	0.90
Phosphate	0.03	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	70.15	1.15
Subtotal	135.50	2.67

CATIONS	mg/l	mmol(c)/l
Sodium (400)	23.80	1.03
Potassium (400)	1.17	0.03
Calcium (200)	18.40	0.92
Magnesium (100)	12.60	1.04
Boron (1.5)	0.01	0.00
Subtotal	55.98	3.02

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	96.60	1.15
Alkalinity	57.50	1.15
Temp. Hardness	57.50	1.15
Perm. Hardness	40.45	0.81

Total	191.00
Less (*)	35.08
Total disolved Solids	155.93

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 9 of 11

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Date / Datum: 2018/05/24
REPORT NO: VERSLAG NR: WATER 201819 11655

Sender ID: TR04 13/05/2018 **Lab. No:** W 183

pH	pHs	SAR	Electric Conductivity
7.83	8.80	0.18	13.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.04	0.00
Nitrite (4.0)	0.00	0.00
Nitrate (44.0)	0.51	0.01
Chloride (250)	1.21	0.03
Sulphate (500)	1.98	0.04
Phosphate	0.11	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	67.10	1.10
Subtotal	70.95	1.19

CATIONS	mg/l	mmol(c)/l
Sodium (400)	2.46	0.11
Potassium (400)	0.81	0.02
Calcium (200)	6.63	0.33
Magnesium (100)	4.53	0.37
Boron (1.5)	0.00	0.00
Subtotal	14.43	0.83

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	33.26	0.40
Alkalinity	55.00	1.10
Temp. Hardness	35.20	0.70
Perm. Hardness	0.00	0.00

Total	85.00
Less (*)	33.55
Total disolved Solids	51.45

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

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Date / Datum: 2018/05/24
REPORT NO: VERSLAG NR: WATER 201819 11655

Sender ID: CR06 13/05/2018 **Lab. No:** W 184

pH	pHs	SAR	Electric Conductivity
8.02	8.43	0.90	27.00 mS/m at 25 °C

ANIONS	mg/l	mmol(c)/l
Fluoride (1.5)	0.13	0.01
Nitrite (4.0)	0.00	0.00
Nitrate (44.0)	0.44	0.01
Chloride (250)	15.89	0.45
Sulphate (500)	32.81	0.68
Phosphate	0.00	0.00
Carbonate (20.0)	0.00	0.00
Bicarbonate	72.59	1.19
Subtotal	121.86	2.34

CATIONS	mg/l	mmol(c)/l
Sodium (400)	18.80	0.82
Potassium (400)	1.09	0.03
Calcium (200)	15.50	0.78
Magnesium (100)	10.70	0.88
Boron (1.5)	0.01	0.00
Subtotal	46.10	2.50

Sodium Carbonate	0.00	0.00
Sodium Bicarbonate	99.96	1.19
Alkalinity	59.50	1.19
Temp. Hardness	59.50	1.19
Perm. Hardness	23.39	0.47

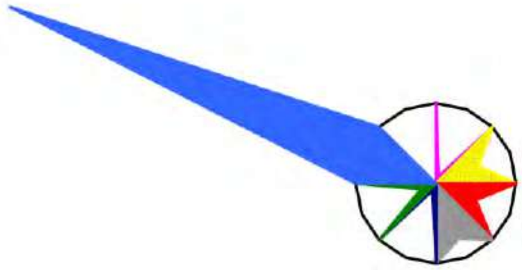
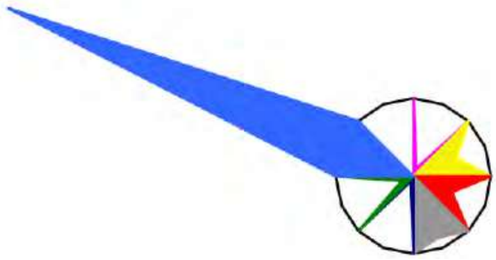
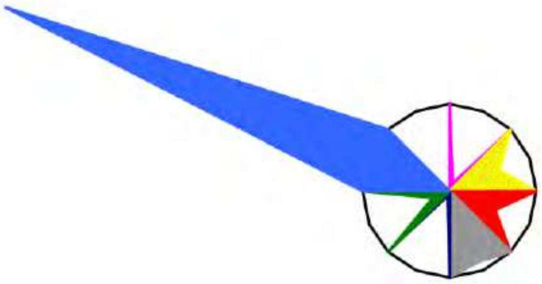
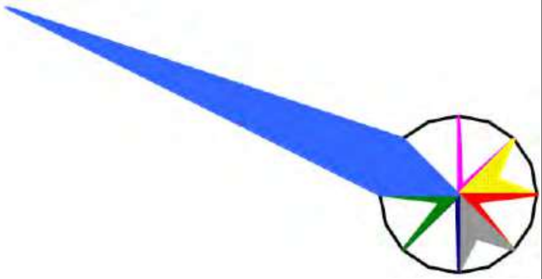
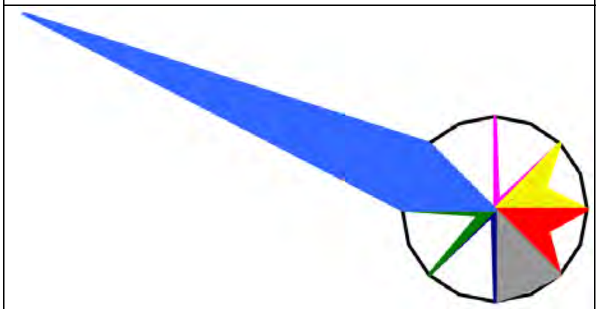
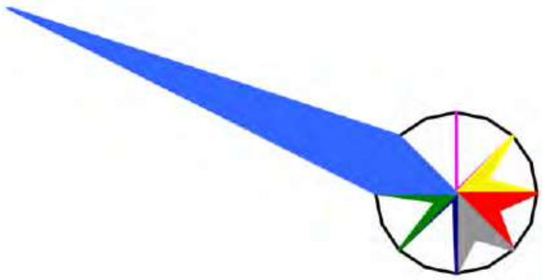
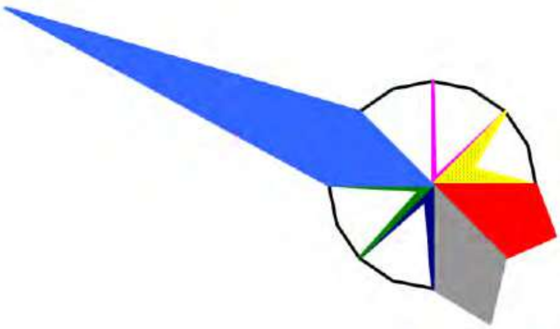
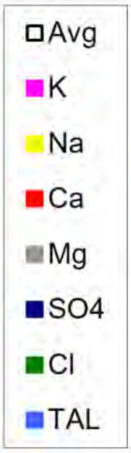
Total	167.00
Less (*)	36.30
Total disolved Solids	130.71

* Correction for any volatile substances, HCO3/2 or .... HCL + HNO3 + HF + ...
() Figures in brackets are the recommended maximum values for human use in mg/l.

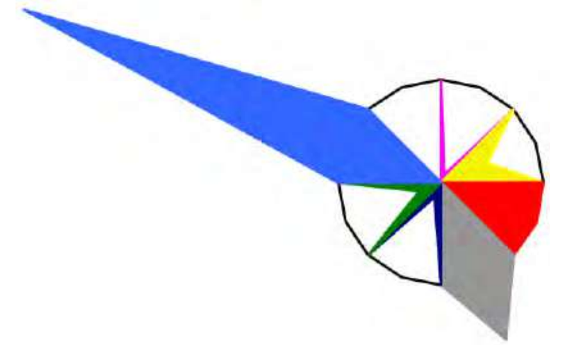
NB: No analysis was done for microbiological pathogenes, organic compounds and insecticides.

Thursday, 24 May 2018 Page 11 of 11

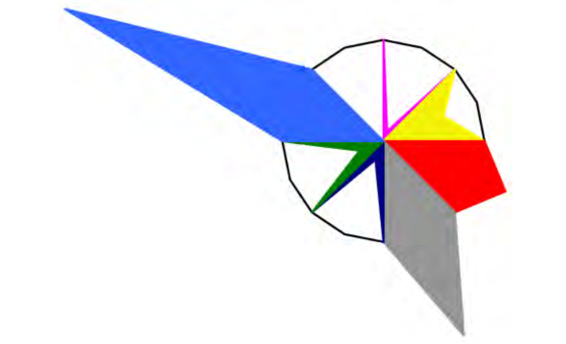
Appendix D2: Water Quality – Maucha Diagrams

SP01	SP02
	
SP03	**TR01**
	
TR02	**TR03**
	
TR04	
	

CR01



CR02



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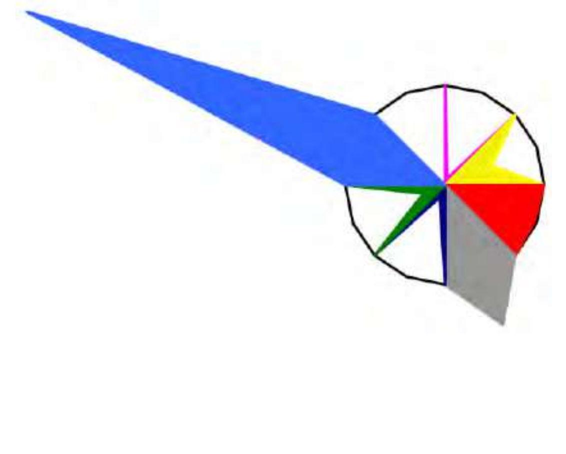
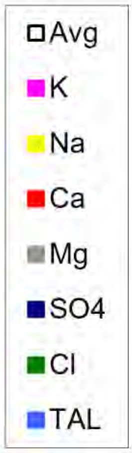
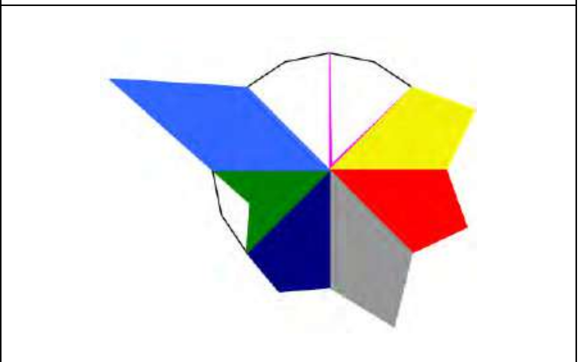




CR05

CR06



Appendix E: Detailed Data – SASS5

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	16-May-2018
Site Code	SP01 (X2STER-R539B)
River	Sterkspruit
Elev (m)	1 100
Grid	S25.41536 E30.49392
Accuracy	GPS
Gradient	
Zonation	C: Transitional
Quat	X21E
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	-
Turbidity	V Low
Colour	Clear
Benthic Algae (%)	20
Temp (°C)	-
pH	7.8
Cond (mS/m)	9
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	4	22.0
Stones Out Current	4	8.0
Bedrock	0	8.0
Aquatic Veg	0	0.5
Marg Veg In Current	0	1.0
Marg Veg Out Of Current	3	1.0
Gravel	3	3.0
Sand	3	1.0
Mud	0	0.5
Visual observation	Yes	
BIOTOPE SUITABILITY	60%	C

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1				
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	A			A
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6	A			A
Baetidae > 2 sp	12				
Caenidae (Squaregills/Cainfles)	6	1	1		A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9	1		1	A
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9			1	1
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4				
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8	A		A	A
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6			1	1
Libellulidae (Darters/Skimmers)	4		A		A
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3	1		B	B
Gerridae* (Pond skaters/Water striders)	5		A		A
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5		A	1	A
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	B			B
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		A		A
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12	A		1	A
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10	A			A

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	1			1
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5	A			A
Chironomidae (Midges)	2			A	A
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	1			1
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					120
No. of Taxa					19
ASPT					6.3
Present Ecological State (A-F)					D

Other biota:

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	16-May-2018
Site Code	SP02
River	Sterkspruit
Elev (m)	1 056
Grid	S25.40276 E30.50390
Accuracy	GPS
Gradient	-
Zonation	C: Transitional
Quat	X21E
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	-
Turbidity	V Low
Colour	Clear
Benthic Algae (%)	10
Temp (°C)	-
pH	7.7
Cond (mS/m)	9
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	3	22.0
Stones Out Current	3	8.0
Bedrock	0	8.0
Aquatic Veg	0	0.5
Marg Veg In Current	0	1.0
Marg Veg Out Of Current	2	1.0
Gravel	2	3.0
Sand	0	1.0
Mud	2	0.5
Visual observation	Yes	
BIOTOPE SUITABILITY	44%	D

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3	A			A
ANNELIDA					
Oligochaeta (Earthworms)	1				
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3				
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4	1	A		
Baetidae 2 sp	6				A
Baetidae > 2 sp	12				
Caenidae (Squaregills/Cainfles)	6	A			A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9	A			A
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	B			B
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10	1			1
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6			B	B
Libellulidae (Darters/Skimmers)	4		1		1
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3			C	C
Gerridae* (Pond skaters/Water striders)	5		1		1
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5		A		A
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4	B			B
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		A		A
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5		A		A
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10	1			1

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	A			A
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5		B		B
Chironomidae (Midges)	2		A		A
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	1			1
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5			1	1
GASTROPODA (Snails)					
Ancylidae (Limpets)	6	A			A
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					128
No. of Taxa					22
ASPT					5.8
Present Ecological State (A-F)					D

Other biota:

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	16-May-2018
Site Code	SP03
River	Sterkspruit
Elev (m)	969
Grid	S25.38320 E30.52509
Accuracy	GPS
Gradient	-
Zonation	C: Transitional
Quat	X21E
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	-
Turbidity	Low
Colour	Clear
Benthic Algae (%)	0
Temp (°C)	-
pH	7.7
Cond (mS/m)	10
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	3	22.0
Stones Out Current	2	8.0
Bedrock	4	8.0
Aquatic Veg	0	0.5
Marg Veg In Current	3	1.0
Marg Veg Out Of Current	1	1.0
Gravel	0	3.0
Sand	0	1.0
Mud	2	0.5
Visual observation	Yes	
BIOTOPE SUITABILITY	53%	C

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1		1		1
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13		A		A
Potamonautidae* (Crabs)	3	A			A
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8		1		1
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6				
Baetidae > 2 sp	12	B			B
Caenidae (Squaregills/Cainfles)	6		1		1
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9		1		1
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	B			B
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10		A		A
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4				
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8	1			1
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6	1			1
Libellulidae (Darters/Skimmers)	4		1		1
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3	1		A	A
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5				
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12	B			B
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		1		1
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8		1		1
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	A	A	1	B
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5			1	1
Chironomidae (Midges)	2			A	A
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5		A		A
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5		1		1
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					145
No. of Taxa					21
ASPT					6.9
Present Ecological State (A-F)					C

Other biota:

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	16-May-2018	Project	Joubert & Seuns (Pty) Ltd
Site Code	TR01 (X2JUNG-MOOIP)	Collector	Rob Palmer
		Flow	Low
		Clarity (NTU)	-
River	Jungle	Turbidity	V Low
Elev (m)	1 160	Colour	Clear
Grid	S25.41247 E30.49719	Benthic Algae (%)	20
Accuracy	GPS	Temp (°C)	-
Gradient	-	pH	7.6
Zonation	B: Mountain Stream	Cond (mS/m)	8
Quat	X21E	DO (mg/ℓ)	-
Ecoregion	10: Northern Escarpment Mountains	Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	4	25.0
Stones Out Current	3	2.0
Bedrock	0	10.0
Aquatic Veg	0	0.5
Marg Veg In Current	0	0.5
Marg Veg Out Of Current	3	0.5
Gravel	2	2.0
Sand	2	0.5
Mud	1	0.0
Visual observation	Yes	
BIOTOPE SUITABILITY	55%	C

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1				
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3				
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6		A		
Baetidae > 2 sp	12	B			B
Caenidae (Squaregills/Cainfles)	6		A		A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9	A	B		B
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	A			A
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10	1			1
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4				
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8		1		1
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6			1	1
Libellulidae (Darters/Skimmers)	4				
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3				
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5			1	1
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4	B			B
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6				
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5	A			A
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12	A			A
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	A			A
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2	1			1
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1	A			A
Simuliidae (Blackflies)	5				
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					99
No. of Taxa					14
ASPT					7.1
Present Ecological State (A-F)					D

Other biota:

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	28-May-2018	Project	Joubert & Seuns (Pty) Ltd	Biotopes	(0-5)	Weight	
Site Code	TR03	Collector	Rob Palmer	Stones In Current	3	22.0	
		Flow	Low	Stones Out Current	3	8.0	
		Clarity (NTU)	3	Bedrock	0	8.0	
River	Devil's Creek	Turbidity	V Low	Aquatic Veg	0	0.5	
Elev (m)	877	Colour	Clear	Marg Veg In Current	4	1.0	
Grid	S25.40392 E30.62253	Benthic Algae (%)	0	Marg Veg Out Of Current	2	1.0	
Accuracy	GPS	Temp (°C)	14.8	Gravel	0	3.0	
Gradient	-	pH	7.1	Sand	2	1.0	
Zonation	C: Transitional	Cond (mS/m)	4.6	Mud	4	0.5	
Quat	X21E	DO (mg/ℓ)	-	Visual observation	Yes		
Ecoregion	10: Northern Escarpment Mountains	Disturbance	-	BIOTOPE SUITABILITY	44%	D	

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1				
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	A			A
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8	1			1
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12	A			A
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6	A			
Baetidae > 2 sp	12		A		B
Caenidae (Squaregills/Cainfles)	6		1		1
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13	A			A
Leptophlebiidae (Prongills)	9	1			1
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9				
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10	A			A
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8	1			1
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6			1	1
Libellulidae (Darters/Skimmers)	4	A			A
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3				
Gerridae* (Pond skaters/Water striders)	5		A		A
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5		A		A
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	B			B
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		A		A
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8	1			1
Gyrinidae* (Whirligig beetles)	5		A		A
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12		1		1
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10	1			1

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10		1		1
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2				
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10			1	1
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	B			B
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6	1			1
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					183
No. of Taxa					24
ASPT					7.6
Present Ecological State (A-F)					A/B

Other biota:

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	28-May-2018
Site Code	TR04
River	Houtbosloop
Elev (m)	739
Grid	S25.43286 E30.75012
Accuracy	GPS
Gradient	-
Zonation	D: Upper Foothills
Quat	X22B
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	3
Turbidity	V Low
Colour	Clear
Benthic Algae (%)	0
Temp (°C)	18.9
pH	7.4
Cond (mS/m)	13
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	4	20.0
Stones Out Current	3	10.0
Bedrock	0	5.0
Aquatic Veg	0	0.5
Marg Veg In Current	0	2.0
Marg Veg Out Of Current	4	2.0
Gravel	2	3.5
Sand	0	1.0
Mud	2	0.5
Visual observation	Yes	
BIOTOPE SUITABILITY	57%	C

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1			1	1
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3				
Atyidae (Freshwater Shrimps)	8		B		B
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6	A	A		
Baetidae > 2 sp	12				B
Caenidae (Squaregills/Cainfles)	6			1	1
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13	A	A		B
Leptophlebiidae (Prongills)	9				
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9				
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10		1		1
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8	A			A
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4				
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3	A			A
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5		A	A	B
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4		A	A	A
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10		1		1
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6	1	1		A
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5	1			1
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10				
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2	A			A
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	A			A
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3			1	1
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					105
No. of Taxa					17
ASPT					6.2
Present Ecological State (A-F)					D/E

Other biota:

Baetidae mostly Baetis harrisoni

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	16-May-2018
Site Code	CR01
River	Crocodile
Elev (m)	964
Grid	S25.38189 E30.52600
Accuracy	GPS
Gradient	-
Zonation	D: Upper Foothills
Quat	X21E
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	-
Turbidity	Low
Colour	Clear
Benthic Algae (%)	0
Temp (°C)	-
pH	8.1
Cond (mS/m)	17
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	4	20.0
Stones Out Current	4	10.0
Bedrock	0	5.0
Aquatic Veg	0	0.5
Marg Veg In Current	0	2.0
Marg Veg Out Of Current	4	2.0
Gravel	2	3.5
Sand	0	1.0
Mud	1	0.5
Visual observation	Yes	
BIOTOPE SUITABILITY	61%	B

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1			1	1
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	A			A
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4	A			
Baetidae 2 sp	6		A		
Baetidae > 2 sp	12				B
Caenidae (Squaregills/Cainfles)	6	A	1		A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13	A	A		B
Leptophlebiidae (Prongills)	9			A	A
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10	1		1	A
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	A			A
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10		1	1	A
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8		A		A
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4			1	1
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3	B			B
Gerridae* (Pond skaters/Water striders)	5		1		1
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3		A		A
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4		1		1
Veliidae/M...veliidae* (Ripple bugs)	5		A		A
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8		1	1	A
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	A			A
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		1		1
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5	1			1
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10			1	1

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10				
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5	A			A
Chironomidae (Midges)	2	B			B
Culicidae* (Mosquitoes)	1		1		1
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5				
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5		1		1
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					157
No. of Taxa					26
ASPT					6.0
Present Ecological State (A-F)					C/D

Other biota:

Comments/Observations:

Rocks with thick covering of diatoms

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	15-May-2018
Site Code	CR02 (X2CROC-RIETV)
River	Crocodile
Elev (m)	928
Grid	S25.38814 E30.56569
Accuracy	GPS
Gradient	-
Zonation	D: Upper Foothills
Quat	X21E
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	-
Turbidity	Low
Colour	Clear
Benthic Algae (%)	5
Temp (°C)	-
pH	8.1
Cond (mS/m)	16
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	4	20.0
Stones Out Current	2	10.0
Bedrock	0	5.0
Aquatic Veg	0	0.5
Marg Veg In Current	1	2.0
Marg Veg Out Of Current	3	2.0
Gravel	0	3.5
Sand	0	1.0
Mud	0	0.5
Visual observation	Yes	
BIOTOPE SUITABILITY	49%	D

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3	A			A
ANNELIDA					
Oligochaeta (Earthworms)	1		1		1
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	A			A
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6	A	A		
Baetidae > 2 sp	12				B
Caenidae (Squaregills/Cainfles)	6	A			A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13	A			A
Leptophlebiidae (Prongills)	9	A			A
Oligoneuridae (Brushlegged mayflies)	15	A			A
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	A			A
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4				
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3	A		1	A
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5		1		1
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	A			A
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6	1			1
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5		A		A
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10	A			A

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10				
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2		A		A
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	A			A
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5	1			1
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6	A			A
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					128
No. of Taxa					20
ASPT					6.4
Present Ecological State (A-F)					D

Other biota:

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	15-May-2018	Project	Joubert & Seuns (Pty) Ltd	**Biotopes**	**(0-5)**	**Weight**
Site Code	CR03	Collector	Rob Palmer	Stones In Current	4	18.0
		Flow	Low	Stones Out Current	4	12.0
		Clarity (NTU)	-	Bedrock	0	3.0
River	Crocodile	Turbidity	Low	Aquatic Veg	0	1.0
Elev (m)	877	Colour	Clear	Marg Veg In Current	2	2.0
Grid	S25.40327 E30.62421	Benthic Algae (%)	0	Marg Veg Out Of Current	3	2.0
Accuracy	GPS	Temp (°C)	-	Gravel	5	4.0
Gradient	-	pH	7.9	Sand	0	2.0
Zonation	E: Lower Foothills	Cond (mS/m)	15	Mud	4	1.0
Quat	X21E	DO (mg/ℓ)	-	Visual observation	Yes	
Ecoregion	10: Northern Escarpment Mountains	Disturbance	-	BIOTOPE SUITABILITY	68%	B

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1			1	1
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	1	1		A
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6				
Baetidae > 2 sp	12	B	B	B	C
Caenidae (Squaregills/Cainfles)	6	A		A	B
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9	B	A		B
Oligoneuridae (Brushlegged mayflies)	15	A			A
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	A			A
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10	1			1
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4	A			
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3	B	B		B
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7			1	1
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3		1		1
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5		A		A
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	B			B
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		1		1
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10	A			A

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	A		B	B
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2		B		B
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	A			A
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6	A			A
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					132
No. of Taxa					20
ASPT					6.6
Present Ecological State (A-F)					D

Other biota:

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	28-May-2018
Site Code	CR04
River	Crocodile
Elev (m)	870
Grid	S25.41200 E30.63819
Accuracy	GPS
Gradient	-
Zonation	E: Lower Foothills
Quat	X21E
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	6
Turbidity	V Low
Colour	Clear
Benthic Algae (%)	5
Temp (°C)	17.7
pH	7.4
Cond (mS/m)	12
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	3	18.0
Stones Out Current	3	12.0
Bedrock	0	3.0
Aquatic Veg	0	1.0
Marg Veg In Current	1	2.0
Marg Veg Out Of Current	3	2.0
Gravel	3	4.0
Sand	0	2.0
Mud	2	1.0
Visual observation	Yes	
BIOTOPE SUITABILITY	50%	D

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3	1			1
ANNELIDA					
Oligochaeta (Earthworms)	1			1	1
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	A			A
Atyidae (Freshwater Shrimps)	8				
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6				
Baetidae > 2 sp	12	B	B		B
Caenidae (Squaregills/Cainfles)	6		1		1
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13	B			B
Leptophlebiidae (Prongills)	9	A		1	1
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	B			B
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10	1			1
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		B		B
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4				
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3			B	B
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5		1		1
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	A			A
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		A		A
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	A			A
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5		1	1	A
Chironomidae (Midges)	2			A	A
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	A	1		A
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6	A			A
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					118
No. of Taxa					19
ASPT					6.2
Present Ecological State (A-F)					D

Other biota:

Simulium rotundum

Comments/Observations:

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	28-May-2018	Project	Joubert & Seuns (Pty) Ltd
Site Code	CR05	Collector	Rob Palmer
		Flow	Low
		Clarity (NTU)	8
River	Crocodile	Turbidity	V Low
Elev (m)	734	Colour	Clear
Grid	S25.43748 E30.74024	Benthic Algae (%)	5 (Cladophora)
Accuracy	GPS	Temp (°C)	20.5
Gradient	-	pH	7.4
Zonation	E: Lower Foothills	Cond (mS/m)	31
Quat	X22B	DO (mg/ℓ)	-
Ecoregion	10: Northern Escarpment Mountains	Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	4	18.0
Stones Out Current	3	12.0
Bedrock	0	3.0
Aquatic Veg	0	1.0
Marg Veg In Current	0	2.0
Marg Veg Out Of Current	4	2.0
Gravel	2	4.0
Sand	0	2.0
Mud	2	1.0
Visual observation	Yes	
BIOTOPE SUITABILITY	56%	C

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1	A		A	A
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3	1			1
Atyidae (Freshwater Shrimps)	8	A	B		B
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6				
Baetidae > 2 sp	12	B			B
Caenidae (Squaregills/Cainfles)	6	A	A		B
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13	A	1		A
Leptophlebiidae (Prongills)	9	A			A
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	A			A
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10		1		1
Chlorocyphidae (Jewels)	10	1			1
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4				
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3				
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3				
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5				
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	A			A
Hydropsychidae > 2 sp	12				
Philopotamidae	10	1			1
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6	A			A
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5	1			1
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10	A			A

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	1			1
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2	A		A	A
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	A			A
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6	A			A
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3	1			1
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					148
No. of Taxa					21
ASPT					7.0
Present Ecological State (A-F)					B/C

Other biota:

Polymorphaniasus
Simulium damnosum

Comments/Observations:

Cladophora present low abundance

SASS Version 5 Score Sheet

Version date: 02-Dec-16

Date	28-May-2018
Site Code	CR06
River	Crocodile
Elev (m)	726
Grid	S25.42667 E30.76442
Accuracy	GPS
Gradient	-
Zonation	E: Lower Foothills
Quat	X22B
Ecoregion	10: Northern Escarpment Mountains

Project	Joubert & Seuns (Pty) Ltd
Collector	Rob Palmer
Flow	Low
Clarity (NTU)	8
Turbidity	V Low
Colour	Clear
Benthic Algae (%)	5 (Cladophora)
Temp (°C)	22.1
pH	7.7
Cond (mS/m)	26
DO (mg/ℓ)	-
Disturbance	-

Biotopes	(0-5)	Weight
Stones In Current	4	18.0
Stones Out Current	3	12.0
Bedrock	0	3.0
Aquatic Veg	0	1.0
Marg Veg In Current	0	2.0
Marg Veg Out Of Current	4	2.0
Gravel	2	4.0
Sand	0	2.0
Mud	2	1.0
Visual observation	Yes	
BIOTOPE SUITABILITY	56%	C

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1	A	1		A
Hirudinea (Leeches)	3				
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3				
Atyidae (Freshwater Shrimps)	8		B		B
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12	A			A
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4				
Baetidae 2 sp	6	A	A		
Baetidae > 2 sp	12				B
Caenidae (Squaregills/Cainfles)	6		A		A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13	A	B		B
Leptophlebiidae (Prongills)	9	A			A
Oligoneuridae (Brushlegged mayflies)	15	1			1
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9	A			A
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		A		A
Lestidae (Emerald Damselflies/Spreadwings)	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8		1		1
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6				
Libellulidae (Darters/Skimmers)	4				
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3				
Corixidae* (Water boatmen)	3				
Gerridae* (Pond skaters/Water striders)	5				
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3		1		1
Notonectidae* (Backswimmers)	3				
Pleidae* (Pygmy backswimmers)	4				
Velilidae/M...veliidae* (Ripple bugs)	5		B		B
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6	B			B
Hydropsychidae > 2 sp	12				
Philopotamidae	10	1			1
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6	A	A		A
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5				
Elmidae/Dryopidae* (Riffle beetles)	8	1			1
Gyrinidae* (Whirligig beetles)	5		A		A
Haliplidae* (Crawling water beetles)	5				
Scirtidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles)	5				
Limnichidae (Marsh-Loving beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10	1			1
Blephariceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5		A		A
Chironomidae (Midges)	2	A	B		B
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5	A			A
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5	1			1
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3		A		A
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					170
No. of Taxa					24
ASPT					7.1
Present Ecological State (A-F)					B

Other biota:

Comments/Observations:

Cladophora present in low abundance

Appendix F1: Fish Expected

	Species Expected	Status	Sterkspruit SP01	SP02	SP03	Tributaries TR01	TR02	TR03	TR04	Crocodile River CR01	CR02	CR03	CR04	CR05	CR06
1	*Amphilius natalensis*	LC	X	X	-	X	-	X	-	-	-	-	-	-	-
2	*Amphilius uranoscopus*	LC	-	-	X	-	-	X	X	X	X	X	X	X	X
3	*Anguilla mossambica*	-	-	-	-	-	-	-	X	-	-	-	-	X	X
4	*Chiloglanis bifurcus*	CR	-	-	X	-	-	X	X	X	X	X	X	X	X
5	*Chiloglanis pretoriae*	LC	X	X	X	X	-	X	X	X	X	X	X	X	X
6	*Clarias gariepinus*	LC	-	-	-	-	-	X	X	X	X	X	X	X	X
7	*Coptodon rendalli*	LC	-	-	-	-	-	X	X	-	-	-	-	-	-
8	*Enteromius anoplus*	LC	X	X	X	X	X	X	X	-	-	-	X	X	X
9	*Enteromius crocodilensis*	LC	X	X	X	-	X	X	X	X	X	X	X	X	X
10	*Enteromius cf neefi*	-	-	-	-	-	X	X	X	X	X	X	X	-	-
11	*Kneria sp nov ("South Africa")*	EN	X	X	X	X	-	-	-	-	-	-	-	-	-
12	*Labeo molybdinus*	LC	-	-	-	-	-	-	-	-	-	-	-	X	X
13	*Labeobarbus marequensis*	LC	-	-	-	-	-	-	X	-	-	-	-	X	X
14	*Labeobarbus polylepis*	LC	-	-	-	-	-	-	-	-	-	-	-	X	X
15	*Micralestes acutidens*	LC	-	-	-	-	-	-	-	-	-	-	-	X	X
16	*Oreochromis mossambicus*	NT	-	-	-	-	-	X	X	-	-	-	-	X	X
17	*Pseudocrenilabrus philander*	-	-	-	-	-	-	X	X	X	X	X	X	X	X
18	*Tilapia sparrmanii*	LC	-	-	-	-	-	-	X	X	X	X	X	X	X
	Total Number Expected		**5**	**5**	**6**	**4**	**3**	**11**	**13**	**8**	**8**	**8**	**9**	**14**	**14**

LC = Least Concern; NT = Near Threatened; EN= Endangered; CR = Critically Endangered

Appendix F2: Fish Observed

			Sterkspruit			Tributaries				Crocodile River					
	Site		SP01	SP02	SP03	TR01	TR02	TR03	TR04	CR01	CR02	CR03	CR04	CR05	CR06
	Date		2018/05/16	2018/05/16	2018/05/16	2018/05/16	2018/05/16	2018/05/28	2018/05/28	2018/05/16	2018/05/15	2018/05/15	2018/05/28	2018/05/28	2018/05/16
	Flow		Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
	Depth-Flow Classes (0-4)														
	Shallow-Slow		3	3	2	2	3	4	4	4	3	2	3	4	4
	Deep-Slow		0	4	0	2	0	0	2	0	1	1	0	1	1
	Shallow-Fast		4	3	2	3	1	2	3	2	4	4	2	3	3
	Deep-Fast		0	0	0	0	0	0	0	0	2	0	0	0	0
	Overall														
	Cover (0-4)														
	Marginal Vegetation		2	0	2	1	3	0	1	2	3	3	3	4	4
	Macrophytes		0	0	0	0	0	0	0	0	0	0	0	0	0
	Undercut Banks & Roots		0	0	0	0	0	3	3	0	0	0	1	2	2
	Woody Debris		0	1	0	0	0	3	4	4	3	2	2	1	1
	Bed Substrate		4	3	1	3	2	3	4	4	4	4	3	4	4
	Overall		**30%**	**20%**	**15%**	**20%**	**25%**	**45%**	**60%**	**50%**	**50%**	**45%**	**45%**	**55%**	**55%**
	Species Observed														
1	*Amphilius natalensis*	4.9	1J; 2A	1J; 3A	-	1J; 3A	-	-	-	-	-	-	-	-	-
2	*Amphilius uranoscopus*	4.8	-	-	-	-	-	1J	-	3A	3A	7A	1A	-	1A
3	*Chiloglanis bifurcus*	4.9	-	-	-	-	-	1A	1A	-	1J; 1A	-	-	-	1A
4	*Chiloglanis pretoriae*	4.5	1J; 5A		1A	4A		1J	1J	20A	5J; 18A	2J; 27A	3J; 3A	5J; 2A	2J; 4A
5	*Clarias gariepinus*	1.0	-	-	-	-	-	-	1J	-	1J	-	-	1J	-
6	*Coptodon rendalli*	2.1	-	-	-	-	-	-	-	-	-	1A	-	-	-
7	*Enteromius anoplus*	2.6	10A	2J; 4A	-	7A	-	-	-	-	-	-	-	-	-
8	*Enteromius crocodilensis*	4.1	12A	8J; 18A	1A	-	2J; 3A	9J; 4A	3J; 1A	18J;	11J;	14J	8J; 3A	8J	12J
9	*Enteromius cf neefi*	3.4	-	-	-	-	16J;	1A	-	-	-	7J; 12A	4J; 16A	-	-
10	*Kneria sp nov ("South Africa")*	4.1	-	-	-	2J; 10A	-	-	-	-	-	-	-	-	-
11	*Labeobarbus marequensis*	2.1	-	-	-	-	-	-	4J	-	-	-	-	8J; 10A	10J; 3A
12	*Micralestes acutidens*	3.1	-	-	-	-	-	-	-	-	-	-	-	-	1J
13	*Oreochromis mossambicus*	1.3	-	-	-	-	-	-	-	-	-	1A	-	-	-
14	*Pseudocrenilabrus philander*	1.4	-	-	-	-	-	8J; 4A	2J; 3A	2J; 3A	1A	5J; 1A	1J; 4A	5J	2J; 1A
15	*Tilapia sparrmanii*	1.4	-	-	-	-	-	-	-	1J	-	-	-	-	-
	Summary														
	Sample size (n)		31	36	2	27	44	29	16	65	59	77	43	39	37
	Effort (min)		20	15	15	18	5	6	20	15	20	18	13	14	20
	Catch per Unit Effort (Number/hr)		93	144	8	90	528	290	48	260	177	257	198	167	111
	Number of species		4	3	2	4	2	6	6	5	6	7	5	5	7
	FAII (%)		80	57	34	100	74	66	50	64	81	85	65	33	63
	PES Category (A-F)		B / C	D	E	A	C	C	D	C	B / C	B	C	E	C

Appendix G: Ecological Importance and Sensitivity

Level 4: HGM Unit:	Hillslope Seeps	Mountain Stream	Transitional	Upper Foothill	Lower Foothill

Ecological Importance

Parameter	Hillslope Seeps	Mountain Stream	Transitional	Upper Foothill	Lower Foothill
Biodiversity support	**0.0**	**1.7**	**2.0**	**2.3**	**3.3**
Red Data species	0.0	4.0	4.0	4.0	4.0
Unique species	0.0	0.0	0.0	0.0	2.0
Migration/breeding/feeding	0.0	1.0	2.0	3.0	4.0
Landscape scale	**0.6**	**1.7**	**0.8**	**2.2**	**2.4**
Protection status of wetland	0.0	0.0	0.0	0.0	0.0
Protection status of vegetation type	0.0	1.0	1.0	3.0	4.0
Regional context	0.0	4.0	0.0	4.0	4.0
Size and rareity	2.5	2.0	1.0	1.5	2.0
Diversity of habitats	0.5	1.5	2.0	2.5	2.0
Sensitivity of the wetland	**0.8**	**2.7**	**3.0**	**3.0**	**3.0**
Sensitivity to floods	0.0	1.0	1.5	2.0	2.0
Sensitivity to low flows	0.5	3.0	4.0	4.0	4.0
Sensitivity to water quality	2.0	4.0	3.5	3.0	3.0
	0.8	**2.7**	**3.0**	**3.0**	**3.3**

Scoring: 0=None; 1=Low; 2=Moderate; 3=High; 4 = Very High

Functional Importance

Parameter	Hillslope Seeps	Mountain Stream	Transitional	Upper Foothill	Lower Foothill
Flood attenuation	0.0	0.5	1.0	2.0	3.0
Streamflow regulation	0.5	1.0	2.0	4.0	4.0
Sediment trapping	1.0	0.0	0.0	0.0	0.0
Phosphate assimilation	2.0	0.5	1.0	2.0	2.0
Nitrate assimilation	2.0	0.5	1.0	2.0	2.0
Toxicant assimilation	2.0	0.5	1.0	2.0	2.0
Erosion control	1.0	2.5	2.5	3.0	3.0
Carbon storage	0.0	2.0	2.0	3.5	4.0
	1.1	**0.9**	**1.3**	**2.3**	**2.5**

Scoring: 0=None; 1=Low; 2=Moderate; 3=High; 4 = Very High

Direct Human Benefits

Parameter	Hillslope Seeps	Mountain Stream	Transitional	Upper Foothill	Lower Foothill
Water for human use	0.0	0.5	1.0	4.0	4.0
Harvestable resources	0.5	1.5	1.5	2.5	3.0
Cultivated foods	0.0	0.0	0.0	2.0	3.0
Cultural heritage	0.0	0.5	1.0	2.0	2.0
Tourism and recreation	0.0	1.0	0.0	0.0	0.0
Education and research	0.0	2.0	1.0	1.5	2.0
	0.1	**0.9**	**0.8**	**2.0**	**2.3**

Scoring: 0=None; 1=Low; 2=Moderate; 3=High; 4 = Very High

Appendix H: Risk Matrix

NAME and REGISTRATION No of SACNASP Professional member: **RW Palmer Reg no. 400108/95**

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE.

No.	Phases	Activity	Aspect	Impact	Severity: Flow Regime	Severity: Water Quality	Severity: Habitat	Severity: Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	PES AND EIS OF WATERCOURSE
1	Construction	• Bulk earthworks • Clearing of natural vegetation clise to a watercourse • Soil disturbance and compaction	• Fragmentation of wildlife habitat • Flood protection (bank stability, siltation and erosion) • Enroachment of alien invasive vegetation • Air quality (aerial drift and runoff of pesticides into receiving watercourses) • Water quality (reduced buffering capacity of riparian vegetation) • Terrestrial migration corridors • Protected tree species (*Breonadia salicina*) • Carbon emmissions from reduced woody vegetation	Impact of Vegetation Clearing on Riparian and Seepage Wetland Habitats	2	3	5	4	3.5	3	5	11.5	1	5	5	1	12.0	138	Moderate	80	**1a) Manage Alien Plants.** Eradicate High Priority alien invasive plant species and control Medium Priority alien invasie plant species in all MUs. Personnel tasked to control alien vegetation must have appropriate training in the following: methods and control measures; equipment and techniques; types of herbicides and dosages applied; mixing techniques; storage of chemicals and equipment; health and safety issues; plant identification; procedures for equipment washing and equipment maintenance. Clearing methods should include cutting, felling and treating the stumps with registered herbicides by appropriately skilled herbicide applicators. The use of a flail mower should be considered, where appropriate. Follow-up methods should include a combination of manual and herbicide control. **1b) Plant Indigenous Trees.** Plant indigenous trees in riparian zones within each MU. The following fast-growing tree species are recommended: *Acacia robusta subsp. clavigera, Trema orientalis, Ficus sycomorus, Combretum erythrophyllum, Syzygium cordatum. Trees may need watering until they are established.*	PES = variable; EIS = variable
2	Construction	• Trenching • Stormwater management	• Encroachment of terrestrial species into wetlands • Water quantity (changes in magnitude, timing, frequency and duration of flow events)	Impact of Agricultural Drains on Seepage Wetland Habitats	2	2	5	5	3.5	3	5	11.5	1	5	5	1	12.0	138	Moderate	80	**2a) Seepage Wetlands.** Agricultural drains in Seepage Wetlands within MUs should be backfilled to restore natural flow patterns. The surface must be level with the surrounding land surface to minimise soil erosion from the areas when the backfilling is complete.	PES = variable; EIS = variable

	Phases	Activity	Aspect	Impact	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	PES AND EIS OF WATERCOURSE
3	Construction	• Vehicle movement • Stormwater runoff • Equipment washing	• Water quality (turbidity; hydrocarbons) • Bank erosion	Impact of Access Roads and Unprotected Stream Crossings on Surface Water Quality	2	3	2	2	2.3	2	2	6.3	2	3	5	2	12.0	75	Moderate	80	**3a) Stream Crossings.** Remove uncessesary stream crossings, or formalise as culverts, where appropriate. Drifts are only suitable for low usage roads, as they have high environmental impacts (sedimentation and pollution from crossing vehicles) and do not enable crossing during flood events	PES = variable; EIS = variable
4	Construction	• Felling and disposal of large trees	• Restriction (blockage) of low and high flows, impacting on bank stability and erosion • Soil properties impacted by burning	Impact of Woody Debris on Stream Flow	2	1	2	1	1.5	1	3	5.5	1	3	5	1	10.0	55	Low	80	**4a) Woody Debris in River Channels.** Woody debris in river channels must be removed and either burnt in one area that is dedicated for incineration of woody debris, with permit for burning if needed, or otherwise stacked in piles outside watercourses and left as "insect hotels". Large woody debris should not be burnt	PES = variable; EIS = variable
5	Construction	• Disposal of rock and rubble	• Restriction (blockage) of high flows, impacting on bank stability and erosion	Impact of Stone Packs and Rubble on Riparian Habitats	1	1	1	1	1.0	1	3	5.0	1	1	5	1	8.0	40	Low	80	**5a) Stone Packs and Rubble.** Stone packs and rubble must be removed from all MUs and placed in areas where they do not impact watercourses or riparian habits. Disturbed areas should be recontoured, where necessary, and rehabilitated.	PES = variable; EIS = variable
6	Construction	• Disposal of solid wastes (plastics, tyres, building materials, fencing materials, excess branches from pruning etc)	• House-keeping	Impact of Solid Waste Disposal on Riparian Habitats	2	1	2	1	1.5	1	2	4.5	1	2	5	1	9.0	41	Low	80	**6a) Solid Waste Removal.** Remove solid wastes and dispose of appropriately. No burning, except for smaller branches and twigs. **6b) Solid Waste management.** Provide adequate waste bins at strategic locations. Bins must be covered to prevent movement of wind-blown waste. **6c) Environmental Awareness.** All staff and contractors must be made aware of the environmental standards and the waste management strategy during induction. The induction process must include rules and regulations regarding disposal of wastes.	PES = variable; EIS = variable

Appendix I: Detailed Data – Management Units

STERKSPRUIT: MU 01a

-25.41182497; 30.49570799

Description

Management Unit 01a covers 2.17 hectares and is situated on either side of the Sterkspruit, between the N4 and its confluence with the Junglespruit, a distance of 290 m. The stream is noted for the presence of Natal Mountain Catfish *Amphilius natalensis*.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. Stone packs (B), and *Solanum mauritianum* (D). [2018-07-05].

Figure D. Clearing of Riparian Zone (A); unprotected stream crossing (C) [2018-07-05].

Key Issues

1. Clearing in riparian zone (A).
2. Stone packs along stream margin (B).
3. Unprotected stream crossing (C).
4. Roads within riparian zones (E).

Other Issues

1. Alien vegetation (D).
2. Cultivation in seepage wetland (Figure B).

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.0	Thee alien species only; Low abundance
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.5	Slight inundation at stream crossing
5	Flow Modification	0.5	Stormwater runoff slightly elevated
6	Water Quality	1.0	Turbidity and sediments elevated
7	Vegetation Removal	4.5	Riparian vegetation cleared on both banks
8	Channel Modification	3.0	Unprotected stream crossing
	Score:	**10.5**	Ecological Condition
	% Modified:	**26%**	**B: Good**

Alien Flora	Rating
Datura stramonium *1b	1
Solanum mauritianum * 1b	2
Lantana camara *1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone (644 trees).
1b) Plant indigenous trees in riparian zone.
1c) Recontour areas disturbed by bulk earthworks, where necessary.
2a) Restore natural drainage pattern of wetland.
3a) Remove uncessesary stream crossings.
3b) Divert stormwater from running directly into watercourses.
3c) Realign access roads outside Managament Units.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

STERKSPRUIT: MU 01b

-25.41203602; 30.49676

Description

Management Unit 01b covers 0.35 hectares , of which 0.12 hectares comprises seepage wetland, and is situated on either side of the Junglespruit, between the N4 and its confluence with the Sterkspruit. The length of river is 62 m. The stream is noted for the presence of an undescribed *Kneria* sp.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in riparian zone (A).
2 Unprotected stream crossing (B).
3 Roads within riparian zones (C).

Other Issues

1 Alien vegetation (D).

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.0	Two alien species only; Low abundance
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.5	Slight inundation at stream crossing
5	Flow Modification	0.5	Stormwater runoff slightly elevated
6	Water Quality	1.0	Turbidity and sediments elevated
7	Vegetation Removal	4.5	Riparian vegetation cleared on both banks
8	Channel Modification	3.0	Unprotected stream crossing
	Score:	10.5	Ecological Condition
	% Modified:	26%	B: Good

Alien Flora	Rating
Rubus sp. *	2
Solanum mauritianum * 1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (100 trees).
2a) Restore natural drainage pattern of wetland.
3a) Remove uncessesary stream crossings.
3b) Divert stormwater from running directly into watercourses.
3c) Realign access roads outside Managament Units.

STERKSPRUIT: MU 01c

-25.4096790330.49857502

Description

Management Unit 01c covers 1.20 hectares of riparian habitat and is situated on the right bank (facing downstream) of the Sterkspruit, from the confluence with the Junglespruit for a distance of 490 m. The stream is noted for the presence of Natal Mountain Catfish *Amphilius natalensis*.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in riparian zone (A).
2 Alien vegetation (B).
3 Acces road in riparian zone (C).

Other Issues

None

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.0	Six alien species
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	0.5	Stormwater slightly elevated
6	Water Quality	1.5	Sediments
7	Vegetation Removal	2.5	Riparian vegetation cleared right bank only
8	Channel Modification	0.0	None
	Score:	6.5	Ecological Condition
	% Modified:	16%	B: Good

Alien Flora	Rating
Grevillea robusta *3	2
Lantana camara complex *1b	2
Ricinus communis *2	2
Rubus sp. *	2
Senna septemtrionalis *1b	2
Solanum mauritianum * 1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (300 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.

3c) Realign access roads outside Managament Units.

STERKSPRUIT: MU 01d

-25.4064550230.50094098

Description

Management Unit 01d covers 1.27 hectares of riparian habitat and is situated on the right bank (facing downstream) of the Sterkspruit for a distance of 420 m up to an agricultural drain. The stream is noted for the presence of Natal Mountain Catfish *Amphilius natalensis*.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1. Clearing in Riparian Zone (A).
2. Road within riparian zone (B).
3. Alien vegetation (C).

Other Issues

None

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.5	Three alien species; Low abundance
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	0.5	Stormwater slightly elevated
6	Water Quality	1.5	Sediments
7	Vegetation Removal	2.5	Riparian cleared right bank only
8	Channel Modification	0.0	None
	Score:	6.0	Ecological Condition
	% Modified:	15%	B: Good

Alien Flora	Rating
Jacaranda mimosifolia *	2
Lantana camara complex *1b	2
Solanum mauritianum * 1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (300 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign roads outside Management Units.

STERKSPRUIT: MU 01e

-25.4038940130.50291701

Description

Management Unit 01e covers 0.89 hectares, of which 0.89 hectares comprises seepage wetland, and is situated on the right bank (facing downstream) of the Sterkspruit, between an agricultral drain and the end of the property, a distance of 320 m. The stream is noted for the presence of Natal Mountain Catfish *Amphilius natalensis*.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

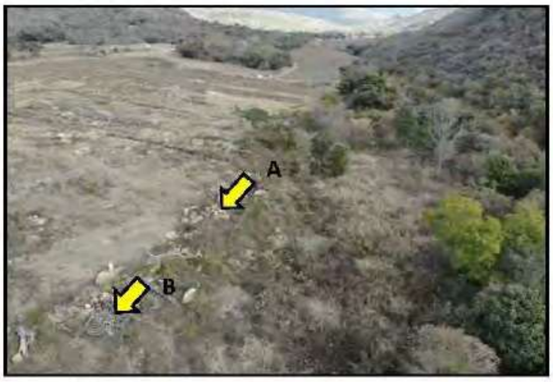


Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Stone packs along stream margin (A).
2 Woody Debris (B).
3 Alien vegetation (C).

Other Issues

None

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Eight alien species
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	0.5	Stormwater slightly elevated
6	Water Quality	2.0	Turbidity
7	Vegetation Removal	0.5	Marginal
8	Channel Modification	0.0	None
	Score:	**6.5**	Ecological Condition
	% Modified:	**16%**	**B: Good**

Alien Flora	Rating
Chromolaena odorata *1b	1
Datura stramonium *1b	3
Grevillea robusta *3	2
Jacaranda mimosifolia *	3
Lantana camara complex *1b	4
Pinus sp.	1
Rubus sp. *	1
Senna septemtrionalis *1b	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1c) Recontour areas disturbed by bulk earthworks, where necessary.
4a) Remove woody debris from watercourses.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

DEON: MU 02a

-25.383117033 0.52551202

Description

Management Unit 02a covers 4.06 hectares of riparian habitat and is situated on the right bank (facing downstream) of the confluence of the Sterkspruit and Crocodile River. The length of the riprian zone is 600 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Roads within Riparian Zone (B).
3 Alien vegetation (C).

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Nine alien species recorded
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.0	Turbidity
7	Vegetation Removal	4.5	Extensive removal of riparian vegetation
8	Channel Modification	0.0	None
	Score:	12.0	Ecological Condition
	% Modified:	30%	C: Fair

Alien Flora	Rating
*Ageratum conyzoides *1b*	2
*Datura stramonium *1b*	2
*Jacaranda mimosifolia **	2
*Lantana camara complex *1b*	3
*Melia azedarach *1b*	1
*Morus alba *3*	2
*Nicandra physalodes *1b*	2
*Psidium guajava *2*	2
*Ricinus communis *2*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (1438 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Units (excluding service road)

DEON: MU 02b

-25.3828140330.53132697

Description

Management Unit 02b covers 2.50 hectares of riparian habitat and is situated on the right bank (facing downstream) of the Crocodile River between two agricultral drains on the farm Deon. The length of the riprian zone is 450 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Roads within riparian zone (B).
3 Alien vegetaton.

Other Issues

1 Stone packs in riparian zone.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.0	Six alien species recorded
2	Rubbish Dumping	0.0	None
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive removal of riparian vegetation
8	Channel Modification	0.0	None
	Score:	**13.0**	Ecological Condition
	% Modified:	**33%**	**C: Fair**

Alien Flora	Rating
Datura stramonium *1b	2
Jacaranda mimosifolia *	1
Lantana camara complex *1b	2
Psidium guajava *2	2
Ricinus communis *2	1
Senna septemtrionalis *1b	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (625 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Units (excluding service road)
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

DEON: MU 02c

-25.3810280130.53477503

Description

Management Unit 02c covers 3.38 hectares of riparian habitat and is situated on the right bank (facing downstream) of the Crocodile River between an agricultral drain and the property boundary. The length of the riprian zone is 540 m.

Figure A. Aerial photograph 2015.

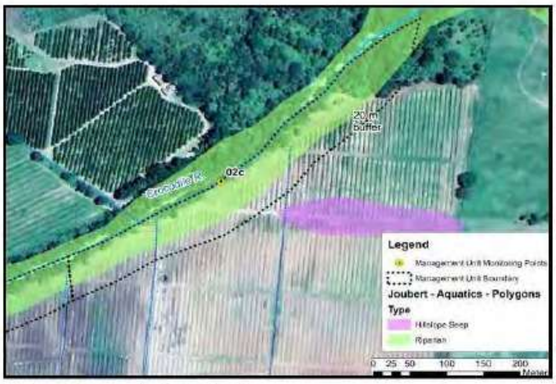


Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along river margin (B).
3 Roads within Riparian Zone (C).
4 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Nine alien species recorded
2	Rubbish Dumping	0.0	None
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive removal of riparian vegetation
8	Channel Modification	0.0	None
	Score:	13.5	Ecological Condition
	% Modified:	34%	C: Fair

Alien Flora	Rating
*Ageratum conyzoides *1b*	3
*Datura stramonium *1b*	3
*Jacaranda mimosifolia **	1
*Lantana camara complex *1b*	3
*Morus alba *3*	3
*Nicandra physalodes *1b*	2
*Psidium guajava *2*	2
*Ricinus communis *2*	2
*Senna septemtrionalis *1b*	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (1413 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Units (excluding service road)
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

HIENNUMAN: MU 03a

-25.37966796;30.53998598

Description

Management Unit 03a covers 2.80 hectares of riparian habitat and is situated on the left bank (facing downstream) of the Crocodile River on the farm Hiennuman. The length of the riprian zone is 474 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

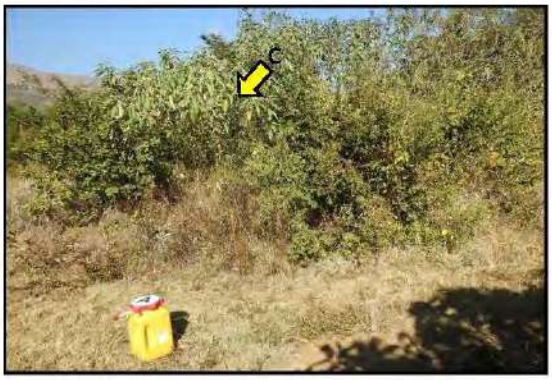


Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along river margin.
3 Roads within riparian zone (B).
4 Alien vegetation (C).

Other Issues

1 Failed weir (Figure C).

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Nine alien species recorded
2	Rubbish Dumping	0.0	None
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive removal of riparian vegetation
8	Channel Modification	0.0	None
	Score:	13.5	Ecological Condition
	% Modified:	34%	C: Fair

Alien Flora	Rating
Lantana camara *1b	4
Melia azedarach *1b	1
Morus alba *3	2
Passiflora subpeltata *1b	1
Psidium guajava *2	2
Ricinus communis *2	2
Senna septemtrionalis *1b	2
Solanum mauritianum * 1b	3
Solanum sisymbriifolium * 1b	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (656 trees)
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Units (excluding service road)
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

TURNBULL: MU 04a

-25.3800680330.54642102

Description

Management Unit 04a covers 3.29 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River on the farm Turnbull. The length of the riprian zone is 791 m. The area developed within the riparian zone was in production in 2018.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along river margin (B).

Other Issues

None

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Eleven alien species recorded
2	Rubbish Dumping	0.5	Slight
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	2.0	Removal of peripheral vegetation
8	Channel Modification	0.0	None
	Score:	11.5	Ecological Condition
	% Modified:	29%	B: Good

Alien Flora	Rating
*Ageratum conyzoides *1b*	2
*Argemone ochroleuca *1b*	2
*Datura stramonium *1b*	2
*Jacaranda mimosifolia **	2
*Lantana camara complex *1b*	2
*Melia azedarach *1b*	1
*Morus alba *3*	1
*Nicandra physalodes *1b*	2
*Passiflora subpeltata *1b*	2
*Senna septemtrionalis *1b*	2
*Solanum mauritianum * 1b*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

DUBAI 1: MU 05a

-25.3798906730.54720431

Description

Management Unit 05a covers 1.04 hectares of riparian habitat and is situated on the left bank (facing downstream) of the Crocodile River on the farm Dubai 1. The length of the riprian zone is 252 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along river margin.
3 Roads within Riparian Zone (B).

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.0	Nine alien species recorded
2	Rubbish Dumping	0.0	None
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Severe
8	Channel Modification	0.0	None
	Score:	12.5	Ecological Condition
	% Modified:	31%	C: Fair

Alien Flora	Rating
Eriobotrya japonica *	1
Jacaranda mimosifolia *	2
Lantana camara complex *1b	3
Melia azedarach *1b	2
Morus alba *3	2
Passiflora subpeltata *1b	1
Populus x canescens *2	2
Psidium guajava *2	2
Ricinus communis *2	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (425 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Unit.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

DUBAI 2: MU 06a

-25.3834460230.54915897

Description

Management Unit 06a covers 2.53 hectares of riparian habitat and is situated on the left bank (facing downstream) of the Crocodile River on the farm Dubai 2. The length of the riprian zone is 627 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

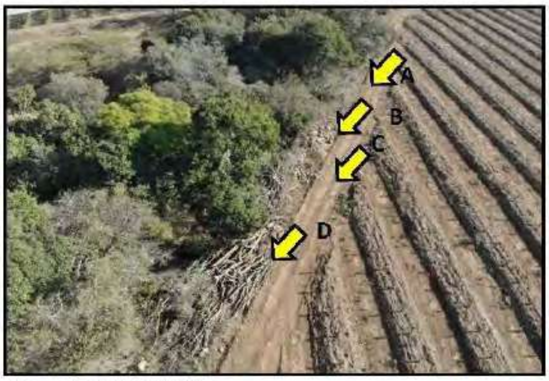


Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along stream margin (B).
3 Roads within Riparian Zones (C).
4 Woody debris in watercourse (D).
5 Alien vegetation (E).

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.0	Nine alien species recorded
2	Rubbish Dumping	0.0	None
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Severe
8	Channel Modification	0.0	None
	Score:	**12.5**	Ecological Condition
	% Modified:	**31%**	**C: Fair**

Alien Flora	Rating
*Eucalyptus grandis *1b*	1
*Jacaranda mimosifolia **	1
*Lantana camara complex *1b*	4
*Melia azedarach *1b*	1
*Morus alba *3*	2
*Nicandra physalodes *1b*	1
*Passiflora subpeltata *1b*	1
*Populus x canescens *2*	1
*Psidium guajava *2*	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (281 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Unit.
4a) Remove woody debris from watercourses.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

SWART: MU 08a

-25.3846560330.55745504

Description

Management Unit 08a covers 1.74 hectares of riparian habitat and is situated on the right bank (facing downstream) of the Crocodile River between two agricultural drains on the farm I Swart. The length of the riprian zone is 373 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along stream margin.
3 Alien vegetation.
4 Road within Riparian Zone.
5 Solid waste (burnt tyres).

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.0	Five alien species recorded
2	Rubbish Dumping	1.0	Burnt tyres
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	2.0	Peripheral riparian vegetation removed.
8	Channel Modification	0.0	None
	Score:	**10.5**	Ecological Condition
	% Modified:	**26%**	**B: Good**

Alien Flora	Rating
Jacaranda mimosifolia *	1
Lantana camara *1b	2
Senna septemtrionalis *1b	2
Solanum mauritianum * 1b	2
Solanum sisymbriifolium * 1b	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (450 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Unit.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.
6a) Remove solid wastes and dispose of appropriately (no burning).

SWART: MU 08b

-25.3873610430.55761497

Description

Management Unit 08b covers 2.27 hectares of riparian and wetland habitat and is situated on the right bank (facing downstream) of the Crocodile River between an agricultural drain and the lower boundarry of the farm I Swart. The length of the riprian zone is 461 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing of Riparian Zone.
2 Draining of seepage wetlands
3 Road within Riparian Zone.
4 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.0	Eight alien species recorded
2	Rubbish Dumping	0.0	None
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	2.5	Peripheral riparian vegetation removed.
8	Channel Modification	0.0	None
	Score:	**11.0**	Ecological Condition
	% Modified:	**28%**	**B: Good**

Alien Flora	Rating
*Lantana camara *1b*	3
*Melia azedarach *1b*	1
*Morus alba *3*	2
*Passiflora subpeltata *1b*	2
*Ricinus communis *2*	2
*Rubus sp. **	1
*Senna septemtrionalis *1b*	2
*Solanum mauritianum * 1b*	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (725 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.

3c) Realign access roads outside Managament Unit.

SPILPUNT: MU 09a

-25.3875144330.55820907

Description

Management Unit 09a covers 3.17 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between the upstream property boundary and an agricultural drain on the farm Spilpunt. The length of the riprian zone is 920 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Alien Vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Nine alien species recorded. Lantana abundant.
2	Rubbish Dumping	0.0	None
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	0.5	Slight peripheral disturbance
8	Channel Modification	0.0	None
	Score:	9.5	Ecological Condition
	% Modified:	24%	B: Good

Alien Flora	Rating
Eucalyptus grandis *1b	1
Jacaranda mimosifolia *	2
Lantana camara complex *1b	5
Melia azedarach *1b	3
Morus alba *3	2
Psidium guajava *2	1
Ricinus communis *2	2
Senna septemtrionalis *1b	1
Solanum mauritianum * 1b	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.

SPILPUNT: MU 09b

-25.3876499630.56284301

Description

Management Unit 09b covers 0.86 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between an agricultural drain and the downstream property boundary of the farm Spilpunt. The length of the riprian zone is 339 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Alien vegetation.
2 Stone packs along stream margin.
3 Solid waste (plastics).

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Seven alien species recorded.
2	Rubbish Dumping	1.0	Low (plastics).
3	Bank Erosion	1.0	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	0.5	Slight peripheral disturbance
8	Channel Modification	0.0	None
	Score:	9.5	Ecological Condition
	% Modified:	24%	B: Good

Alien Flora	Rating
*Lantana camara *1b*	3
*Melia azedarach *1b*	1
*Morus alba *3*	1
*Passiflora subpeltata *1b*	1
*Psidium guajava *2*	1
*Senna septemtrionalis *1b*	1
*Solanum mauritianum * 1b*	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (63 trees).
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.
6a) Remove solid wastes and dispose of appropriately (no burning).

RIETVLEI MACS: MU 12a

-25.3919580 30.575295

Description

Management Unit 12a covers 2.50 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between the upstream property boundary and an agricultural drain on the farm Rietvlei Macs. The length of the riprian zone is 760 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along stream margin (B).
3 Unprotected Stream Crossing (C).
4 Roads within Riparian Zones (E).
5 Alien vegetation.

Other Issues

None.

Riparian Health Index

Criteria	Rating	Comment
Alien Vegetation	3.0	Ten alien species recorded.
Rubbish Dumping	0.5	Slight
Bank Erosion	0.0	None
Inundation	0.0	None
Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
Water Quality	2.5	Turbidity
Vegetation Removal	2.0	Moderate removal
Channel Modification	0.0	None
Score:	10.0	Ecological Condition
% Modified:	25%	B: Good

Alien Flora	Rating
Dolichandra unguis-cati *1b	1
Eucalyptus grandis *1b	1
Jacaranda mimosifolia *	2
Lantana camara complex *1b	4
Melia azedarach *1b	1
Morus alba *3	2
Nicandra physalodes *1b	2
Psidium guajava *2	1
Ricinus communis *2	2
Solanum sisymbriifolium	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (600 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

RIETVLEI MACSC: MU 12b

-25.3879819730.58025097

Description

Management Unit 12b covers 1.67 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between two agricultral drains on the farm Rietvlei Macs. The length of the riprian zone is 471 m.

Figure A. Aerial photograph 2015.

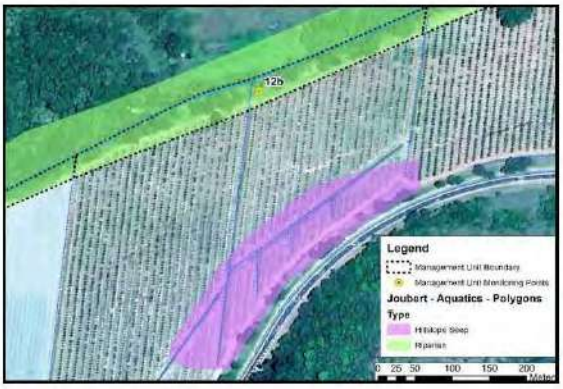


Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues
1 Clearing in Riparian Zone.
2 Stone packs along stream margin.
3 Alien vegetation.

Other Issues
Solid waste (burnt tyres).

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.0	Five alien species recorded. Low abundance.
2	Rubbish Dumping	0.5	Slight (burnt tyres)
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	2.5	Moderate removal
8	Channel Modification	0.0	None
	Score:	**8.5**	Ecological Condition
	% Modified:	**21%**	**B: Good**

Alien Flora	Rating
*Ageratum conyzoides *1b*	3
*Lantana camara *1b*	2
*Passiflora subpeltata *1b*	1
*Solanum sisymbriifolium * 1b*	1
*Verbena bonariensis * 1b*	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (344 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.
6a) Remove solid wastes and dispose of appropriately (no burning).

RIETVLEI MACS: MU 12c

-25.3860210330.58490703

Description

Management Unit 12c covers 2.14 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between two agricultral drains on the farm Rietvlei Macs. The length of the riprian zone is 459 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

Clearing in Riparian Zone.
Alien vegetation.

Other Issues

None.

Riparian Health Index

Criteria	Rating	Comment
Alien Vegetation	2.0	Nine alien species recorded. Low abundance.
Rubbish Dumping	0.0	None
Bank Erosion	0.0	None
Inundation	0.0	None
Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
Water Quality	2.5	Turbidity
Vegetation Removal	3.0	Moderate
Channel Modification	0.0	None
Score:	9.5	Ecological Condition
% Modified:	24%	B: Good

Alien Flora	Rating
Ageratum conyzoides *1b	2
Lantana camara *1b	2
Nicandra physalodes *1b	1
Passiflora subpeltata *1b	1
Ricinus communis *2	1
Senna septemtrionalis *1b	2
Solanum mauritianum * 1b	2
Solanum sisymbriifolium * 1b	1
Tithonia rotundifolia *1b	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (638 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.

RIETVLEI MACS: MU 12d

-25.38611599 30.59040598

Description

Management Unit 12d covers 3.80 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between two agricultral drains on the farm Rietvlei Macs. The length of the riprian zone is 802 m.

Figure A. Aerial photograph 2015.

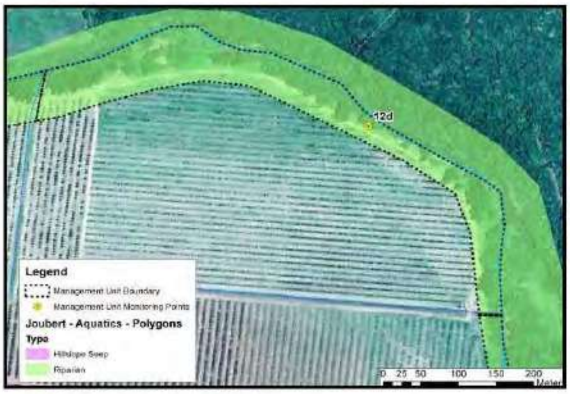


Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone.
2 Roads within Riparian Zones.
3 Alien vegetation.

Other Issues

None.

Riparian Health Index

Criteria	Rating	Comment
Alien Vegetation	1.5	Seven alien species recorded. Low abundance.
Rubbish Dumping	0.0	None
Bank Erosion	0.0	None
Inundation	0.0	None
Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
Water Quality	2.5	Turbidity
Vegetation Removal	3.0	Moderate
Channel Modification	0.0	None
Score:	9.0	Ecological Condition
% Modified:	23%	B: Good

Alien Flora	Ratinc
*Cirsium vulgare *1b*	1
*Passiflora subpeltata *1b*	1
*Ricinus communis *2*	1
*Rubus sp. **	1
*Senna septemtrionalis *1b*	1
*Solanum mauritianum * 1b*	2
*Solanum sisymbriifolium * 1b*	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (963 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.

RIETVLEI MACS: MU 12e

-25.3908189930.592237

Description

Management Unit 12e covers 2.07 hectares of riparian and wetland habitat on the right bank (facing downstream) of the Crocodile River between an agricultral drain and the lower boundary of the farm Rietvlei Macs. The length of the riprian zone is 691 m.

Figure A. Aerial photograph 2015.

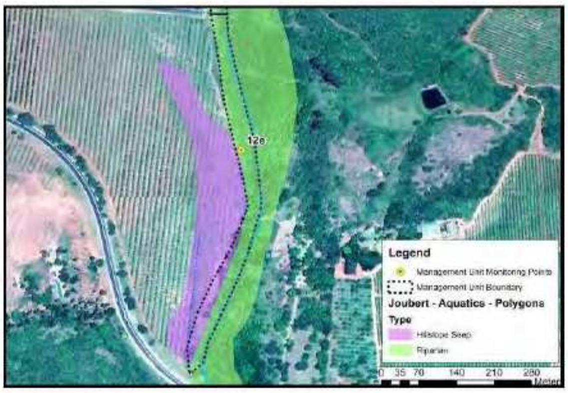


Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in Riparian Zone.
2 Draining of seepage wetland
3 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Seven alien species recorded. Moderate abund.
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive
8	Channel Modification	0.0	None
	Score:	**11.0**	Ecological Condition
	% Modified:	**28%**	**B: Good**

Alien Flora	Ratinc
*Lantana camara *1b*	3
*Morus alba *3*	3
*Rubus sp. **	2
*Sesbania punicea *1b*	1
*Solanum mauritianum * 1b*	3
*Solanum sisymbriifolium * 1b*	2
*Tithonia diversifolia * 1b*	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (138 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.

LOXLEY: MU 13a

-25.3962929630.59526304

Description

Management Unit 13a covers 1.23 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River on the farm Loxley. The length of the riprian zone is 192 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in Riparian Zone.
2 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Eight alien species recorded. Moderate abund.
2	Rubbish Dumping	0.0	None
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	0.5	Peripheral riparian vegetation removed
8	Channel Modification	0.0	None
	Score:	7.5	Ecological Condition
	% Modified:	19%	B: Good

Alien Flora	Rating
Bidens pilosa *1b	1
Lantana camara *1b	2
Morus alba *3	3
Nicandra physalodes *1b	1
Pennisetum purpureum * 1b	1
Psidium guajava *2	3
Solanum sisymbriifolium * 1b	2
Tithonia rotundifolia *1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (75 trees).

IN DIE MIDDEL: MU 14a

-25.3939252430.59888327

Description

Management Unit 14a covers 1.15 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between the upstream property boundary and an access road on the farm In Die Middel. The length of the riprian zone is 444 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in Riparian Zone.
2 Stone packs along stream margin.
3 Alien vegetation, particularly *Populus x canescens*.
4 Access roads within riparian zone.

Other Issues

Building rubble.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.0	Twelve alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive riparian vegetation removed
8	Channel Modification	1.0	Bridge
	Score:	13.5	Ecological Condition
	% Modified:	34%	C: Fair

Alien Flora	Rating
*Ageratum conyzoides *1b*	2
Cardiosp. grandiflorum	2
*Datura stramonium *1b*	1
*Grevillea robusta *3*	2
*Lantana camara *1b*	2
*Melia azedarach *1b*	2
*Morus alba *3*	2
Parthenium hysterophorus	2
*Populus x canescens *2*	2
*Solanum mauritianum * 1b*	3
Solanum sisymbriifolium	2
Tecoma stans	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (388 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
3c) Realign access roads outside Managament Unit.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

IN DIE MIDDEL: MU 14b

-25.389627; 30.60216897

Description

Management Unit 14b covers 1.83 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between two access roads on the farm In Die Middel. The length of the riprian zone is 568 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in Riparian Zone.
2 Alien vegetation, particularly *Eucalyptus* sp.

Other Issues

None.

Riparian Health Index

Criteria	Rating	Comment
Alien Vegetation	3.0	Eight alien species recorded. Moderate abund.
Rubbish Dumping	0.5	Slight.
Bank Erosion	0.0	None
Inundation	0.0	None
Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
Water Quality	3.0	Turbidity; Nutrient discharge from fish farm.
Vegetation Removal	4.5	Extensive riparian vegetation removed
Channel Modification	0.0	None
Score:	**13.0**	Ecological Condition
% Modified:	**33%**	**C: Fair**

Alien Flora	Rating
Ageratum conyzoides *1b	2
Lantana camara *1b	2
Morus alba *3	2
Nicandra physalodes *1b	1
Ricinus communis *2	2
Solanum mauritianum * 1b	2
Bidens pilosa *1b	2
Eucalyptus grandis *1b	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (169 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.

IN DIE MIDDEL: MU 14c

-25.38987896; 30.60796003

Description

Management Unit 14c covers 1.77 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between two acess roads on the farm In Die Middel. The length of the riprian zone is 480 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in Riparian Zone.

2 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Nine alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	3.0	Turbidity; Nutrient discharge from fish farm.
7	Vegetation Removal	4.5	Extensive riparian vegetation removed
8	Channel Modification	0.0	None
	Score:	12.5	Ecological Condition
	% Modified:	31%	**C: Fair**

Alien Flora	Rating
*Ageratum conyzoides *1b*	4
*Datura stramonium *1b*	1
*Eucalyptus grandis *1b*	2
*Lantana camara *1b*	3
*Morus alba *3*	1
*Nicandra physalodes *1b*	1
*Pennisetum clandestinum **	2
*Psidium guajava *2*	1
*Ricinus communis *2*	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (231 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.

IN DIE MIDDEL: MU 14d

-25.39305839; 30.61040788

Description

Management Unit 14d covers 2.89 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between two access roads on the farm In Die Middel. The length of the riprian zone is 753 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Eight alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	1.0	Slight.
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive riparian vegetation removed
8	Channel Modification	1.5	Incised
	Score:	**14.5**	Ecological Condition
	% Modified:	**36%**	**C: Fair**

Alien Flora	Rating
*Ageratum conyzoides *1b*	1
*Pennisetum purpureum * 1b*	1
*Eucalyptus grandis *1b*	2
*Lantana camara *1b*	2
*Rubus sp. **	2
*Senna septemtrionalis *1b*	2
*Morus alba *3*	3
*Solanum mauritianum * 1b*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.

MOOILAND: MU 15a

-25.39526601; 30.61308799

Description

Management Unit 15a covers 0.95 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between an access road and a bridge on the farm Mooiland. The length of the riprian zone is 394 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Roads within Riparian Zone.
3 Alien vegetation.

Other Issues

1 Abultion facilities within riparian zone.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Nine alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	5.0	Complete removal of natural riparian vegetation
8	Channel Modification	0.0	None
	Score:	12.5	Ecological Condition
	% Modified:	31%	C: Fair

Alien Flora	Rating
*Lantana camara *1b*	3
*Morus alba *3*	3
*Psidium guajava *2*	2
*Ricinus communis *2*	1
*Rubus sp. **	1
*Senna septemtrionalis *1b*	2
*Sesbania punicea *1b*	1
*Solanum mauritianum * 1b*	2
*Verbena bonariensis * 1b*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.

7a) Relocate ablution facilities to outside riparian zone.

MOOILAND: MU 15b

-25.39855926; 30.61540953

Description

Management Unit 15b covers 1.15 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between an access road and a bridge on the farm Mooiland. The length of the riprian zone is 458 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Roads within Riparian Zone.
3 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	13 alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**13.0**	Ecological Condition
	% Modified:	**33%**	**C: Fair**

Alien Flora	Rating
Ageratum conyzoides *1b	2
Bidens pilosa *1b	2
Eucalyptus grandis *1b	3
Grevillea robusta *3	2
Jacaranda mimosifolia *	1
Lantana camara *1b	4
Melia azedarach *1b	1
Morus alba *3	3
Populus x canescens *2	3
Senna septemtrionalis *1b	2
Solanum mauritianum * 1b	3
Tithonia rotundifolia *1b	2
Verbena bonariensis * 1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.

MOOILAND: MU 15c

-25.40110996; 30.61797104

Description

Management Unit 15c covers 0.64 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between two access roads on the farm Mooiland. The length of the riprian zone is 344 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1. Clearing in Riparian Zone.
2. Roads within Riparian Zone.
3. Alien vegetation. Particularly *Babusa balcooa*.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Six alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**13.0**	Ecological Condition
	% Modified:	**33%**	**C: Fair**

Alien Flora	Rating
*Bambusa balcooa *1b*	4
*Lantana camara *1b*	2
*Melia azedarach *1b*	1
*Populus x canescens *2*	2
*Psidium guajava *2*	1
*Solanum mauritianum * 1b*	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.

MOOILAND: MU 15d

-25.4026555; 30.62056675

Description

Management Unit 15d covers 0.57 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between two access roads on the farm Mooiland. The length of the riprian zone is 302 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1. Clearing in Riparian Zone.
2. Roads within Riparian Zone.
3. Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Six alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.5	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**13.0**	Ecological Condition
	% Modified:	**33%**	**C: Fair**

Alien Flora	Rating
Bidens pilosa	2
*Grevillea robusta *3*	1
*Morus alba *3*	3
*Ricinus communis *2*	1
*Senna septemtrionalis *1b*	1
*Solanum mauritianum * 1b*	1
*Verbena bonariensis * 1b*	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.

MOOILAND: MU 15e

-25.40310527; 30.62325876

Description

Management Unit 15e covers 2.43 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between an access roads and the downstream property boundary of the farm Mooiland. The length of the riprian zone is 453 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Roads within Riparian Zone.
3 Alien vegetation, particular *Populus x canescens*.
4 Unprotected stream crossing.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	4.0	Nine alien species recorded. High abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	13.0	Ecological Condition
	% Modified:	33%	C: Fair

Alien Flora	Rating
Lantana camara *1b	1
Morus alba *3	1
Populus x canescens *2	4
Psidium guajava *2	1
Ricinus communis *2	1
Senna septemtrionalis *1b	1
Sesbania punicea *1b	1
Solanum mauritianum *1b	2
Tithonia rotundifolia *1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees (481 trees).

3d) Remove stream crossing or construct bridge over Crocodile River.

KOEDOESHOEK: MU 16a

-25.40348103; 30.62591004

Description

Management Unit 16a covers 1.50 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River on the farm Koedoeshoek, from Devil's Creek tributary junction downstream for a distance of 489 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone (Extensive).
2 Roads within Riparian Zone.
3 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Ten alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**12.5**	Ecological Condition
	% Modified:	**31%**	**C: Fair**

Alien Flora	Rating
*Ageratum conyzoides *1b*	3
*Bidens pilosa *1b*	1
*Casuarina sp. **	1
*Eucalyptus grandis *1b*	1
*Gleditsia triacanthos *1b*	1
*Jacaranda mimosifolia **	1
*Morus alba *3*	1
*Psidium guajava *2*	1
*Senna septemtrionalis *1b*	2
*Verbena bonariensis * 1b*	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.

KOEDOESHOEK: MU 16b

-25.40374825; 30.62974585

Description

Management Unit 16b covers 1.11 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River on the farm Koedoeshoek. Th distance of riparian habitat is 382 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Roads within Riparian Zone.
3 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Ten alien species recorded. Low abundance.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	12.5	Ecological Condition
	% Modified:	31%	C: Fair

Alien Flora	Rating
Bidens pilosa *1b	1
Morus alba *3	1
Psidium guajava *2	1
Senna septemtrionalis *1b	1
Verbena bonariensis * 1b	1
Grevillea robusta *3	1
Nicandra physalodes *1b	1
Rubus sp. *	1
Tecoma stans *1b	1
Ageratum conyzoides *1b	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees (150 trees).

KOEDOESHOEK: MU 16c

-25.40497041; 30.6323336

Description

Management Unit 16c covers 0.80 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between an access road and an agricultural drain on the farm Koedoeshoek. The length of the riprian zone is 308 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Roads within Riparian Zone.
3 Alien vegetation.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Eight alien species recorded. Low abundance.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	11.5	Ecological Condition
	% Modified:	29%	B: Good

Alien Flora	Rating
Gleditsia triacanthos *1b	1
Lantana camara *1b	2
Psidium guajava *2	2
Ricinus communis *2	1
Senna septemtrionalis *1b	1
Sesbania punicea *1b	1
Tithonia rotundifolia *1b	1
Verbena bonariensis * 1b	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees (188 trees).

KOEDOESHOEK: MU 16d

-25.40688467; 30.63488103

Description

Management Unit 16d covers 1.14 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between an agricultural drain and an access road on the farm Koedoeshoek. The length of the riprian zone is 339 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Roads within Riparian Zone.
3 Alien vegetation.
4 Stone packs.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.5	Three alien species recorded. Low abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	10.5	Ecological Condition
	% Modified:	26%	B: Good

Alien Flora	Rating
Tecoma stans *1b	1
Senna septemtrionalis *1b	2
Solanum mauritianum * 1b	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.

KOEDOESHOEK: MU 16e

-25.40858519; 30.63524128

Description

Management Unit 16e covers 0.58 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between an access road and the main agricultural drain and wetland tributary juction on the farm Koedoeshoek. The length of the riprian zone is 253 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

<u>Key Issues</u>

1 Clearing in Riparian Zone.
2 Localised erosion from stormwater discharge (hanging culvert).
3 Solid waste (tyres) (Figure D).
4 Roads within riparian zone.

<u>Other Issues</u>

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.5	Four alien species recorded. Low abundance.
2	Rubbish Dumping	2.0	Tyres
3	Bank Erosion	2.0	Local erosion at stormwater discharge point
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	1.0	Incised
	Score:	15.0	Ecological Condition
	% Modified:	38%	C: Fair

Alien Flora	Rating
*Gleditsia triacanthos *1b*	1
*Morus alba *3*	1
*Rubus sp. **	1
*Solanum mauritianum * 1b*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.
6a) Remove solid wastes (tyres) and dispose of appropriately (no burning).
7b) Stabilise discharge point to prevent bank erosion (no hanging culvert).

KOEDOESHOEK: MU 16f

-25.41126908; 30.6362104

Description

Management Unit 16f covers 1.31 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between the main agricultural drain and wetland tributary junction and downstream boundary of the farm Koedoeshoek. The length of the riprian zone is 381 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone (A).
2 Stone packs along stream margin (B).
3 Unprotected Stream Crossing (C).
4 Roads within Riparian Zones (E).

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.5	Six alien species recorded. Low abundance.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	3.0	Turbidity; Citrus wastes
7	Vegetation Removal	3.5	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**10.5**	Ecological Condition
	% Modified:	**26%**	**B: Good**

Alien Flora	Rating
*Ageratum conyzoides *1b*	1
*Gleditsia triacanthos *1b*	1
*Melia azedarach *1b*	1
*Morus alba *3*	1
*Rubus sp. **	1
*Solanum mauritianum * 1b*	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.

KOEDOESHOEK: MU 16e

-25.40858519; 30.63524128

Description

Management Unit 16e covers 0.58 hectares of riparian habitat on the right bank (facing downstream) of the Crocodile River between an access road and the main agricultural drain and wetland tributary juction on the farm Koedoeshoek. The length of the riprian zone is 253 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in Riparian Zone.
2 Localised erosion from stormwater discharge (hanging culvert).
3 Solid waste (tyres) (Figure D).
4 Roads within riparian zone.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	1.5	Four alien species recorded. Low abundance.
2	Rubbish Dumping	2.0	Tyres
3	Bank Erosion	2.0	Local erosion at stormwater discharge point
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	1.0	Incised
	Score:	15.0	Ecological Condition
	% Modified:	38%	C: Fair

Alien Flora	Rating
*Gleditsia triacanthos *1b*	1
*Morus alba *3*	1
*Rubus sp. **	1
*Solanum mauritianum * 1b*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.
6a) Remove solid wastes (tyres) and dispose of appropriately (no burning).
7b) Stabilise discharge point to prevent bank erosion (no hanging culvert).

KOEDOESHOEK: MU 16G

-25.40415997; 30.62238101

Description

Management Unit 16g covers 0.98 hectares of riparian habitat on beither side of lower Devil's Creek, between the N4 highway and its junction with the Crocodile River on the farm Koedoeshoek. The length of the riprian zone is 554 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-03].

Figure D. [2018-07-03].

Key Issues

1 Clearing in riparian zone.
2 Unprotected stream crossing.
3 Roads within riparian zones.
4 Alien vegetation, particularly *Parthenium hysterophorus*.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	2.5	Nine alien species recorded. Mod. abundance.
2	Rubbish Dumping	1.0	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Koedoeshoek Dam
6	Water Quality	0.5	Turbidity
7	Vegetation Removal	3.0	Moderate removal of riparian vegetation.
8	Channel Modification	1.5	Siltation
	Score:	10.5	Ecological Condition
	% Modified:	26%	B: Good

Alien Flora	Rating
Jacaranda mimosifolia *	3
Lantana camara *1b	1
Melia azedarach *1b	1
Parthenium hysterophorus *1b	1
Psidium guajava *2	1
Rubus sp. *	1
Solanum mauritianum * 1b	1
Solanum sisymbriifolium * 1b	2
Tecoma stans *1b	1

Actions

1a) Control alien invasive woody vegetation from riparian zone, particularly *Parthenium hysterophorus*.
1b) Plant indigenous trees in riparian zone (138 trees).

3a) Remove uncessesary stream crossing or construct formal culvert over Devil's Creek.

MONTROSE 1: MU 17a

-25.43768599; 30.74188197

Description

Management Unit 17a covers 2.98 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between the upstream property boundary and an access road on the farm Montrose 1. The length of the riprian zone is 429 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in riparian zone.
2 Stone packs along river margin.
3 Alien vegetation.
4 Solid wastes (seedling bags)
5 Woody debris

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Nine alien species recorded. Moderate abund.
2	Rubbish Dumping	1.5	Seedling bags.
3	Bank Erosion	0.5	Slight.
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly elevated; Kwena Dam
6	Water Quality	3.5	Turbidity; Salinity; Sulphates, *Cladophora*.
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	15.0	Ecological Condition
	% Modified:	38%	C: Fair

Alien Flora	Rating
Ageratum conyzoides *1b	2
Bidens pilosa *1b	2
Dolichandra unguis-cati *1b	1
Gleditsia triacanthos *1b	3
Lantana camara *1b	1
Melia azedarach *1b	2
Nicandra physalodes *1b	1
Passiflora subpeltata *1b	1
Ricinus communis *2	2

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (694 trees).
1c) Recontour areas disturbed by bulk earthworks, where necessary.
4a) Remove woody debris from Crocodile River.
5a) Remove stone packs and/or rubble from riparian zones and rehabilitate disturbed areas.
6a) Remove solid wastes (seedling bags) and dispose of appropriately (no burning).

MONTROSE 1: MU 17b

-25.43679801; 30.74521696

Description

Management Unit 17b covers 2.74 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between two access roads on the farm Montrose 1. The length of the riprian zone is 541 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in riparian zone.
2 Alien vegetation.
3 Woody debris

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Nine alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly evevated; Kwena Dam
6	Water Quality	3.5	Turbidity; Salinity; Sulphates
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**13.5**	Ecological Condition
	% Modified:	**34%**	**C: Fair**

Alien Flora	Rating
*Cardiospermum grandiflorum *1b*	3
*Eucalyptus grandis *1b*	1
*Gleditsia triacanthos *1b*	1
*Grevillea robusta *3*	1
*Ipomoea alba *1b*	2
*Jacaranda mimosifolia **	2
*Melia azedarach *1b*	3
*Passiflora subpeltata *1b*	3
*Senna didymobotrya *1b or 0*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (388 trees)
4a) Remove woody debris from Crocodile River.

MONTROSE 1: MU 17c

-25.43540603; 30.74975057

Description

Management Unit 17c covers 2.48 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between an access road nad the confluencec with the Houtbosloop, on the farm Montrose 1. The length of the riprian zone is 412 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-05].

Figure D. [2018-07-05].

Key Issues

1 Clearing in riparian zone.
2 Alien vegetation.
3 Woody debris

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Ten alien species recorded. Moderate abund.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.0	None
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly evevated; Kwena Dam
6	Water Quality	2.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**12.5**	Ecological Condition
	% Modified:	**31%**	**C: Fair**

Alien Flora	Rating
Ageratum conyzoides *1b	4
Bidens pilosa *1b	2
Cardiospermum grandiflorum	2
Gleditsia triacanthos *1b	1
Grevillea robusta *3	1
Ipomoea alba *1b	1
Jacaranda mimosifolia *	1
Melia azedarach *1b	2
Morus alba *3	1
Senna didymobotrya	1
Senna septemtrionalis *1b	3
Solanum mauritianum *1b	1
Tithonia rotundifolia *1b	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (625 trees)
4a) Remove woody debris from Crocodile River.

MONTROSE 1: MU 17d

-25.43302498; 30.75017997

Description

Management Unit 17d covers 4.68 hectares of riparian habitat on either side of the lower Houtbosloop, between the upper bounadry of the prioperty and the cinfluence with the Crocodile River, on the farms Montrose 1 and Montrose 2. The length of the riprian zone is 722 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1. Clearing in riparian zone.
2. Woody debris.
3. Unprotected stream crossing.
4. Roads within riparian zones.
5. Concrete railway sleeperws to support Jakfruit in riparian zone.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.0	Nine alien species recorded. Low abundance.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	0.5	Slight.
4	Inundation	0.0	None
5	Flow Modification	0.5	Stormwater slightly elevated.
6	Water Quality	1.5	Turbidity
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	10.0	Ecological Condition
	% Modified:	25%	B: Good

Alien Flora	Rating
Ageratum conyzoides *1b	2
Bidens pilosa *1b	2
Caesalpinia decapetala * 1b	1
Dolichandra unguis-cati *1b	1
Eucalyptus grandis *1b	1
Psidium guajava *2	1
Ricinus communis *2	1
Senna septemtrionalis *1b	1
Solanum mauritianum * 1b	1

Actions

1a) Control alien invasive woody vegetation from riparian zone. 1b) Plant indigenous trees in riparian zone (2044 trees).
3b) Divert stormwater from running directly into watercourse at road crossing. 3c) Realign access roads outside Managament Units.
4a) Remove woody debris from Houtbosloop.

MONTROSE 2: MU 18a

-25.43244403; 30.75524096

Description

Management Unit 18a covers 2.99 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between the confluence of the Houtbosloop and bridge across the Crocodile River, on the farm Montrose 2. The length of the riprian zone is 750 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in Riparian Zone.
2 Stone packs in riparian zone.
3 Solid waste in riparian zone (burnt tyres)
4 Roads within riparian zone.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	3.5	Ten alien species recorded. High abundance.
2	Rubbish Dumping	1.0	Burnt tyres
3	Bank Erosion	0.5	Slight
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly evevated; Kwena Dam
6	Water Quality	3.0	Turbidity; Salinity; Sulphates
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	14.0	Ecological Condition
	% Modified:	35%	C: Fair

Alien Flora	Rating
*Ageratum conyzoides *1b*	2
*Argemone ochroleuca *1b*	2
*Bidens pilosa *1b*	3
Cardiospermum grandiflorum	2
*Datura stramonium *1b*	2
*Gleditsia triacanthos *1b*	2
*Jacaranda mimosifolia **	1
*Lantana camara *1b*	1
*Psidium guajava *2*	1
*Tithonia rotundifolia *1b*	3

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (750 trees)
4a) Remove woody debris from Crocodile River.

MONTROSE 2: MU 18b

-25.428413; 30.75961104

Description

Management Unit 18b covers 2.53 hectares of riparian habitat on the left bank (facing downstream) of the Crocodile River between a bridge across the Crocodile River and the lower boundarry of the farm Montrose 2. The length of the riprian zone is 540 m.

Figure A. Aerial photograph 2015.

Figure B. Google Earth 2018.

Figure C. [2018-07-04].

Figure D. [2018-07-04].

Key Issues

1 Clearing in Riparian Zone.
2 Stone packs in riparian zone.
3 Solid waste in riparian zone (burnt tyres)
4 Roads within riparian zone.

Other Issues

None.

Riparian Health Index

	Criteria	Rating	Comment
1	Alien Vegetation	5.0	16 alien species recorded. High abundance.
2	Rubbish Dumping	0.5	Slight.
3	Bank Erosion	1.0	Slight.
4	Inundation	0.0	None
5	Flow Modification	2.0	Stormwater slightly evevated; Kwena Dam
6	Water Quality	3.0	Turbidity; Salinity; Sulphates
7	Vegetation Removal	4.0	Extensive removal of riparian vegetation.
8	Channel Modification	0.0	None
	Score:	**15.5**	Ecological Condition
	% Modified:	**39%**	**C: Fair**

Alien Flora	Rating
Ageratum conyzoides *1b	3
Argemone ochroleuca *1b	2
Bambusa balcooa *1b	4
Caesalpinia decapetala * 1b	2
Datura stramonium *1b	3
Eucalyptus grandis *1b	2
Ipomoea alba *1b	2
Melia azedarach *1b	3
Morus alba *3	3
Pennisetum clandestinum *	2
Populus x canescens *2	4
Ricinus communis *2	2
Senna didymobotrya *1b or 0	2
Senna septemtrionalis *1b	3
Sesbania punicea *1b	1
Solanum nigrum *1b	1

Actions

1a) Control alien invasive woody vegetation from riparian zone.
1b) Plant indigenous trees in riparian zone (550 trees)

4a) Remove woody debris from Crocodile River.

Annexure B:	Ecological Sensitivity Assessment

GELUK, KOEDOESHOEK AND BRUINT JIESLAAGTE

TERRESTRIAL ECOLOGICAL ASSESSMENT

JANUARY 2021

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

CARA - Conservation of Agriculture Resources Act

CBA - Critical Biodiversity Area

DEA – Department of Environmental Affairs

EAP - Environmental Assessment Practitioner

EWT - Endangered Wildlife Trust

IUCN - International Union for Conservation of Nature

masl - Metres above mean sea level

MAT – Mean annual temperature.

MBSP – Mpumalanga Biodiversity Sector Plan

NEMBA - National Environmental Management: Biodiversity Act

NFA - National Forest Act

SANBI - South African National Biodiversity Institute

PRECIS - National Herbarium Pretoria (PRE) Computerised Information System

QDGS - Quarter-Degree Grid Square, for example 2431 AB

SABAP2 - Southern African Bird Atlas Project 2

SANBI - South African National Biodiversity Institute

SCC - Species of Conservation Concern

DECLARATION OF INDEPENDANCE

This declaration serves to inform any interested party that I, Matthew Altenkirk of Smart Ecological Services, have been appointed as an independent consulting ecologist to compile a terrestrial ecological assessment by Steven Henwood of Henwood Environmental Solutions. I have no affiliation with nor any vested financial interests in the proponent, other than for the work necessary to compile this report. I have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. Remuneration for my services is not linked to approval by any decision-making authority responsible for authorising this development.

MA

Matthew A Altenkirk

January 2021

1. INTRODUCTION

Steven Henwood of Henwood Environmental Solutions appointed Smart Ecological Services to perform an assessment of the terrestrial ecology for proposed land clearing and planting of agricultural plants in the Schoemanskloof valley, Mpumalanga Province of South Africa (Figure 1). The key criteria for the study including carrying out a terrestrial ecology survey while assessing the ecological importance of the represented terrestrial habitats. This study aimed to provide the scope for assessing the potential impacts of the proposed project on the terrestrial ecology, provide a baseline description of the vegetation dynamics and supply advice on the suggested location of the planned infrastructure. The two key deliverables for this study were to conduct a baseline terrestrial ecology survey and assess the Ecological Importance of the terrestrial habitats represented.

The study was carried out by Matthew Altenkirk who is a Terrestrial Ecologist. Matthew has spent his early career actively involved in Ecological management. He has 12 years' experience in management of properties in Kwa-Zulu Natal, Limpopo and Mpumalanga. Matthew has recently moved out of management and started Smart Ecological Services; an ecological based consultancy focused on sustainable/ best practice management of our natural ecosystems. Matthew has been actively involved in the development, implementation, and management of numerous Environmental management systems on the ground and as such has experience in the processes and semantics of terrestrial ecology patterns and processes.

2. OBJECTIVES

The objectives of the Ecology Survey are to:

- Provide a baseline ecological assessment of the terrestrial ecosystems that are likely to be impacted by the proposed upgrade.
- Provide an assessment of the ecological importance and conservation value of potentially affected ecosystems.
- Provide an overview of key potential impacts of the project on terrestrial ecosystems.
- Make recommendations regarding infrastructure layout, where appropriate.

The expected outcomes of the report on Terrestrial Ecosystems, are:

- Biodiversity Baseline Description.
- Ecological Importance Assessment.
- Broad-scale Vegetation Map.
- Ecological Importance Map.
- Overview of the key potential impacts on the environment.
- Recommendations regarding infrastructure layout, where appropriate.

3. LOCATION AND PROJECT DESCRIPTION OF STUDY AREA

The study took place on a section of land covering small sections of Portion 5 of the farm Geluk 299 JT, Bruint Jieslaagte 499 JT, and Koedoeshoek 301 JT in the Schoemanskloof valley, approximately 35 km south-east of Mbombela, in the Mpumalanga Province (Figure 1). The area surrounds the central coordinate of -25. 401074 S 30.617251 E and therefore falls within the quarter degree grid unit 2530 BC. A large proportion of land in the area has been transformed under agriculture.

The area that is under proposal is small with a total area sampled of roughly 15 Ha (150 000 m²) in extent. The study area lies alongside and therefore drained by the Crocodile River; this is a perennial river of national importance that drains westwards. On the southern extent of the study site (forms the boundary) is the R539 – Schoemanskloof road. The north, east and western portions of land are all transformed from natural to agricultural lands.

LOCALITY OF THE STUDY SITE

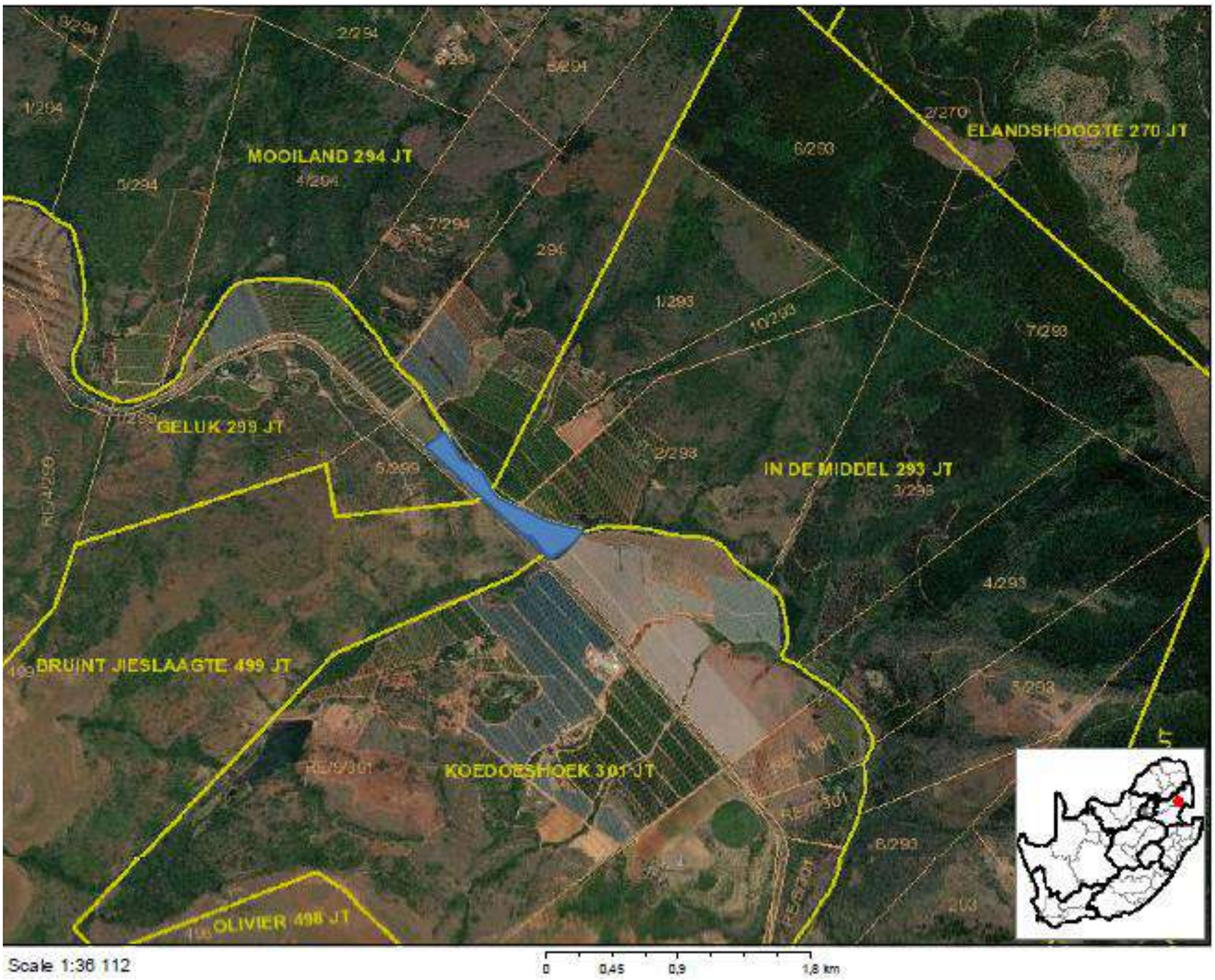


Figure 1: Locality of the study area

4. METHODOLOGY

Prior to site investigations, an in-depth desktop analysis was carried out with emphasis on scale dependent terrestrial biodiversity, conservation importance, and legal implications and/or limitations of development on the study site. An initial screening of the study area was undertaken using the Environmental Screening Tool (EST) of the Department of Environmental Affairs (DEA). This indicated that the study area had a Very High Terrestrial Biodiversity theme. This was followed by the Mpumalanga Biodiversity sector plan of 2014 for a more detailed screening of the study site. The results and discussions thereof will be broken down in more detail in section 5 of this document.

4.1 FLORA

The broad scale vegetation dynamics of the study site were studied prior to fieldwork using satellite imagery. A broad scale plant species list was obtained, with emphasis on the Red Data plant species listed area using the BODATSA - POSA data from the South African National Biodiversity Institute (SANBI, 2016).

Homogenous vegetation communities that were delineated during the desktop analysis were surveyed over a single site visit in January 2021une 2020. The entire portion of land identified by Steven Henwood of HES (Figure 1) is set to be transformed and this area of operation was pre-loaded onto a Garmin Etrex 10 GPS unit. During the site visit, GPS coordinates are recorded for any species of Conservation Concern (SCC) (Raimondo et al, 2009) as well any nationally and provincially protected species. These include species listed under SANBI's Red List of South African Plants and the IUCN list of threatened species. The following legislation was referenced with regards to protected species:

- Mpumalanga Nature Conservation Act (No. 10 of 1998) (MNCA)
- National Environmental Management: Biodiversity Act (No. 10 of 2004) Threatened and Protected Species Lists (GG Notice 256, 2015) (NEMBA ToPS)
- Conservation of Agricultural resources Act (Act 43 of 1983)

4.2 FAUNA

An in-depth desktop analysis was conducted prior to the site visit on the dynamics of the faunal assemblages possibly occurring in and around the study site. Lists were compiled for mammal, bird, reptile, and frog species potentially occurring with emphasis on SCC and provincially and/or nationally protected species. The following databases were assessed for the QDGS 2530 BC:

- Southern African Bird Atlas Project 2 http://sabap2.adu.org.za
- The FitzPatrick Institute of African Ornithology (2020)
    - Child *et al*. (2016) Mammals
    - Bates *et al*. (2014) Reptiles
    - Minter *et al*. (2004) Frogs
- The IUCN Red List of Threatened Species

The following legislation was assessed to ascertain legal links:

- Mpumalanga Nature Conservation Act (No. 10 of 1998) (MNCA)
- National Environmental Management: Biodiversity Act (No. 10 of 2004) Threatened and Protected Species Lists (GG Notice 256, 2015)

Faunal assemblages were quantified through both direct and indirect observations. Direct evidence, included physical sightings and indirect evidence included spoor, sound and dung findings. Observations were made as they were encountered during the site visit. Bird observations were made visually using Tasco 10x42 binoculars and quantified by sound as well. The potential presence of conservation important species was investigated more intensely by looking for nesting sites, burrows and any other tracks and signs.

4.3 BIODIVERSITY VALUE ASSESMENT

The biodiversity value (BV) was calculated using the below described methodology. The BV of each vegetation community was based on a combination of Conservation Importance (CI) and Functional Importance (FI). Each category was weighted according to a 5-point scale (Very low – Very high) (Table 1). This method was adapted from a Biodiversity Action Plan guideline developed by Anglo American (Coombes, 2004).

4.3.1 Conservation Importance

Calculating the CI was done by focusing on six parameters, each allocated a score that ranged between zero (Not Important) and twenty (Very Important) (Table 2). The medium value calculated over these 6 parameters was taken as the CI value, the parameters utilized are:

1. **Protection Status**. This includes the level to which the vegetation community is currently formally protected (e.g: National Park; Provincial Game Reserve; Private Conservancy etc);
2. **Size.** This refers to the extent to which the larger vegetation type still exists; it looks at conservation status of threatened vegetation types with the general assumption that vegetation types with high threat statuses have already seen major reduction in extent;
3. **Species Diversity**. The extent to which the vegetation community supports a high diversity of plants or animals;
4. **Species of Conservation Concern (SCC)**. Identifies the extent to which the vegetation community supports threatened species and other SCC;
5. **Habitat**. Identifies the presence of plants or animals with range-specific habitats and/or unusual natural features;
6. **Ecological State**. The extent to which the vegetation community is modified from natural conditions.

4.3.2 Functional Importance

Calculating the FI was done by focusing on the three main ecosystem service categories, each allocated a score that ranged between zero (Not Important) and twenty (Very Important) (Table 3). The medium value calculated over these 4 parameters was taken as the FI value, the parameters utilized are:

1. **Regulating Services.** The extent to which the vegetation community provides regulating services (e.g. flood attenuation, water purification, etc);
2. **Cultural Services.** The extent to which the vegetation community provides cultural services (e.g. tourism attraction, aesthetic value, etc), and;
3. **Ecological services**. The extent to which the vegetation community provides supporting ecological services, either positive (e.g. migration corridor, refuge area, primary production, pollination, pest control, nutrient cycling, soil formation), or negative (e.g. disease sources, pest outbreaks).

An assessment of Biodiversity Value was made by integrating the findings of Conservation importance and Functional importance. The overall BV calculations and descriptions can be found further in this report.

Table 1: Method of calculating overall Biodiversity Value of a vegetation community.

Conservation Importance (CI)	Functional Importance (FI)				
	Very High	High	Moderate	Low	Very Low
Very High	Very High	Very High	High	High	Moderate
High	Very High	High	High	Moderate	Moderate
Moderate	High	High	Moderate	Moderate	Low
Low	High	Moderate	Moderate	Low	Low
Very Low	Moderate	Moderate	Low	Low	Very Low

Table 2: Method of calculating Conservation Importance of a vegetation community.

Parameter	Very High	High	Moderate	Low	Very Low
Protection Status	International	National	Regional	Local	None
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Size	Very Small	Small	Moderate	Large	Very Large
	(<500km²)	(500 - 1,000 km²)	(1,000 - 20, 000 km²)	(20, 000 - 50, 000km²)	(> 50, 000km²)
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species Diversity	High		Moderate		Low
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species of Conservation Concern (SCC)	High		Moderate		Low
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Habitat	High		Moderate		Low
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological State	Natural, largely unmodified	Slightly modified	Moderately modified	considerably modified	Severely modified
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*

Table 3: Method of calculating Functional Importance of a vegetation community.

Parameter	Very High	High	Moderate	Low	Very Low
Regulating Services	Very High	High	Moderate	Low	Very Low
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Cultural Services	Very High	High	Moderate	Low	Very Low
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological services	Very High	High	Moderate	Low	Very Low
	20 - 17,	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*

4.4 ASSUMPTIONS AND LIMITATIONS

The Terrestrial Biodiversity assessment, which entails two key components (Desktop and Physical analysis) was carried out in the wet, growing season. Limitations that were identified included a major density of alien plant species, individuals were not logged on the GPS as the density was deemed too great and the information would be irrelevant. Secondly and linked to the above, the density of alien species in the riparian zine limited the access the specialist had to certain areas as the plants are impenetrable. The specialist does not believe that these limitation and conditions would mark any major threat to the overall decision on the proposed development. The development is planned for an area adjacent to existing infrastructure and land that has been completely transformed under agriculture and as such the specialist does not envisage any SCC or protected species being present in alternate seasons or under more favourable conditions.

5. BIODIVERSITY BASELINE DESCRIPTION

5.1 FLORA

5.1.1 Regional

The study area falls within the Legogote Sour Bushveld (SVI 9) vegetation type (Mucina & Rutherford, 2006). This vegetation type is found in Mpumalanga and Limpopo Provinces along the lower eastern slopes and hills of the north-eastern escarpment from Mariepskop in the north through White River to the Nelspruit area extending westwards up the valleys of the Crocodile, Elands and Houtbosloop Rivers and terminating in the south in the Barberton area (Mucina & Rutherford, 2006). Most of the area is underlain by gneiss and migmatite of the Nelspruit Suite which weather into Mispah, Glenrosa and Hutton forms, shallow to deep, sandy, or gravelly and well drained. Diabase intrusions are common, giving rise to Hutton soils. Its original extent in Mpumalanga was roughly 377 000 hectares with approximately 50% having been transformed by either cultivation and/or settlement development (Lotter et al, 2014). According to Mucina & Rutherford (2006), the vegetation type is considered as Endangered with a conservation target of 19%. Currently only about 2% statutorily conserved mainly in the Bosbokrand and Barberton Nature Reserves. An estimated further 2% is conserved in private reserves including the Mbesan and Kaapsehoop Reserves and Mondi Cycad Reserve (Mucina & Rutherford, 2006).

The vegetation and Landscape features are characterised by gentle to moderately sloping upper pediment slopes with dense woodland including many medium to large shrubs often dominated by *Parinari curatellifolia* and *Bauhinia galpinii* with *Hyperthelia dissoluta* and *Panicum maximum* in the undergrowth. The short thickets are dominated by *Acacia ataxacantha*, which occurs on less rocky sites. The many exposed granite outcrops have low vegetation cover, typically with *Englerophytum magalismontanum*, *Aloe petricola* and *Myrothamnus flabellifolia*.

The dominant plants associated with this vegetaton type include tall trees, *Pterocarpus angolensis*, *Sclerocarya birrea* subsp. *caffra*. Small Trees: *Acacia davyi*, *A. sieberiana* var. *woodii*, *Combretum zeyheri*, *Erythrina latissima*, *Parinari curatellifolia*, *Terminalia sericea*, *Trichilia emetica*, *Peltophorum africanum*, *Pterocarpus rotundifolius*, *Schotia brachypetala*. Tall Shrubs: *Diospyros lycioides* subsp. *sericea*, *Erythroxylum delagoense*, *Olea europaea* subsp. *africana*, *Pachystigma macrocalyx*, *Pseudarthria hookeri* var. *hookeri*, *Rhus pentheri*. Climbers: *Acacia ataxacantha*, *Bauhinia galpinii*. Graminoids: *Bothriochloa bladhii*, *Cymbopogon caesius*, *C. nardus*, *Hyparrhenia cymbaria*, *Hyperthelia dissoluta*, *Panicum maximum*, *Andropogon schirensis*, *Paspalum scrobiculatum*, *Schizachyrium sanguineum*. Herbs: *Gerbera ambigua*, *G. viridifolia*, *Hemizygia persimilis*, *Hibiscus sidiformis*, *Ocimum gratissimum*, *Waltheria indica*.

5.1.2 Site specific - Vegetation Assemblages

According to SANBI'S Botanical dataset of South Africa (BODATSA) for an area of roughly 100 km² around the study area, 910 species of plant have been recorded. During the site survey of January 2021, a total of 116 species of plant from 34 families were identified. This equates to roughly 13 % of the BODATSA total for the greater area. Worryingly 33 of these species where not indigenous to South Africa.

Three (3) vegetation communities were identified during the field surveys with the delineation based on overall vegetation structure (woodland, thicket), species composition (dominant species) and general location within the catena (mid-slope, riparian fringe.) (Figure 5). Due to the limited scope and area of the survey (15 Ha), the separation of said communities is rather slight due to the lack of spatial separation however, for the purposes of the study, these fine scale vegetation communities are described in more detail below.

5.1.2.1 *Senegalia ataxacantha – Panicum maximum* tall, closed thicket (Riparian zone)

This vegetation community extends as a narrow belt along the Crocodile river and falls exclusively within the riparian fringe. The zone is almost entirely inundated with alien plant species (See 5.1.4). The unit is extremely thick and dominated by species that male access next to impossible. It supports some large and settled tree species including species such as *Vachellia erioloba, V. sieberiana var. woodii*. The herbaceous layer was almost absent from the zone apart from the dominant species of *Panicum maximum*, *Sporobolus africanus* and numerous *Aristida* sp. These riparian zones give the banks of the river structure and allow for adequate protection of soils during high rainfall periods and most importantly flood attenuation. This zone is extremely far from a natural state and requires immediate action in the form of a detailed and managed Alien and exotic plant removal plan.

The vegetation structure is classified as tall, closed thicket (Edwards, 1983) with a dominance of woody plant species. The dominant tall trees are *Melia azedarach* (Alien), *Senegalia ataxacantha* and *S galpini.* Less common tall trees include Combretum *erythrophyllum, C mole, Dalbergia melanoxylon.* Dominant shrubs and small trees are *Combretum hererohense, Grewia flava, Peltophorum Africana.* Dominant herbaceous species included *Panicum maximum, Urochloa mozambicensus, Pogonarthria squarrosa*, and less dominant plants including *Brachiaria deflexa, Eragrostis rigidior, E superba, Chloris gayana* and *Tragus berteronianus*.

There was no SCC (Raimondo et al, 2009) identified during the survey in this zone.

Figure 2: Riparian zone with signs of major Alien plant infestation

Figure 3: Picture of a patch of undisturbed riparian zone structure.

5.1.2.2 *Vachillia erioloba– Panicum maximum* open woodland

This community lies to the south and east of the building footprint (5.1.2.3 below) and the zone made up approximately 50000 m² (5 Ha) of the study area. The zone had particularly good ground cover with a moderate density of plant species identified. The herbaceous layer was dense with a moderate diversity of dominant species. The woody layer was open with scattered tall trees with a low species diversity. Evidence of wildlife movement through the zone was not evident. The site boarders onto the Riparian zone (5.1.2.1 above) above with a gradual ecotone evident in the northern half of the study area.

The structure of this vegetation community can be described as a tall, open woodland (Edwards, 1983). Large trees that dominate the zone include *Vachillia erioloba, V nilotica, Combretum apiculatum, C hererohense, Senegalia nigrescens* and *Peltophorum africanum.* Less common tall trees include *Ziziphus mucronata, Dalbergia melanoxylon.* Dominant shrubs include *Combretum zehyeri, C hererohense, C apiculatum, Peltophorum africanum, Grewia Flava,* and *Gymnosporia buxifolia*. The herbaceous layer was dominated by the graminoids *Panicum maximum, Digiteria eriantha, Heteropogon contortus, Eragrostis rigidior, E superba* and *Aristida* sp.

There was no SCC (Raimondo et al, 2009) identified during the survey in this zone.

Figure 4: Picture of the structure of the open woodland dominated by *Vachillia erioloba* tall trees.

5.1.2.3 Disturbed / existing infrastructure

This vegetation community falls to the South and east of the study area as well as a section on the south-central area that has been developed as a shooting range. The unit makes up roughly makes up roughly 35000 m² (3.5 Ha) of the study area. The area is secondary in nature with low ground cover and supports a relatively low diversity of indigenous species. A large proportion of the plant species in this unit are exotic / alien species. There is a large, cleared area that has absolutely no vegetation cover and numerous dwellings and buildings that have been developed in the past thus indicating anthropogenic disturbance of the area. There are numerous access roads and cleared patches spread out throughout this unit.

The overall structure of this unit can be described as sparse shrubland (Edwards, 1983). Large tree species in the area include *Senegalia nigrescens* and *Peltophorum africanum*, smaller trees and shrubs make up most of the woody strata and are dominated by *Euclea divinorum, Peltophorum africanum, Grewia flava*, *G flavescense* and *Ziziphus mucronata*. The herbaceous layer was extremely sparse with the dominant species being *Eragrostis ridigior, Sporobolus nitens, Aristida sp, Sporobolus ioclados*, *Pogonarthria squarrosa*, *Brachiaria deflexa* and *Chloris virgate, and C. gyana.*

There was no SCC (Raimondo et al, 2009) identified during the survey in this zone.

Figure 5: Open and cleared patch of roughly 10 000 m² (1 Ha)

Figure 6: Existing infrastructure and disturbance in this zone.

Figure 7: Existing infrastructure in the form of a shooting range with major disturbance in this zone.

5.1.3 Conservation-Important Flora

A total of 116 plant species were recorded during the field survey (Appendix 1), none of which are regarded as threatened (i.e., Vulnerable, Endangered or Critically Endangered), or as NT by the IUCN (Raimondo *et al*, 2009).

According to the BODATSA – POSA database, there is only one SCC within an area of 400 km² of which the study area is part of namely *Merwilla plumbea* (NT). According to SANBI threatened plant database, it is considered as Vulnerable. The plant occurs on the east of southern Africa, throughout the Eastern Cape, Lesotho, KwaZulu-Natal, Free State, Swaziland and into Mpumalanga where it is found growing in a variety of habitats from sunny slopes, rocky hills, cliffs and ledges to damp cliff faces, near waterfalls, in moist depressions, on the edges of streams and vleis (wetlands) to coastal areas, in groups or as solitary specimens.

5.1.4 Invasive Alien Species

Alien species were identified in mass within the study area during the field surveys (Table 5). The entire riparian zone is inundated by numerous exotic and alien plant species. Further detail will be found under recommendations. The species list of identified alien species can be found in the appendix list. Due to the severe infestations, GPS coordinates of individual plants were not taken. There are numerous species of alien plant that are listed by the Conservation of Agricultural Resources Act of 1983 (Act No. 43 of 1983, CARA). The relevant category is listed next to each specie listed in the faunal assemblage appendix. A detailed management strategy to identify, control and eradicate Alien and invasive plants must be enforced, irrespective of the decision taken around this transformation.

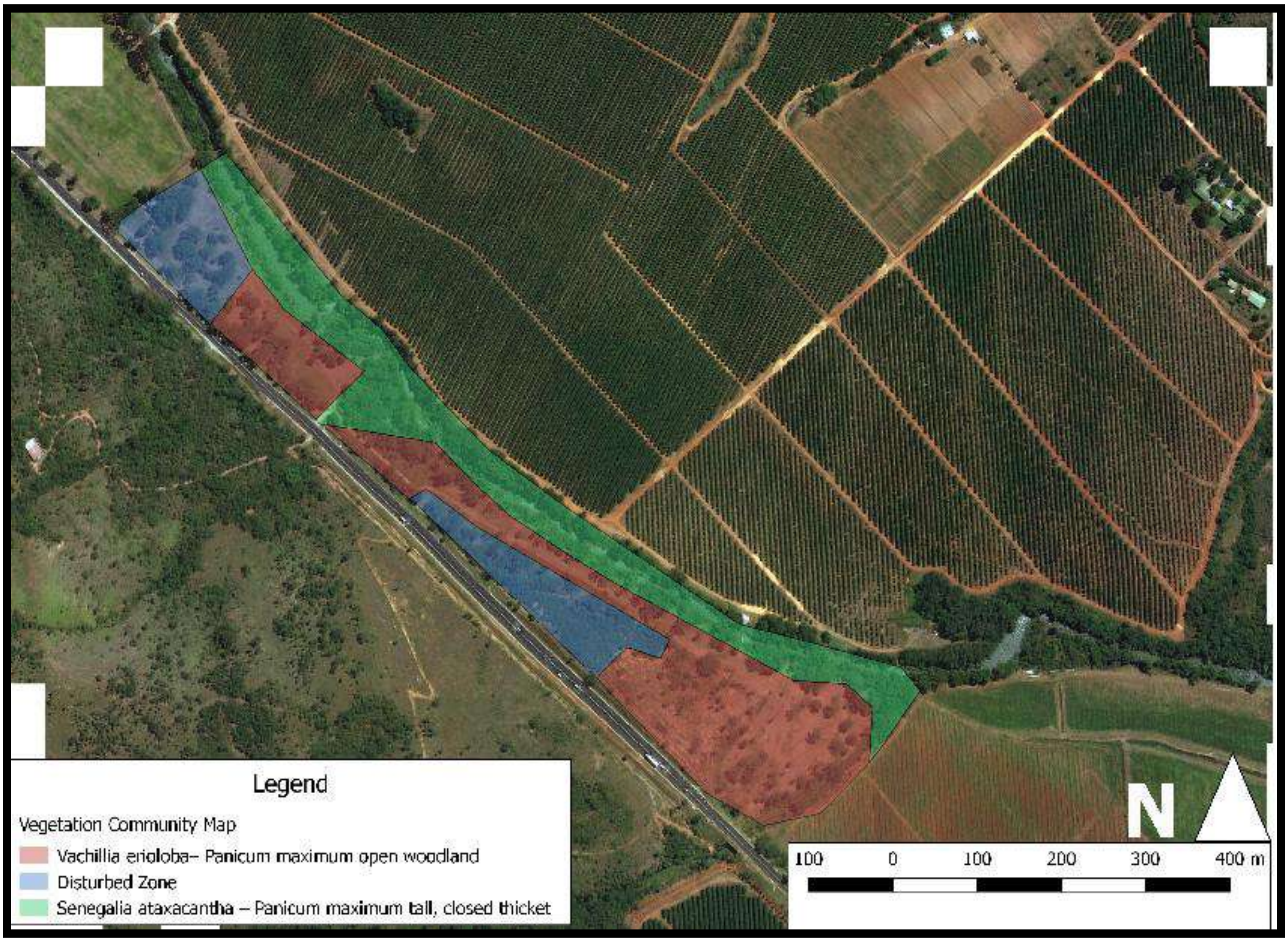


Figure 8: Vegetation community map of the study site.

5.2 TERRESTRIAL FAUNA

5.2.1 Mammals

5.1.2.1 Regional

The study area is situated within an area that has been extensively transformed due to agriculture and as such the faunal assemblages of the area are limited with a low biodiversity. Meaningful natural habitats are extremely fragmented thus placing faunal populations under stress for adequate land use. According to the Animal Demography Unit's Virtual Museum, there have been 68 mammal species recorded for the quarter degree grid 2530 BC and a total of 147 species listed for the degree grid 2530.

5.2.2.2 Confirmed Species.

During the survey, a total of six (6) mammal species were confirmed to be present in the study area. Animal tracks were identified in the study site, particularly along the riverbanks. All mammals confirmed to be present in the area are considered common in the area and are listed in Appendix 2.

5.2.2.3 Conservation-Important Species

An estimated nine (9) mammal of conservation importance have the potential of occurring in the QDGS 2530BC in which the study area falls. Of these species, five (5) are considered as SCC (VU, EN, CR) (Raimondo et al, 2009) (Table 4). These include the Oribi (*Ourebia ourebi*), Percival's Short-eared Trident Bat (*Cloeotis percivali*), Cohen's Horseshoe Bat (*Rhinolophus cohenae*) (VU), the African wild dog (*Lycaon pictus*) (EN and NEMBA-EN), and the leopard (*Panthera pardus*),

The remaining four (4) species of conservation importance are listed as Near threatened (NT) (Child et al, 2016) and protected under NEMBA. It is highly unlikely that the likes of the African Wild dog (Lycaon pictus) would be found near the study site. It is however likely that the remaining 9 species have the potential of occurring in and around the study area from time to time with a variety of likelihoods due to population densities and suitable habitat.

Table 4: List of mammals of SCC or those that are protected that potentially occur in the study site.

Family	Species	Common name	IUCN status
Bovidae	*Ourebia ourebi*	Oribi	EN
Canidae	*Lycaon pictus*	African wild dog	EN
Hipposideridae	*Cloeotis percivali*	Percival's Short-eared Trident Bat	EN
Rhinolophidae	*Rhinolophus hildebrandtii*	Hildebrandt's Horseshoe Bat	NT
Bovidae	*Cephalophus natalensis*	Red Duiker	NT
Rhinolophidae	*Rhinolophus blasii*	Blasius's Horseshoe Bat	NT
Soricidae	*Crocidura mariquensis*	Swamp Musk Shrew	NT
Felidae	*Panthera pardus*	Leopard	VU
Rhinolophidae	*Rhinolophus cohenae*	Cohen's Horseshoe Bat	VU
			9

5.2.2 Birds

5.2.2.1 Regional

At a QDGS scale, (QDGS 2530 BC), a large avifaunal diversity exists with a total of 372 species recorded during the second Southern African Bird Atlas Project (SABAP2). At a finer scale, 178 bird species have been recorded within the pentad in which the study area is situated (2520 3035) (SABAP2). A pentad is a 5 x 5 min grid unit (approximately 80 km²). This scale is clearly more significant and as such provides a better indication of species possibly occurring in the study site.

5.2.2.2 Confirmed Species.

During the site survey, a total of 63 bird species were confirmed to occur within the general study area (Appendix 2). This density represents close on 36% of the possible 178 species recorded during the SABAP2 program of 2019 (Appendix 3). This relatively low density can be attributed to the limited area surveyed in this study (15 Ha), Due to the size and dynamics of the study area, it was not necessary to separate birds into habitat type or assemblage categories.

5.2.2.3 Conservation-Important Species

There are no SCC bird species that are likely to occur within the study area. conservation-important birds that have the potential of occurring in the general area surrounding the study site.

5.2.3 Reptiles

5.2.3.1 Regional

The granitic zones east of the escarpment play host to a high diversity of reptiles with 147 species recorded for the 2530-degree grid (http://vmus.adu.org.za/). At a finer scale, there is data to suggest that an estimated 68 species occur within the QDGS 2530 BC.

5.2.3.2 Confirmed Species.

There were six (6) species of reptiles confirmed to be present in the study area (Appendix 2). It is highly likely that more species would be in the study area if a dedicated reptile survey were to be conducted, however, this improved species list is unlikely to lead to any change in the overall recommendations in this report due to the lack of potentially occurring SCC in the study site.

5.2.3.3 Conservation-Important Species

There are two (2) conservation important species that have the potential of occurring within the degree grid 2530, namely The Nile crocodile (*Crocodylus niloticus*) and the Breyer's Long-tailed Seps (*Tetradactylus breyeri*). The Nile crocodile has recently been re-evaluated as Least concern by the IUCN and therefore is not included in the SCC listing. Neither of these species have been recorded for the QDGS 2530 BC, therefore there are no possible reptiles of SCC potentially occurring in the study site.

5.2.4 Frogs

5.2.4.1 Regional

According to the Frogs of Southern Africa website, accessed through the FitzPatrick Institute of African Ornithology's virtual museum (http://vmus.adu.org.za/), Forty-one (41) species of frogs have been recorded for the degree grid 2530. At a finer scale, 16 species have been recorded within the QDGS 2530 BC. None of the possibly occurring frog species are endemic to South Africa (Minter *et al.*, 2004).

5.2.4.2 Confirmed Species.

During the field survey, two frog species was located within the study area. Namely, Guttural toad (*Sclerophrys gutturalis*) and Southern Foam nest frog (*Chiromantis xerampelina*). It is highly likely that frog species would be located if a dedicated survey was to be conducted, however, this improved species list is unlikely to lead to any change in the overall recommendations in this report due to the lack of potentially occurring SCC in the study site.

5.2.4.3 Conservation-Important Species

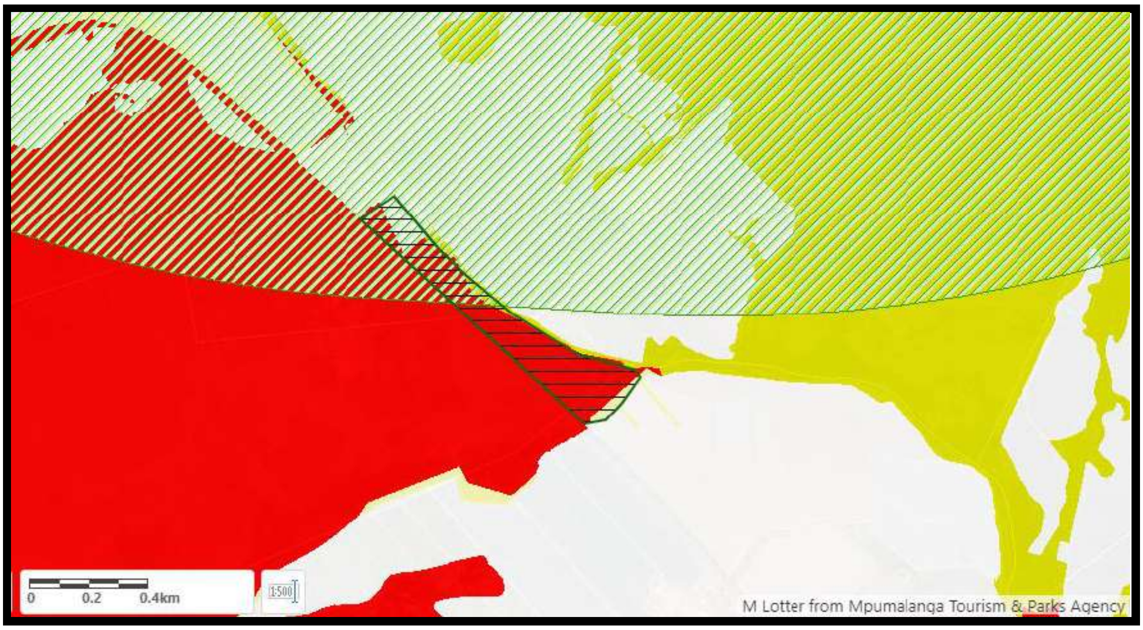
There are no SCC that potentially occurs in the degree grid 2530, Therefore, there are no SCC that potentially occur in the study site.

5.3 ECOLOGICAL IMPORTANCE

5.3.1 Environmental Screening Tool (EST)

Figure 9: Map detailing the sensitivity rating as per the Governments Environmental Screening tool.

5.3.2 Mpumalanga Biodiversity Sector Plan (MBSP)



(red)	CBA	Irreplaceable
(yellow)	CBA	Optimal

Figure 10: MBSP - CBA map including the study area.

5.3.3 Biodiversity Value Assessment

A biodiversity value assessment, integrating conservation and functional importance, was carried out for the vegetation communities identified in the study site. The methodology used is described in section 4.3 with the integrated biodiversity values summarised in table 5 and illustrated spatially in Figure 11. The data sheets for conservation importance and functional importance calculations for each community are presented in Appendix 4, as well as described in more detail below.

Firstly, it must be noted that the Legogote sour Bushveld (SvI 9) is a classified threatened terrestrial ecosystem. The study site is made up of areas that are classified as Heavily or Moderately modified and Critical Biodiversity Area (CBA Irreplaceable) according to the MBSP of 2014 (Lotter *et al*, 2014) (Figure 10). These CBA areas are essential for meeting biodiversity targets for species, ecosystems, or ecological processes. The desired management objectives for CBAs are that they be kept in a natural or near-natural state, with little to no further loss of habitat or species. Management objectives for these areas are limited to low-impact, biodiversity-sensitive land-uses. At a finer scale, the open woodland and the riparian zone vegetation communities identified in the study area (See section 5.1.2), both have high biodiversity values with the riparian zone having a very high value (Table 8). The very high BV and associated limitations of the CBA criteria highlight that this site is a key area that needs to remain functional and intact to maintain ecological processes that keep the ecosystem stable. It is believed that developments and associated impacts within this community would have major terrestrial impacts and as such need to be avoided. The open woodland, indicative of the vegetation type, had a high BV rating since the vegetation unit is classified as a threatened ecosystem. This unit is approximately 5 hectares in extent. The unit runs as a thin strip along a national highway, with the majority (N, E,W) of the neighbouring land portions being transformed under agriculture. This fragment, although important, is highly unlikely adding to the conservation of any specific fauna or flora.

Table 5: Overview of the calculation of the Biodiversity Value of each vegetation community in the study area.

	Geluk et al		
Assessment Criteria	Riparian Zone	Open Woodland	Disturbed zone
Conservation Importance (CI)	High	Moderate	Low
Functional Importance (FI)	Very High	High	Low
Biodiversity Value	Very High	High	Low

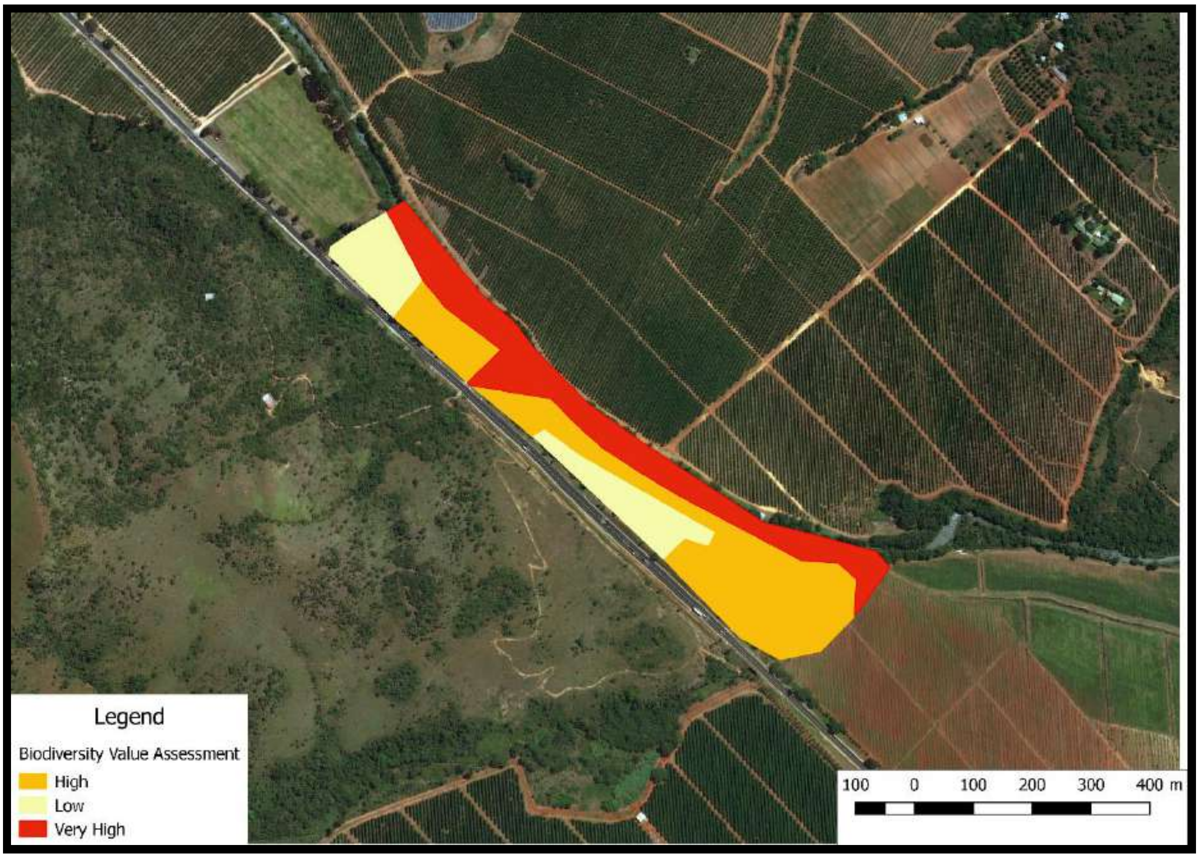


Figure 11: Biodiversity value map of the study area.

6. CONCLUSIONS AND RECOMMENDATIONS

The proposed transformation of land from natural to agriculture on the Farms Geluk, Koedoeshoek and Brunt Jieslaagte. In the Mpumalanga Province (Figure 1) necessitated a Terrestrial Biodiversity assessment into the impacts of the planned transformation. The Mpumalanga Biodiversity Sector Plan of 2014 delineated the area, that the study area falls within, as a Critical Biodiversity Area (CBA) (Irreplaceable). These areas are extremely limited with regards to permissible land use and subsequent management objectives and are those areas (outside of Protected Areas) that are required to meet biodiversity targets for biodiversity pattern (species and ecosystems) and ecological processes (Lotter et al, 2014). Such areas are often at risk of being lost due to their remaining extent already being near to or lower than the required biodiversity target.

The three vegetation communities identified during the study have varying values in terms of Biodiversity (Table 8). The vegetation in the riparian zone, albeit inundated with exotic and alien plant species, has very-high biodiversity value, falls within the CBA (Irreplaceable) and is a key unit for the maintenance of the crocodile river system. It is the recommendation of the specialist that no further development and or transformation be permitted in these areas. The vegetation composition and structure associated with the open woodland, although representative of the Legogote sour bushveld vegetation type, was secondary in nature with historic anthropogenic impacts evident in and around the site. The limited extent of the patches of this vegetation community (+- 5Ha) make it an unsuitable fragment and it is highly unlikely that the patches will play host to any SCC in either the faunal or floral assemblages. The site received a High Biodiversity value rating, this is highly impacted by the fact that the study site patch falls within a classified Threatened ecosystem. The unit had a moderate to low species diversity and an absence of any SCC. The secondary nature of the site, coupled with the lack of species diversity, vegetation cover and protected species suggest that the site may be suitable for transformation. Lastly, the disturbed zone was almost completely un-natural and overrun by exotic and alien species of plant, dilapidated infrastructure, cleared areas, powerline infrastructure and what seems to be staff accommodation and a large shooting range. This unit had a low BV due to the lack of biodiversity and complete secondary nature. This unit, although within a threatened ecosystem (Legogote Sour bushveld) is possibly suitable for transformation if approved.

The lack of the presence of flora species of conservation importance, in the study area is of note and stresses the secondary nature of the entire site. Any approved development must be accompanied by a detailed management plan indicating strategy to mitigate impacts on any plant species of conservation concern that may be present and where not recorded in this study. A specialist should be utilized to ensure that no conservation important species (SCC, protected) are destroyed and if unavoidable relevant legislation and protocols to mitigate their presence must be followed.

There was no evidence of protected fauna species in the immediate study area. The habitat, in the immediate and surrounding area, is secondary in nature and it is unlikely that it is conducive to the presence of a high diversity of faunal species. If approval is granted for the land transformation, impacts on the riparian zone (once rehabilitated) must be avoided as this zone has the greatest ability of hosting any SCC faunal species.

The density of alien plant species within the study area (Appendix 1), is of grave concern. The riparian and developed zones were almost complete overrun by Alien species (33 species out of 116 in total). Most concerning is the integrity of the riparian zone along the Crocodile river. Many species present are listed under CARA and the owner/s of the land must produce an adequate management action plan to remove (or have removed) all listed alien/invasive species to promote the establishment and growth of indigenous vegetation and provide ideal habitat for optimal levels of biodiversity. The eradication of these species will result in the restoration of the immediate ecosystem. A detailed management strategy to quantify, control and eradicate alien infestations needs to be implemented.

The overall Biodiversity value of the study area is detailed in section 5 of this report. The riparian zine is of high biodiversity and ecosystem value and as such must not be developed or cleared for agricultural purposes. The remaining extent of the study area, although within an area classified as "Threatened terrestrial ecosystem" is extremely fragmented and showing signs of anthropogenic impacts that have compromised the integrity of the area. The large proportion of the study area (11 HA) is secondary in nature and not considered as natural by this specialist. The Open woodland, dominated by *V. erioloba* (+- 5 Ha) is the closest remnant of the vegetation dynamics associated with the Legogote Sour Bushveld, however this limited patch is extremely fragmented from the remaining vegetation type and has a high density of alien and exotic plant species. If authorization is granted to transform the land, it is the specialist's recommendation that the riparian zone (as per NEMA definition/s) is excluded.

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8. APPENDICE LIST

APPENDIX 1. FLORA

Family	*Species*			Presence	CARA
Amaranthaceae	*Alternanthera*	*caracasana*		Not Ind	
Apocynaceae	*Schizoglossum*	*filiforme*		Not Ind	
Apocynaceae	*Gomphocarpus*	*fruticosus*			
Aristolochiaceae	*Aristolochia*	*macrophylla*		Not Ind	
Asteraceae	*Acanthospermum*	*hispidum*			
	Tithonia	*rotundifolia*		Not Ind	1
	Leptilon	*bonariensis*		Not Ind	
	Schkuhria	*pinnata*		Not Ind	
	Artemisia	*vulgaris*		Not Ind	
	Chromolaena	*odorata*		Not Ind	1
	Parthenium	*hysterophorus*		Not Ind	1
	Tagetes	*minuta*			
	Bidens	*pilosa*		Not Ind	
	Taraxacum	*spp.*		Not Ind	
	Ageratum	*houstonianum*		Not Ind	1
	Gerbera	*ambigua*			
Boraginaceae	*Heliotropium*	*steudneri*			
Cannabaceae	*Celtis*	*africana*			
	Celtis	*sinensis*			
Caryophyllaceae	*Dianthus*	*spp.*			
Celastraceae	*Gymnosporia*	*buxifolia*			
	Maytenus	*mossambicensis*			
	Maytenus	*polyacantha*			
Chrysobalanaceae	*Parinari*	*curatellifolia*			
Combretaceae	*Combretum*	*microphyllum*			
	Combretum	*molle*			
	Combretum	*mossambicense*			
	Combretum	*zeyheri*			
	Combretum	*hereroense*			
	Combretum	*apiculatum*			
	Combretum	*collinum*			
	Combretum	*erythrophyllum*			
	Terminalia	*sericea*			
	Terminalia	*sericea*			
Cucurbitaceaea	*Cucurbita*	*spp.*		Not Ind	
Cyperaceae	*Cyperus*	*papyrus*			
	Cyperus	*spp.*			
Ebenaceae	*Euclea*	*crispa*			
	Euclea	*divinorum*			
	Euclea	*natalensis*			

	Diospyros	*lycioides*			
	Diospyros	*mespiliformis*			
Euphorbiaceae	*Ricinus*	*communis*		Not Ind	2
Fabaceae	*Poinciana*	*pulcherrima*		Not Ind	
	Vachellia	*erioloba*			
	Vachellia	*exuvialis*			
	Vachellia	*gerrardii*			
	Vachellia	*karroo*			
	Vachellia	*nilotica*			
	Vachellia	*sieberiana*			
	Bauhinia	*galpinii*			
	Acacia	*ataxacantha*			
	Albizia	*spp.*			
	Senna	*petersiana*			
	Acacia	*davyi*			
	Peltophorum	*africanum*			
	Pterocarpus	*rotundifolius*			
Lamiaceae	*Salvia*	*coccinea*		Not Ind	
	Hemizygia	*persimilis*			
Lauraceae	*Persea*	*americana*		Not Ind	
Malvaceae	*Dombeya*	*rotundifolia*			
	Waltheria	*indica*			
	Hibiscus	*sidiformis*			
Meliaceae	*Melia*	*azedarach*			
Moraceae	*Ficus*	*abutilifolia*			
	Ficus	*natalensis*			
	Ficus	*stuhlmannii*			
	Ficus	*thonningii*			
	Morus	*alba*	var. alba		
Myrtaceae	*Eucalyptus*	*spp*		Not Ind	2
	Syzygium	*cordatum*			
	Psidium	*guajava*		Not Ind	2
Nyctaginaceae	*Bougainvillea*	*glabra*		Not Ind	
Oleaceae	*Olea*	*europaea*	subsp. Africana		
Oxalidaceae	*Oxalis*	*spp.*			
Poaceae	*Pennisetum*	*setaceum*		Not Ind	1
	Cenchrus	*ciliaris*			
	Cynodon	*dactylon*			
	Sporobolus	*africanus*			
	Sporobolus	*fimbriatus*			
	Sporobolus	*natalensis*			
	Sporobolus	*nitens*			
	Sporobolus	*spicatus*			
	Paspalum	*notatum*			

	Urochloa	*mosambicensis*			
	Urochloa	*panicoides*			
	Panicum	*deustum*			
	Panicum	*maximum*			
	Bambusa	*balcooa*		Not Ind	
	Tragus	*berteronianus*			
	Pogonarthria	*squarrosa*			
	Melinis	*nerviglumis*			
	Melinis	*repens*			
	Urochloa	*mosambicensis*			
	Urochloa	*panicoides*			
	Arundo	*donax*			
	Dactyloctenium	*aegyptium*			
	Dactyloctenium	*australe*			
	Dactyloctenium	*giganteum*			
	Setaria	*megaphylla*			
	Setaria	*pallide-fusca*			
	Setaria	*sphacelata*			
	Andropogon	*schirensis*			
	Schizachyrium	*sanguineum*			
Proteaceae	*Grevillea*	*robusta*		Not Ind	3
Rhamnaceae	*Ziziphus*	*mucronata*			
Rosaceae	*Prunus*	*dulcis*		Not Ind	
	Prunus	*persica*		Not Ind	
Rubiaceae	*Richardia*	*scabra*		Not Ind	
Rubiaceae	*Breonadia*	*salicina*			
Salicaceae	*Populus*	*alba*		Not Ind	2
Solanaceae	*Datura*	*stramonium*		Not Ind	1
	Solanum	*incanum*		Not Ind	
	Solanum	*mauritianum*		Not Ind	1
	Solanum	*spp*		Not Ind	1
Verbenaceae	*Lantana*	*camara*		Not Ind	1
	116				

APPENDIX 2. FAUNA

Fauna List

Mammals					
Family	Common specie	Genus	Specie	Red data	Protected
Herpestidae	Slender Mongoose	*Herpestes*	*sanguineus*	LC	
	White-tailed Mongoose	*Ichneumia*	*albicaunda*	LC	
	Common Dwarf Mongoose	*Helogale*	*parvula*	LC	
Hippopotamidae	Common Hippopotamus	*Hippopotamus*	*amphibius*	LC	
Viverridae	Common Genet	*Genetta*	*genetta*	LC	
Cercopithecidae	Vervet Monkey	*Chlorocebus*	*pygerythus*	LC	
Sub total	6			0	0
Birds					
Common Group	Common specie	Genus	Specie	Red data	Protected
Apalis	Bar-throated	*Apalis*	*thoracica*		
Babbler	Arrow-marked	*Turdoides*	*jardineii*		
Barbet	Black-collared	*Lybius*	*torquatus*		
Batis	Chinspot	*Batis*	*molitor*		
Bee-eater	White-fronted	*Merops*	*bullockoides*		
Brownbul	Terrestrial	*Phyllastrephus*	*terrestris*		
Brubru	Brubru	*Nilaus*	*afer*		
Bulbul	Dark-capped	*Pycnonotus*	*tricolor*		
Bush-shrike	Gorgeous	*Telophorus*	*quadricolor*		
Bush-shrike	Orange-breasted	*Telophorus*	*sulfureopectus*		
Camaroptera	Green-backed	*Camaroptera*	*brachyura*		
Canary	Cape	*Serinus*	*canicollis*		
Canary	Yellow-fronted	*Crithagra*	*mozambicus*		
Chat	Familiar	*Cercomela*	*familiaris*		
Cisticola	Croaking	*Cisticola*	*natalensis*		
Cliff-chat	Mocking	*Thamnolaea*	*cinnamomeiventris*		
Coucal	Burchell's	*Centropus*	*burchellii*		
Crombec	Long-billed	*Sylvietta*	*rufescens*		
Dove	Laughing	*Streptopelia*	*senegalensis*		
Dove	Red-eyed	*Streptopelia*	*semitorquata*		
Drongo	Fork-tailed	*Dicrurus*	*adsimilis*		
Eagle	African Crowned	*Stephanoaetus*	*coronatus*		

Eagle	Long-crested	*Lophaetus*	*occipitalis*		
Firefinch	African	*Lagonosticta*	*rubricata*		
Flycatcher	African Dusky	*Muscicapa*	*adusta*		
Flycatcher	Ashy	*Muscicapa*	*caerulescens*		
Flycatcher	Southern Black	*Melaenornis*	*pammelaina*		
Greenbul	Sombre	*Andropadus*	*importunus*		
Guineafowl	Helmeted	*Numida*	*meleagris*		
Honeyguide	Lesser	*Indicator*	*minor*		
Hoopoe	African	*Upupa*	*africana*		
Ibis	Hadeda	*Bostrychia*	*hagedash*		
Kingfisher	Brown-hooded	*Halcyon*	*albiventris*		
Mannikin	Bronze	*Spermestes*	*cucullatus*		
Masked-weaver	Southern	*Ploceus*	*velatus*		
Mousebird	Speckled	*Colius*	*striatus*		
Oriole	Black-headed	*Oriolus*	*larvatus*		
Prinia	Tawny-flanked	*Prinia*	*subflava*		
Puffback	Black-backed	*Dryoscopus*	*cubla*		
Robin-chat	White-browed	*Cossypha*	*heuglini*		
Robin-chat	White-throated	*Cossypha*	*humeralis*		
Scimitarbill	Common	*Rhinopomastus*	*cyanomelas*		
Scrub-robin	White-browed	*Cercotrichas*	*leucophrys*		
Sparrow	House	*Passer*	*domesticus*		
Spurfowl	Natal	*Pternistis*	*natalensis*		
Spurfowl	Swainson's	*Pternistis*	*swainsonii*		
Starling	Red-winged	*Onychognathus*	*morio*		
Starling	Violet-backed	*Cinnyricinclus*	*leucogaster*		
Swallow	Barn	*Hirundo*	*rustica*		
Tchagra	Black-crowned	*Tchagra*	*senegalus*		
Tchagra	Southern	*Tchagra*	*tchagra*		
Thrush	Groundscraper	*Psophocichla*	*litsipsirupa*		
Thrush	Kurrichane	*Turdus*	*libonyanus*		
Turaco	Purple-crested	*Gallirex*	*porphyreolophus*		
Turtle-dove	Cape	*Streptopelia*	*capicola*		
Warbler	Marsh	*Acrocephalus*	*palustris*		
Waxbill	Blue	*Uraeginthus*	*angolensis*		
Weaver	Spectacled	*Ploceus*	*ocularis*		

Weaver	Village	*Ploceus*	*cucullatus*		
Widowbird	White-winged	*Euplectes*	*albonotatus*		
Wood-dove	Emerald-spotted	*Turtur*	*chalcospilos*		
Woodpecker	Cardinal	*Dendropicos*	*fuscescens*		
Woodpecker	Golden-tailed	*Campethera*	*abingoni*		
Sub total	63			0	0
Reptiles					
Family	Common specie	Genus	Specie	Red data	Protected
Pelomedusidae	Central marsh terrapin	*Pelomedusa*	*subrufa*	LC	
Testudinidae	Leopard Tortoise	*Stigmochelys*	*pardalis*	LC	
Varanidae	Rock monitor	*Varanus*	*albigularis albigularis*	LC	
Scincidae	Rainbow Skink	*Trachylepsis*	*margaritifera*	LC	
Scincidae	Striped skink	*Trachylepsis*	*striata*	LC	
Colubridae	Spotted Bush Snake	*Philothamnus*	*semivarigatus*	LC	
Sub total	6			0	0
Amphibians					
Family	Common specie	Genus	Specie	Red data	Protected
Bufonidae	Guttural toad	*Sclerophrys*	*gutturalis*	LC	
Rhacophoridae	Southern Foam Nest Frog	*Chiromantis*	*xerampelina*	LC	
Sub total	1			0	0
Total	76			0	0

APPENDIX 3. AVIFAUNA

List of both potentially occurring bird species for the Pentad 2520 3035 (SABAP2) and confirmed species present in the study area.

Common group	Common species	Genus	Species	Red data	Protected (NEMBA)	Confirmed Species
Apalis	Bar-throated	*Apalis*	*thoracica*			x
Apalis	Yellow-breasted	*Apalis*	*flavida*			
Babbler	Arrow-marked	*Turdoides*	*jardineii*			x
Barbet	Black-collared	*Lybius*	*torquatus*			x
Batis	Cape	*Batis*	*capensis*			
Batis	Chinspot	*Batis*	*molitor*			x
Bee-eater	European	*Merops*	*apiaster*			
Bee-eater	Swallow-tailed	*Merops*	*hirundineus*			
Bee-eater	White-fronted	*Merops*	*bullockoides*			x
Boubou	Southern	*Laniarius*	*ferrugineus*			
Brownbul	Terrestrial	*Phyllastrephus*	*terrestris*			x
Brubru	Brubru	*Nilaus*	*afer*			x
Bulbul	Dark-capped	*Pycnonotus*	*tricolor*			x
Bunting	Cinnamon-breasted	*Emberiza*	*tahapisi*			
Bunting	Golden-breasted	*Emberiza*	*flaviventris*			
Bush-shrike	Gorgeous	*Telophorus*	*quadricolor*			x
Bush-shrike	Grey-headed	*Malaconotus*	*blanchoti*			
Bush-shrike	Olive	*Telophorus*	*olivaceus*			
Bush-shrike	Orange-breasted	*Telophorus*	*sulfureopectus*			x
Buzzard	Jackal	*Buteo*	*rufofuscus*			
Camaroptera	Green-backed	*Camaroptera*	*brachyura*			x
Canary	Brimstone	*Crithagra*	*sulphuratus*			
Canary	Cape	*Serinus*	*canicollis*			x
Canary	Yellow-fronted	*Crithagra*	*mozambicus*			x
Chat	Familiar	*Cercomela*	*familiaris*			x
Cisticola	Croaking	*Cisticola*	*natalensis*			x

Cisticola	Lazy	*Cisticola*	*aberrans*			
Cisticola	Levaillant's	*Cisticola*	*tinniens*			
Cisticola	Red-faced	*Cisticola*	*erythrops*			
Cisticola	Wailing	*Cisticola*	*lais*			
Cisticola	Wing-snapping	*Cisticola*	*ayresii*			
Cliff-chat	Mocking	*Thamnolaea*	*cinnamomeiventris*			x
Coucal	Burchell's	*Centropus*	*burchellii*			x
Crested-flycatcher	Blue-mantled	*Trochocercus*	*cyanomelas*			
Crombec	Long-billed	*Sylvietta*	*rufescens*			x
Crow	Pied	*Corvus*	*albus*			
Cuckoo	African Emerald	*Chrysococcyx*	*cupreus*			
Cuckoo	Black	*Cuculus*	*clamosus*			
Cuckoo	Diderick	*Chrysococcyx*	*caprius*			
Cuckoo	Klaas's	*Chrysococcyx*	*klaas*			
Cuckoo	Red-chested	*Cuculus*	*solitarius*			
Cuckoo-shrike	Black	*Campephaga*	*flava*			
Cuckoo-shrike	Grey	*Coracina*	*caesia*			
Dove	Laughing	*Streptopelia*	*senegalensis*			x
Dove	Lemon	*Aplopelia*	*larvata*			
Dove	Red-eyed	*Streptopelia*	*semitorquata*			x
Dove	Tambourine	*Turtur*	*tympanistria*			
Drongo	Fork-tailed	*Dicrurus*	*adsimilis*			x
Duck	African Black	*Anas*	*sparsa*			
Eagle	African Crowned	*Stephanoaetus*	*coronatus*			x
Eagle	Long-crested	*Lophaetus*	*occipitalis*			x
Egret	Cattle	*Bubulcus*	*ibis*			
Firefinch	African	*Lagonosticta*	*rubricata*			x
Fiscal	Common (Southern)	*Lanius*	*collaris*			
Flycatcher	African Dusky	*Muscicapa*	*adusta*			x
Flycatcher	Ashy	*Muscicapa*	*caerulescens*			x

Flycatcher	Southern Black	*Melaenornis*	*pammelaina*			x
Flycatcher	Spotted	*Muscicapa*	*striata*			
Goose	Spur-winged	*Plectropterus*	*gambensis*			
Goshawk	African	*Accipiter*	*tachiro*			
Grassbird	Cape	*Sphenoeacus*	*afer*			
Greenbul	Sombre	*Andropadus*	*importunus*			x
Guineafowl	Helmeted	*Numida*	*meleagris*			x
Harrier-Hawk	African	*Polyboroides*	*typus*			
Hawk	African Cuckoo	*Aviceda*	*cuculoides*			
Hobby	Eurasian	*Falco*	*subbuteo*			
Honeybird	Brown-backed	*Prodotiscus*	*regulus*			
Honeyguide	Greater	*Indicator*	*indicator*			
Honeyguide	Lesser	*Indicator*	*minor*			x
Honeyguide	Scaly-throated	*Indicator*	*variegatus*			
Hoopoe	African	*Upupa*	*africana*			x
House-martin	Common	*Delichon*	*urbicum*			
Ibis	Hadeda	*Bostrychia*	*hagedash*			x
Indigobird	Dusky	*Vidua*	*funerea*			
Kestrel	Rock	*Falco*	*rupicolus*			
Kingfisher	Brown-hooded	*Halcyon*	*albiventris*			x
Kingfisher	Giant	*Megaceryle*	*maximus*			
Kingfisher	Half-collared	*Alcedo*	*semitorquata*			
Kite	Black-shouldered	*Elanus*	*caeruleus*			
Kite	Yellow-billed	*Milvus*	*aegyptius*			
Lapwing	African Wattled	*Vanellus*	*senegallus*			
Lark	Rufous-naped	*Mirafra*	*africana*			
Longclaw	Cape	*Macronyx*	*capensis*			
Longclaw	Yellow-throated	*Macronyx*	*croceus*			
Mannikin	Bronze	*Spermestes*	*cucullatus*			x
Mannikin	Red-backed	*Spermestes*	*nigriceps*			
Martin	Rock	*Hirundo*	*fuligula*			

Masked-weaver	Southern	*Ploceus*	*velatus*			x
Mousebird	Red-faced	*Urocolius*	*indicus*			
Mousebird	Speckled	*Colius*	*striatus*			x
Neddicky	Neddicky	*Cisticola*	*fulvicapilla*			
Olive-pigeon	African	*Columba*	*arquatrix*			
Oriole	Black-headed	*Oriolus*	*larvatus*			x
Palm-swift	African	*Cypsiurus*	*parvus*			
Paradise-flycatcher	African	*Terpsiphone*	*viridis*			
Petronia	Yellow-throated	*Petronia*	*superciliaris*			
Pipit	Bushveld	*Anthus*	*caffer*			
Pipit	Nicholson's	*Anthus*	*nicholsoni*			
Pipit	Striped	*Anthus*	*lineiventris*			
Prinia	Drakensberg	*Prinia*	*hypoxantha*			
Prinia	Tawny-flanked	*Prinia*	*subflava*			x
Puffback	Black-backed	*Dryoscopus*	*cubla*			x
Pygmy-Kingfisher	African	*Ispidina*	*picta*			
Raven	White-necked	*Corvus*	*albicollis*			
Robin	White-starred	*Pogonocichla*	*stellata*			
Robin-chat	Cape	*Cossypha*	*caffra*			
Robin-chat	Chorister	*Cossypha*	*dichroa*			
Robin-chat	Red-capped	*Cossypha*	*natalensis*			
Robin-chat	White-browed	*Cossypha*	*heuglini*			x
Robin-chat	White-throated	*Cossypha*	*humeralis*			x
Rock-thrush	Cape	*Monticola*	*rupestris*			
Rush-warbler	Little	*Bradypterus*	*baboecala*			
Saw-wing	Black (Southern race)	*Psalidoprocne*	*holomelaena*			
Scimitarbill	Common	*Rhinopomastus*	*cyanomelas*			x
Scrub-robin	White-browed	*Cercotrichas*	*leucophrys*			x
Seedeater	Streaky-headed	*Crithagra*	*gularis*			
Shikra	Shikra	*Accipiter*	*badius*			

Sparrow	House	*Passer*	*domesticus*			x
Sparrow	Southern Grey-headed	*Passer*	*diffusus*			
Sparrowhawk	Little	*Accipiter*	*minullus*			
Spurfowl	Natal	*Pternistis*	*natalensis*			x
Spurfowl	Red-necked	*Pternistis*	*afer*			
Spurfowl	Swainson's	*Pternistis*	*swainsonii*			x
Starling	Red-winged	*Onychognathus*	*morio*			x
Starling	Violet-backed	*Cinnyricinclus*	*leucogaster*			x
Stonechat	African	*Saxicola*	*torquatus*			
Sunbird	Amethyst	*Chalcomitra*	*amethystina*			
Sunbird	Collared	*Hedydipna*	*collaris*			
Sunbird	Greater Double-collared	*Cinnyris*	*afer*			
Sunbird	Scarlet-chested	*Chalcomitra*	*senegalensis*			
Sunbird	Southern Double-collared	*Cinnyris*	*chalybeus*			
Sunbird	White-bellied	*Cinnyris*	*talatala*			
Swallow	Barn	*Hirundo*	*rustica*			x
Swallow	Greater Striped	*Hirundo*	*cucullata*			
Swallow	Lesser Striped	*Hirundo*	*abyssinica*			
Swallow	Red-breasted	*Hirundo*	*semirufa*			
Swallow	White-throated	*Hirundo*	*albigularis*			
Swallow	Wire-tailed	*Hirundo*	*smithii*			
Swift	African Black	*Apus*	*barbatus*			
Swift	Little	*Apus*	*affinis*			
Swift	White-rumped	*Apus*	*caffer*			
Tchagra	Black-crowned	*Tchagra*	*senegalus*			x
Tchagra	Southern	*Tchagra*	*tchagra*			x
Thrush	Groundscraper	*Psophocichla*	*litsipsirupa*			x
Thrush	Kurrichane	*Turdus*	*libonyanus*			x
Tinkerbird	Yellow-fronted	*Pogoniulus*	*chrysoconus*			
Tinkerbird	Yellow-rumped	*Pogoniulus*	*bilineatus*			
Tit	Southern Black	*Parus*	*niger*			

Trogon	Narina	*Apaloderma*	*narina*			
Turaco	Knysna	*Tauraco*	*corythaix*			
Turaco	Purple-crested	*Gallirex*	*porphyreolophus*			x
Turtle-dove	Cape	*Streptopelia*	*capicola*			x
Twinspot	Green	*Mandingoa*	*nitidula*			
Wagtail	African Pied	*Motacilla*	*aguimp*			
Wagtail	Cape	*Motacilla*	*capensis*			
Wagtail	Mountain	*Motacilla*	*clara*			
Warbler	Dark-capped Yellow	*Chloropeta*	*natalensis*			
Warbler	Marsh	*Acrocephalus*	*palustris*			x
Warbler	Willow	*Phylloscopus*	*trochilus*			
Waxbill	Blue	*Uraeginthus*	*angolensis*			x
Waxbill	Common	*Estrilda*	*astrild*			
Waxbill	Swee	*Coccopygia*	*melanotis*			
Weaver	Golden	*Ploceus*	*xanthops*			
Weaver	Spectacled	*Ploceus*	*ocularis*			x
Weaver	Thick-billed	*Amblyospiza*	*albifrons*			
Weaver	Village	*Ploceus*	*cucullatus*			x
White-eye	Cape	*Zosterops*	*virens*			
Whydah	Pin-tailed	*Vidua*	*macroura*			
Widowbird	Fan-tailed	*Euplectes*	*axillaris*			
Widowbird	Red-collared	*Euplectes*	*ardens*			
Widowbird	White-winged	*Euplectes*	*albonotatus*			x
Wood-dove	Emerald-spotted	*Turtur*	*chalcospilos*			x
Wood-owl	African	*Strix*	*woodfordii*			
Woodpecker	Cardinal	*Dendropicos*	*fuscescens*			x
Woodpecker	Golden-tailed	*Campethera*	*abingoni*			x
Woodpecker	Olive	*Dendropicos*	*griseocephalus*			
Wryneck	Red-throated	*Jynx*	*ruficollis*			
				Red data	Protected (NEMBA)	63

APPENDIX 4: Biodiversity value calculations for the vegetation communities identified on the study site.

Site 1 Riparian Zone -

Conservation Importance

Parameter		Very High	High	Moderate	Low	Very Low
Protection Status		International	National	Regional	Local	None
	11	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Size		Very Small	Small	Moderate	Large	Very Large
		(<500km²)	(500 - 1,000 km²)	(1,000 - 20, 000 km²)	(20, 000 - 50, 000km²)	(> 50, 000km²)
	15	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species Diversity		High		Moderate		Low
	15	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species of Conservation Concern (SCC)		High		Moderate		Low
	0	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Habitat		High		Moderate		Low
	16	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological State		Natural, largely unmodified	Slightly modified	Moderately modified	considerably modified	Severley modified
	18	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Average Score	13					

Functional Importance

Parameter		Very High	High	Moderate	Low	Very Low
Regulating Services		Very High	High	Moderate	Low	Very Low
	18	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Cultural Services		Very High	High	Moderate	Low	Very Low
	18	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological services		Very High	High	Moderate	Low	Very Low
	18	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Average Score	18					

Site 2 Open Woodland

Conservation Importance

Parameter		Very High	High	Moderate	Low	Very Low
Protection Status		International	National	Regional	Local	None
	7	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Size		Very Small	Small	Moderate	Large	Very Large
		(<500km²)	(500 - 1,000 km²)	(1,000 - 20, 000 km²)	(20, 000 - 50, 000km²)	(> 50, 000km²)
	8	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species Diversity		High		Moderate		Low
	14	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species of Conservation Concern (SCC)		High		Moderate		Low
	0	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Habitat		High		Moderate		Low
	15	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological State		Natural, largely unmodified	Slightly modified	Moderately modified	considerably modified	Severley modified
	15	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Average Score	10					

Functional Importance

Parameter		Very High	High	Moderate	Low	Very Low
Regulating Services		Very High	High	Moderate	Low	Very Low
	13	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Cultural Services		Very High	High	Moderate	Low	Very Low
	10	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological services		Very High	High	Moderate	Low	Very Low
	15	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Average Score	13					

Site 3 Disturbed zone

Conservation Importance

Parameter		Very High	High	Moderate	Low	Very Low
Protection Status		International	National	Regional	Local	None
	7	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Size		Very Small	Small	Moderate	Large	Very Large
		(<500km²)	(500 - 1,000 km²)	(1,000 - 20, 000 km²)	(20, 000 - 50, 000km²)	(> 50, 000km²)
	8	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species Diversity		High		Moderate		Low
	3	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Species of Conservation Concern (SCC)		High		Moderate		Low
	0	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Habitat		High		Moderate		Low
	8	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological State		Natural, largely unmodified	Slightly modified	Moderately modified	considerably modified	Severley modified
	2	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Average Score	5					

Functional Importance

Parameter		Very High	High	Moderate	Low	Very Low
Regulating Services		Very High	High	Moderate	Low	Very Low
	9	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Cultural Services		Very High	High	Moderate	Low	Very Low
	8	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Ecological services		Very High	High	Moderate	Low	Very Low
	8	*20 - 17,*	*16 - 13,*	*12 - 9,*	*8 - 5,*	*4 - 0*
Average Score	8					

APPENDIX 5. CURRICULUM VITAE OF MATTHEW ALTENKIRK

Full name:	Matthew Alexander Altenkirk	
Age:	33	
Date of birth:	23 / 11 / 1987	
Languages:	English and Afrikaans (spoken, written)	
Profession:	Ecologist / Nature Conservationist	
Qualifications:	Nat Dip: Nature Conservation	(2008)
	BTech: Nature Conservation	(2011)
Current Position:	Ecological consultant (Private)	
Years of relevant work experience:	11	
Relevant memberships:	Grassland Society of South Africa (GSSA)	
	South African Wildlife Managers association (SAWMA)	

Experience summary

- 13 years in wildlife management on private conservation properties
- 11 years involved in active Ecological management of ecosystems.
- 8 years as full-time ecologist in the private sector (6 in GKNP)
- Development, management and monitoring of 3 dynamic ecological management strategies.

Annexure C: Historical Impact Assessment

Phase 1 Archaeological and Heritage Impact Assessment on the farms Bruintjieslaagte 465 JT, Geluk 299 JT and Koedoeshoek 301 JT in respect of proposed agricultural development, Mpumalanga Province.

Compiled for:

For **Henwood Environmental Solutions**

Surveyor: Mr JP Celliers

17 February, 2021

I, Jean-Pierre Celliers as authorized representative of Kudzala Antiquity CC , hereby confirm my independence as a specialist and declare that neither I or the Kudzala Antiquity CC have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which I was appointed as Heritage Consultant, other than fair remuneration for work performed on this project.

SIGNATURE: ____________________

Table of Contents

Executive summary

Site name and location: An area of approximately 14,5 ha on the farms Bruintjieslaagte 465 JT, Geluk 299 JT and Koedoeshoek 301 JT, of which suitable areas will be cleared of vegetation for agricultural development.

Purpose of the study: An archaeological and heritage study in order to identify cultural heritage resources in respect of proposed vegetation clearing for the establishment of agricultural activity.

Topographical Maps: 1:50 000 2530 BC (1969, 1984, 2010); 1:250 000 2530 (1942).

EIA Consultant: Henwood Environmental Solutions

Client: Joubert & Seuns (Pty) Ltd

Heritage Consultant: Kudzala Antiquity CC.
Contact person: JP Celliers

Report date: 17 February 2021

Description and findings:

An Archaeological and Heritage Impact Assessment was undertaken by Kudzala Antiquity CC in respect of the proposed clearing of vegetation for agricultural development on suitable portions of an area of approximately 14,5 hectares on the farms Bruintjieslaagte 465 JT, Geluk 299 JT and Koedoeshoek 301 JT in the Schoemanskloof near Mbombela, Mpumalanga Province. The study was done with the aim of identifying sites which are of heritage significance on the identified project areas and assess their current preservation condition, significance and possible impact of the proposed action. This forms part of legislative requirements as appears in section 38 of the National Heritage Resources Act (Act No. 25 of 1999). This report can be submitted in support of the National Environmental Management Act (Act 25 of 1998).

The survey was conducted on foot and with the aid of a motor vehicle in an effort to locate archaeological remains and historic sites, structures and features. Background historical information including scrutiny of previous heritage surveys of the area formed the baseline against which the survey was conducted. A site which may represent the grave of an individual was located outside of and to the north of the study area. This site was named GJS 1 and consists of an engraved slate stone located on an elevated hill overlooking the Schoemanskloof. It has inscriptions on it made in two different fonts. One of which reads: “J H Joubert ZAR C 1883 – 1901. This may suggest that the stone represents a headstone of a grave.

The capitals L J R are inscribed above the aforementioned inscription in triangular fashion and in a different, reminiscent of the current Times New Roman, font. It is uncertain what these capitals represent, further research is needed.

In terms of section 34 of the National Heritage Resources Act (NHRA, 25 of 1999), no significant buildings or structures were located.
In terms of section 35 of the NHRA, no archaeological sites were recorded.
In terms of section 36 of the NHRA, one site which may represent a grave was documented. It is located outside of the proposed development area.
A total of five survey orientation locations were documented (SO 1-5) which includes a GPS location and photographs of the landscape at that particular location.
It is not within the expertise of this report or the surveyor to comment on possible palaeontological remains which may be located in the study area.

Disclaimer: *Although all possible care is taken to identify all sites of cultural importance during the investigation of study areas, it is always possible that hidden or sub-surface sites could be overlooked during the study. Kudzala Antiquity CC will not be held liable for such oversights or for costs incurred as a result of such oversights.*

Introduction

1.1. Terms of reference

Kudzala Antiquity CC was commissioned to conduct an archaeological and heritage resources survey in respect of proposed new agricultural activities on the farms Bruintjieslaagte 465 JT, Geluk 299 JT and Koedoeshoek 301 JT in the Schoemanskloof near Mbombela, Mpumalanga Province. The survey was conducted in order to assess the potential impact that the proposed activity may have on archaeological and heritage resources. The survey was conducted for Henwood Environmental Solutions.

1.1.1 Project overview

The client is in the process of obtaining environmental authorization to clear indigenous vegetation on an area of approximately 14,5 hectares for farming purposes. Suitable pieces of land within this identified area will be utilized for this activity pending environmental authorization.

1.1.2. Constraints and limitations

Surface visibility and access was reduced in the study area due to grass and undergrowth. This limited exploration and surface visibility of portions of the study area.

1.2. Legislative Framework

The National Heritage Resources Act (NHRA) (Act No. 25, 1999) require that individuals or institutions have specialist heritage impact assessment studies undertaken whenever development activities are planned and such activities trigger activities listed in the legislation. This report is the result of an archaeological and heritage study in accordance with the requirements as set out in Section 38 (3) of the NHRA in an effort to ensure that heritage features or sites that qualify as part of the national estate are properly managed and not damaged or destroyed.

The study aims to address the following objectives:

- Analysis of heritage issues;
- Assess the cultural significance of identified places including archaeological sites and features, buildings and structures, graves and burial grounds within a specific historic context;

- Identifying the need for more research;
- Surveying and mapping of identified places including archaeological sites and features, buildings and structures, graves and burial grounds;
- A preliminary assessment of the feasibility of the proposed development or construction from a heritage perspective;
- Identifying the need for alternatives when necessary; and
- Recommending mitigation measures to address any negative impacts on archaeological and heritage resources.

Heritage resources considered to be part of the national estate include those that are of archaeological, cultural or historical significance or have other special value to the present community or future generations.

The national estate may include:

- places, buildings, structures and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living
- heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and paleontological sites;
- graves and burial grounds including:
    - (i) ancestral graves;
    - (ii) royal graves and graves of traditional leaders;
    - *(iii)* graves of victims of conflict;
    - (iv) graves of individuals designated by the Minister by notice in the *Gazette;*
    - (v) historical graves and cemeteries; and other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);
- sites of significance relating to slavery in South Africa;
- movable objects including:

(i) objects recovered from the soil or waters of South Africa, including archaeological and paleontological objects and material, meteorites and rare geological specimens;

(ii) objects to which oral traditions are attached or which are associated with living heritage

(iii) ethnographic art and objects;

(iv) military objects

(v) objects of decorative or fine art;

(vi) objects of scientific or technological interest; and

(vii) books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1 of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

Cultural resources are unique and non-renewable physical phenomena (of natural occurrence or made by humans) that can be associated with human (cultural) activities (Van Vollenhoven 1995:3). These would be any man-made structure, tool, object of art or waste that was left behind on or beneath the soil surface by historic or pre-historic communities. These remains, when studied in their original context by archaeologists, are interpreted in an attempt to understand, identify and reconstruct the activities and lifestyles of past communities. When these items are removed from their original context, any meaningful information they possess is lost, therefore it is important to locate and identify such remains before construction or development activities commence.

1.3. Approach and statutory requirements

The SAHRA Minimum standards of 2007 and 2016 guideline documents, forms the background against which the survey was planned and the report compiled. An Archaeological Impact Assessment (AIA) consists of three phases. This document deals with the first phase. This (phase 1) investigation is aimed at getting an overview of cultural resources in the project area, assigning significance to these resources, assessing the possible impact that the proposed activity may have on these resources, making recommendations pertaining to the management of heritage resources and putting forward mitigation measures where applicable.

When the archaeologist or heritage specialist encounters a situation where the planned project will lead to the destruction or alteration of an archaeological/ heritage site or feature, a second phase investigation is normally recommended. During a phase two investigation mitigation measures are put in place and detailed investigation into the nature of the cultural material is undertaken. Often at this stage, archaeological excavation and detailed mapping of a site is carried out in order to document and preserve the cultural heritage.

Phase three consists of the compiling of a management plan for the safeguarding, conservation, interpretation and utilization of cultural resources (Van Vollenhoven, 2002).

Continuous communication between the developer and heritage specialist after the initial assessment has been carried out may result in the modification of a planned route or development to incorporate or protect existing archaeological and heritage sites.

2. Description of surveyed area

The study area falls within the Mbombela Local Municipality, Mpumalanga Province.
The survey was carried out on a project footprint consisting of approximately 14,5 hectares of Legogote Sour Bushveld vegetation.

Veld type: The vegetation forms part of the Savanna Biome and classed as Legogote Sour Bushveld. This veld type occurs in Mpumalanga and Limpopo Provinces on the lower eastern slopes and hills or the north-eastern escarpment from Mariepskop in the north through White River to the Nelspruit area and extending westwards up valleys of the Crocodile, Elands and Houtbosloop Rivers and terminating in the south in the Barberton area. Altitude is 600-1000 m and sometimes higher. The landscape is characterised by gently to moderately upper pediment slopes with dense woodland including many medium to large shrubs, short thicket occurs on less rocky sites (Mucina and Rutherford, 2009).

Geology and soils: The larger part of the area is underlain by gneiss and migmatite of the Nelspruit Suite but the southern part occurs on the potassium-poor rocks of the Kaap Valley Tonalite. Pretoria Group shale and quartzite occur in the westernmost areas. Archaean granite plains with granite inselbergs and large granite boulders also occur (Mucina and Rutherford, 2009).

Limiting factors: As mentioned under Constraints and Limitations above, in some parts of the project areas dense undergrowth and impenetrable thicket limited surface visibility in certain areas.

3. Methodology

This study consists of a detailed archival study in order to understand the study area in a historical timeframe, an archaeological background study which include scrutiny of previous archaeological reports of the area, obtained through the SAHRIS database, and published as well as unpublished written sources on the archaeology of the area, social consultation with people who live nearby and a lastly a physical survey of the affected and immediate area.

The South African Heritage Resources Agency (SAHRA) and the relevant legislation (NHRA) require that the following components be included in an archaeological impact assessment:

- Archaeology;
- Shipwrecks;
- Battlefields;
- Graves;

- Structures older than 60 years;
- Living heritage;
- Historical settlements;
- Landscapes;
- Geological sites; and
- Paleontological sites and objects.

All the above-mentioned heritage components are addressed in this report, except shipwrecks, geological sites and paleontological sites and objects.

The ***purpose*** of the archaeological, archival and heritage study is to establish the whereabouts and nature of cultural heritage sites should they occur on project area. This includes settlements, structures and artefacts which have value for an individual or group of people in terms of historical, archaeological, architectural and human (cultural) development.

The ***aim*** of this study is to locate and identify such objects or places in order to assess and rate their significance and establish if further investigation is needed. Mitigation measures can then be suggested and put in place when necessary.

3.1. Archaeological and Archival background studies

The purpose of the desktop study is to compile as much information as possible on the heritage resources of the area. This helps to provide an historical context for located sites. Sources used for this study include published and unpublished documents, archival material and maps. Information obtained from the following institutions or individuals were consulted:

- Published and unpublished archaeological reports and articles;
- Published and unpublished historical reports and articles;
- Archival documents from the National Archives in Pretoria;
- Historical maps; and
- South African Heritage Resource Information System (SAHRIS) database.

3.1.1. Previous archaeological studies in the area

Some archaeological impact assessments (AIA's) and heritage impact assessments have been done in the vicinity of the proposed development area.

In 2007 Mr JA van Schalkwyk conducted a “Heritage Impact and scoping report for the planned Hendrina-Marathon Powerline, Mpumalanga Province”. He identified a range of cultural heritage sites including initiation sites, industrial and farming related sites and cemeteries.

In 2008 Mr JP Celliers conducted an “Archaeological Impact Assessment for the proposed development on Portion 3 of the farm Geluk 299 JT, and Portions 6, 35, 35 and 68 of the farm Rietvly 295 JT in Schoemanskloof”. In this study a total of eleven heritage sites were located ranging from formal graveyards to stone-walled enclosures and terraces associated with the BaKoni (1650’s-1820’s) and some historical ruins.

In 2017 Mr JP Celliers conducted a “Phase 1 Archaeological and Heritage Impact Assessment on the farm Bruintjieslaagte 465 JT in respect of the proposed construction of an irrigation dam, Mpumalanga Province”. A number of LIA stone-walled sites and features, associated with BaKoni occupation, were recorded. As a result of pending impacts mitigation measures in the form of archaeological excavation and mapping was conducted in February 2019. Much was learned about BaKoni stone-walled settlement layout, construction and function which can be applied to similar sites and features in the Schoemanskloof Valley (Celliers, 2019).

3.1.2. Historic maps

Historical maps were scrutinized and features that were regarded as important in terms of heritage value were identified and if they were located within the boundaries of the project area they were physically visited in an effort to determine:

(i) whether they still exist;
(ii) their current condition; and
(iii) significance.

3.1.3. Physical survey

- The survey of the proposed development was conducted on 15 February 2020
- The survey took one day to complete.
- The documented sites were numbered sequentially.
- Sites were recorded by using a handheld Garmin Oregon 450 GPS unit and the unit was given time to reach an accuracy of at least 5 metres.
- Sites were plotted on 1:50 000 topographical maps which are geo-referenced (WGS 84) and also on Google Earth.

- One site, located outside of the proposed project area, was documented and numbered GJS 1. Five survey orientation sites were mapped for survey purposes.

3.2. Social Consultation

Social consultation forms an important part of identifying sites which may be of heritage significance. General Manager of Joubert & Seuns farms Mr Lionel Eva was consulted about the presence of heritage sites within the project area. He pointed out the site with the engraved stones which could possibly be a grave and stated that to his knowledge there are no heritage sites or graves present within the proposed project area.

3.3. Heritage site significance

The South African Heritage Resources Agency (SAHRA) formulated guidelines for the conservation of all cultural resources (sections 6 and 7 of the NHRA, 1999) and therefore also divided such sites into three main categories. These categories might be seen as guidelines that suggest the extent of protection a given site might receive. They include sites or features of local (Grade 3) provincial (Grade 2) national (Grade 1) significance, grades of *local significance* and *generally protected* sites with a variety of degrees of significance.

For practical purposes the surveyor uses his own classification for sites or features and divides them into three groups, those of low or no significance, those of medium significance and those of high significance **(*Also see table 5.2.Significance rating guidelines for sites*).**

Values used to assign significance and impact characteristics to a site include:

- **Types of significance**

The site's scientific, aesthetic and historic significance or a combination of these is established.

- **Degrees of significance**

The archaeological or historic site's rarity and representative value is considered. The condition of the site is also an important consideration.

- **Spheres of significance**

Sites are categorized as being significant in the international, national, provincial, regional or local context. Significance of a site for a specific community is also taken into consideration.

To arrive at the specific allocation of significance of a site or feature, the specialist considers the following:

- Historic context;
- Archaeological context or scientific value;
- Social value;
- Aesthetic value; and
- Research value.

More specific criteria used by the specialist in order to allocate value or significance to a site include:

- The unique nature of a site;
- The integrity of the archaeological deposit;
- The wider historic, archaeological and geographic context of the site;
- The location of the site in relation to other similar sites or features;
- The depth of the archaeological deposit (when it can be determined or is known);
- The preservation condition of the site;
- Quality of the archaeological or historic material of the site; and
- Quantity of sites and site features.

Archaeological and historic sites containing data, which may significantly enhance the knowledge that archaeologists currently have about our cultural heritage, should be considered highly valuable. In all instances these sites should be preserved and not damaged during construction activities. However, when development activities jeopardize the future of such a site, a second and third phase in the Cultural Resource Management (CRM) process is normally advised. This entails the excavation or rescue excavation of cultural material, along with a management plan to be drafted for the preservation of the site or sites.

Graves are considered very sensitive sites and should never under any circumstances be jeopardized by development activities. Graves and burial grounds are incorporated in the NHRA under section 36 and in all instances where graves are found by the surveyor, the recommendation would be to steer clear of these areas. If this is not possible or if construction activities have for some reason damaged graves, specialized consultants are normally contacted to aid in the process of exhumation and re-interment of the human remains.

4. History and Archaeology

4.1. Historic period

4.1.1. Early History

In Southern Africa the domestication of the environment began only a couple of thousands of years ago, when agriculture and herding were introduced. At some time during the last half of the first millennium BC, people living in the region where Botswana, Zambia and Angola are today, started moving southward, until they reached the Highveld and the Cape in the area of modern South Africa. As time passed and the sub-continent became fully settled, these agro-pastoralists, who spoke Bantu languages, started dominating all those areas which were ecologically suitable for their way of life. This included roughly the eastern half of modern South Africa, the eastern fringe of Botswana and the north of Namibia. Historians agree that the earliest Africans to inhabit in the Lowveld in Mpumalanga were of Sotho, or more particularly BaKoni-origin.

Up until the 1930s, malaria would have occurred sporadically in the study area during the rainy season. During the first half of the nineteenth century, Tsetse flies also thrived in this area. Pastoralists would have avoided the moist low-lying valleys and thickly wooded regions where these insects preferred to congregate. It is unlikely that populations would be dense in areas where malaria and the “sleeping sickness” transferred by Tsetse flies was a constant threat to humans and their stock (Bergh 1999: 3; Shillington 1995: 32).

In a few decades, the course of history in the old Transvaal province would change forever. The Difaqane (Sotho), or Mfekane (“the crushing” in Nguni) was a time of bloody upheavals in Natal and on the Highveld, which occurred around the early 1820s until the late 1830s. It came about in response to heightened competition for land and trade, and caused population groups like gun-carrying Griquas and Shaka’s Zulus to attack other tribes.

During the time of the Difaqane, a northwards migration of white settlers from the Cape was also taking place. Some travellers, missionaries and adventurers had gone on expeditions to the northern areas in South Africa – some as early as the 1720’s. One such an adventurer was Robert Schoon, who formed part of a group of Scottish travellers and traders who had travelled the northern provinces of South Africa in the late 1820s and early 1830s. Schoon had gone on two long expeditions in the late 1820’s and once again ventured eastward and northward of Pretoria in 1836 (Bergh, 1999: 13, 116-121).

By the late 1820s, a mass-movement of Dutch speaking people in the Cape Colony started advancing into the northern areas. This was due to feelings of mounting dissatisfaction caused by economical and other circumstances in the Cape. This movement later became known as the Great Trek. This migration resulted in a massive increase in the numbers of people of European descent.

As can be expected, the movement of whites into the Northern provinces would have a significant impact on the local farmer – herders who populated the land.

By 1860, the population of Europeans in the central Transvaal was already very dense and the administrative machinery of their leaders was firmly in place. Many of the policies that would later be entrenched as legislation during the period of apartheid had already been developed (Ross 2002: 39; Bergh, 1999: 170).

However, relations were at times also interdependent in nature. After the Great Trek, when European farmers had settled at various areas in the northern provinces, wealthier individuals were often willing to lodge needy white families on their property in exchange for odd jobs and commando service. These “bywoners” often arrived with a family and a few cows. He would till the soil and pay a minimal rent to the farmer from the crops he grew. The farmer did not consider him a labourer, but mostly kept native workers for hard labour on the farm.

The discovery of gold in South Africa had a major impact in the region. In 1873 gold was discovered in Pilgrims Rest, 80 kilometres north of Nelspruit. This drew scores of prospectors into the region. The establishment of Barberton in 1884, after the discovery of the Sheba gold reef, also brought about greater activity in the area. The Nelspruit settlement first received official recognition in August 1884 (South African History Online 2013).

A large Homeland was located a small distance to the east of Nelspruit, and later became known as Kangwane. This area was proclaimed by the Land Act of 1936. In the Surplus People Project Report, the forced removal of people to the Kangwane area, or homeland, is discussed. According to this source the area could be regarded as a “dumping ground” allocated to South Africa’s Swazis, consisting of two blocks of land. The first of these, the Nsikazi reserve, was a finger of land stretching along the western boundary of the Kruger National Park, and had been under black occupation for over 50 years. The second block was adjacent to the western and northern boundaries of Swaziland, and consisted of the Nkomazi and Mswati/Mlondozi reserves released under the 1935 Land Act. (Bergh 1999: 42; Surplus people project 1983: 59)

4.1.2. The Voortrekkers

The Groot Trek of the Voortrekkers started with the Tregardt- van Rensburg trek in 1835. The two men met where Tregardt and his followers crossed the Orange River at Buffelsvlei (Aliwal North). Here van Rensburg joined the trek northwards. On August 23, 1837 the Tregardt trek left for Delagoabay from the Soutpansberg. They travelled eastwards alongside the Olifants River to the eastern foothills of the Drakensberg. From here they travelled through the Lowveld and the current Kruger National Park where they eventually crossed the Lebombo mountains in March 1838. They reached the Fortification at Lourenço Marques on 13 April 1838 (Bergh, 1998:124-125).

Permanent European (Voortrekker) settlement of the eastern areas of Mpumalanga can be traced back to a commission under the leadership of A.H. (Hendrik) Potgieter who negotiated with the Portuguese Governor at Delagoabaai in 1844 for land. It was agreed that these settlers could settle in an area that was four days journey from the east coast of Africa between the 10˚ and 26˚ south latitudes. Voortrekkers started migrating into the area in 1845. Andries-Ohrigstad was the first town established in this area in July 1845 after the Voortrekkers successfully negotiated for land with the Pedi Chief Sekwati. Farms were given out as far west as the Olifants River. The western boundary was not officially defined but at a Volksraad meeting in 1849 it was decided that the Elands River would be the boundary between the districts of Potchefstroom and Lydenburg as this eastern portion of the Transvaal was then known (Bergh, 1998).

Due to internal strife and differences between the various Voortrekker groups that settled in the broader Transvaal region, the settlers in the Ohrigstad area now governed from the town of Lydenburg decided to secede from the Transvaal Republic in 1856. The Republic of Lydenburg laid claim to a large area that included not only the land originally obtained from the Pedi Chief Sekwati in 1849 but also other areas of land negotiated for from the Swazis. The Republic of Lydenburg was a vast area and stretched from the northern Strydpoort mountains to Wakkerstroom in the south and Bronkhortsspruit in the west to the Swazi border and the Lebombo mountains east.

As can be expected, the migration of Europeans into the north would have a significant impact on the indigenous people who populated the land. This was also the case in Mpumalanga. In 1839 Mswati succeeded Sobhuza (also known as Somhlomo) as king of the Swazi. Threatened by the ambitions of his half brothers, including Malambule, who had support from the Zulu king Mpande, he turned to the Ohrigstad Boers for protection. He claimed that the land that the Boers had settled on was Swazi property. The Commandant General of the Ohrigstad settlement, Andries Hendrik Potgieter, responded that the land was ceded to him by the Pedi leader Sekwati, in return for protection of the Pedi from Swazi attacks (Giliomee, 2003).

However, in reaction to the increasingly authoritarian way in which Potgieter conducted affairs at Ohrigstad, the Volksraad of Ohrigstad saw Mswati's offer as a means to obtain more respectable title deeds for the property (Bonner, 1978). According to a sales contract set up between the Afrikaners and the Swazi people on 25 July 1846, the whites were the rightful owners of the land that had its southern border at the Crocodile River, which stretched out in a westerly direction up to Elandspruit; of which the eastern border was where the Crocodile and Komati rivers joined and then extended up to Delagoa bay in the north (Van Rooyen, 1951). The Europeans bought the land for a 100 heads of cattle (Huyser).

4.1.3. History of the Anglo Boer War (1899-1902) in the area

The discovery of diamonds and gold in the Northern provinces had very important consequences for South Africa. After the discovery of these resources, the British, who at the time had colonized the Cape and Natal, had intensions of expanding their territory into the northern Boer republics. This eventually led to the Anglo-Boer War, which took place between 1899 and 1902 in South Africa, and which was one of the most turbulent times in South Africa's history.

Even before the outbreak of war in October 1899 British politicians, including Sir Alfred Milner and Mr. Chamberlain, had declared that should Britain's differences with the Z.A.R. result in violence, it would mean the end of republican independence. This decision was not immediately publicised, and as a consequence republican leaders based their assessment of British intentions on the more moderate public utterances of British leaders. Consequently, in March 1900, they asked Lord Salisbury to agree to peace on the basis of the status quo ante bellum. Salisbury's reply was, however, a clear statement of British war aims (Du Preez, 1977).

During the British advance between February to September 1900, Lord Roberts replaced Genl. Buller as the supreme commander and applied a different tactic in confronting the Boer forces instead of a frontal attack approach he opted to encircle the enemy. This proved successful and resulted for instance in the surrender of Genl. Piet Cronje and 4000 burghers at Paardeberg on 27 February 1900.

This was the start of a number of victories for the British and shortly after they occupied Pretoria on 5 June 1900, a skirmish at Diamond Hill resulted in the Boer forces under command of Louis Botha, retreated alongside the Delagoa Bay railway to the east. Between the 21-27 August, Botha and 5000 burghers defended their line at Bergendal but were overwhelmed by superior numbers and artillery. This resulted in the Boer forces retreating even further east and three weeks later the British reached Komatipoort and thus the whole of the Eastern Transvaal south of the Delagoa Bay railway line was now occupied by British Forces.

General Louis Botha, with his Boer forces, marched through Nelspruit on 11 September 1900. A week later, on 18 September 1900, the British battalion of Lieutenant General F. Roberts arrived in Nelspruit. No major skirmishes in the war took place near Nelspruit, but a concentration camp for black people was established a small distance to the north of the town. Another event of import in the area was the arrival of the President of the Transvaal, Paul Kruger, in Nelspruit on 29 May 1900, where he received a message saying Lord Roberts had annexed the Transvaal. Kruger declared the annexation illegitimate on 3 September 1900, the same day that Nelspruit was proclaimed as the administrative capital of the Transvaal Republic. Kruger left Nelspruit in June of that year in order to board a ship to Swaziland (Bergh, 1999: 51; 54).

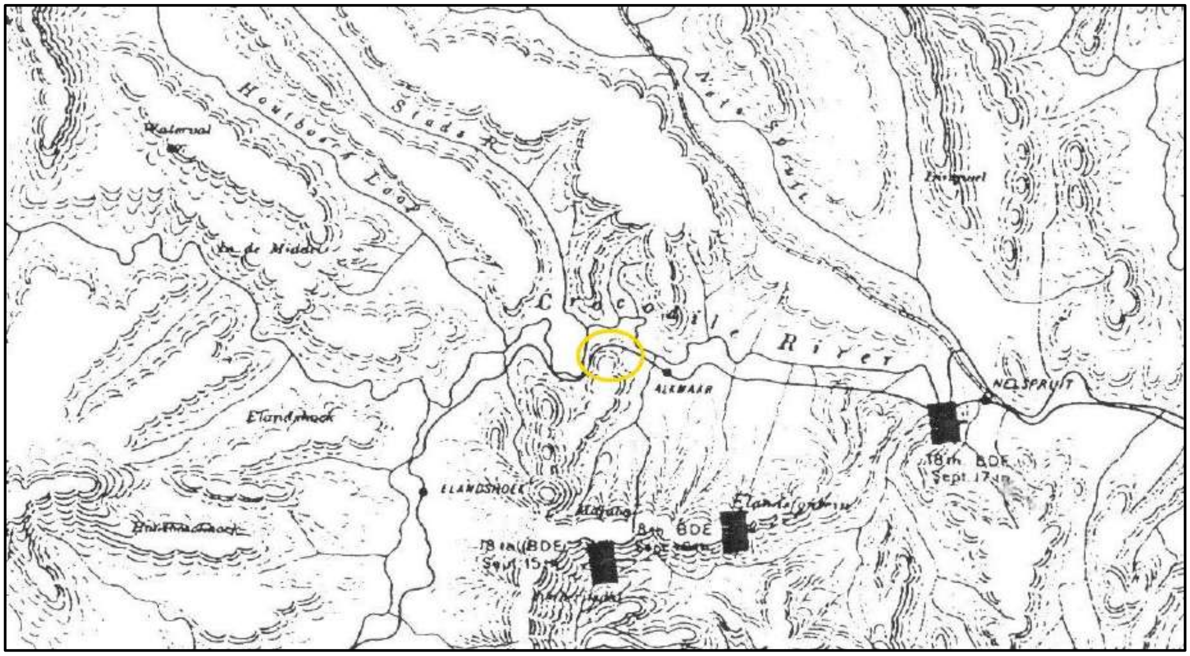

Fig. 4.1. Anglo Boer War map showing "The second stage of the combined advance on Koomati Poort, Sept. 3rd -24th 1900. The approximate location of the study area is encircled in yellow.

During the Battle of Helvetia, ZAR forces succeeded in capturing "The Lady Roberts" British naval gun after an attack on enemy fortifications located at Helvetia between Lydenburg and Machadodorp on 28 December 1900. It was the only gun captured during the War and later destroyed by the ZAR forces to prevent the British claiming it back. The largest portions of the gun are at the National Museum in Pretoria but an inscribed piece which comes from the breech of the gun is part of the Lydenburg Museum collection.

4.1.4. Historic maps of the study area

Since the early 18th century South Africa has been divided and re-divided into various districts. The study area was originally located on the farms Geluk 486 and Koedoeshoek 344, Lydenburg district. The Lydenburg district was proclaimed in 1845 (Bergh, 1999: 22).

In 1926 the Belfast district was proclaimed, and the farm became Geluk 24, Belfast district. In 1930 the Nelspruit district was proclaimed and the Koedoeshoek 344 became Koedoeshoek 33, Nelspruit. (Bergh, 1999: 24).

By 1969, the property was located on Koedoeshoek 301 JT and Geluk 299 JT. By 1984 the farm Bruintjieslaagte 465 JT had been proclaimed, leaving the farms Koedoeshoek and Geluk reduced in size.

Fig. 4.2. A Map of the Transvaal and Orange River Colonies in the year 1900. The yellow border shows the approximate location of the area under investigation (Philip et al, 1900).

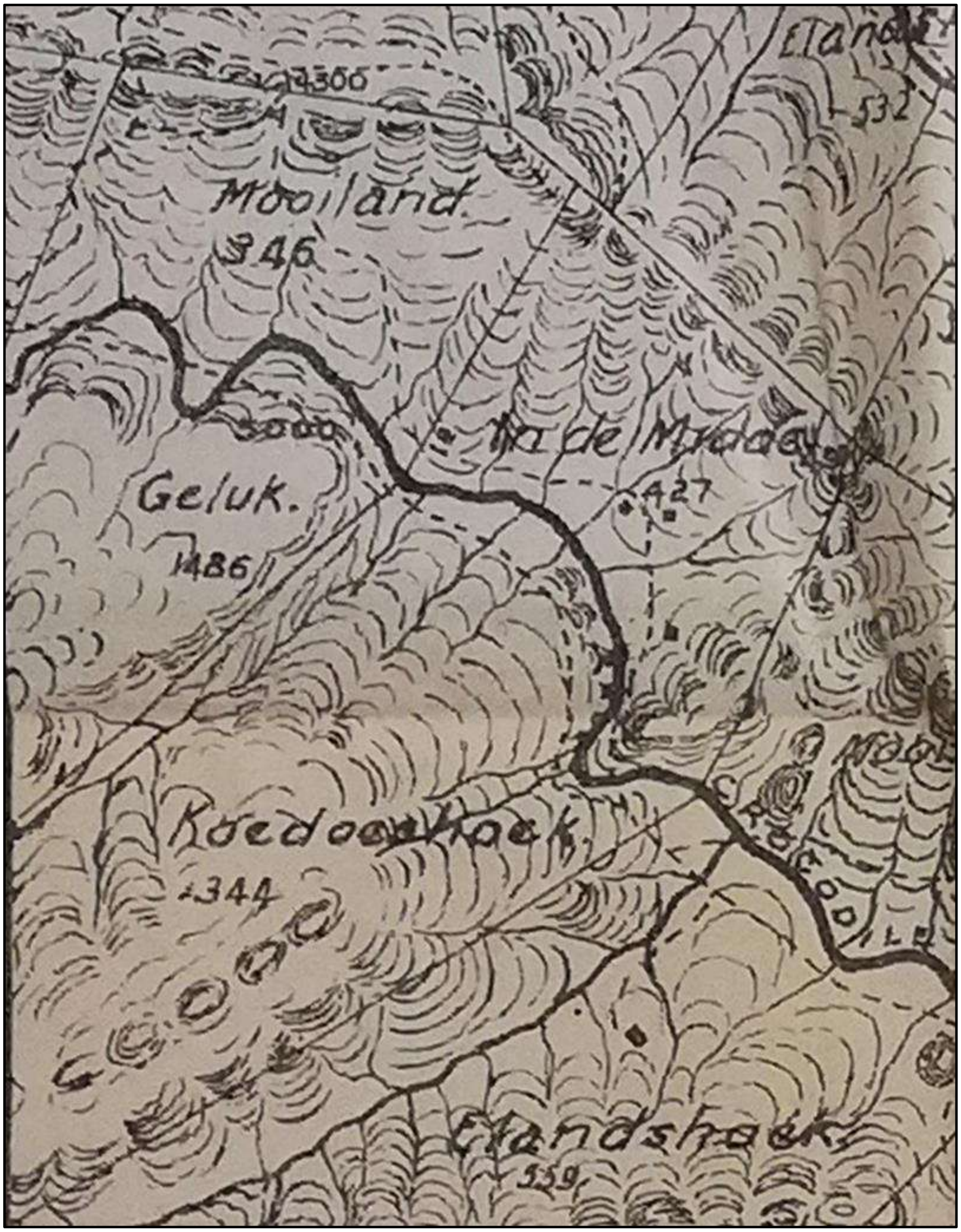

Fig. 4.3. Map of the Barberton District in the year 1902. The study area was comprised of the northern most sections of Geluk 486 and Koedoeshoek 344. The only visible development on the farms was an ordinary road that ran parallel and to the south of the Crocodile River. The river formed the north eastern boundary of Geluk and Koedoeshoek (Major Jackson, 1902).

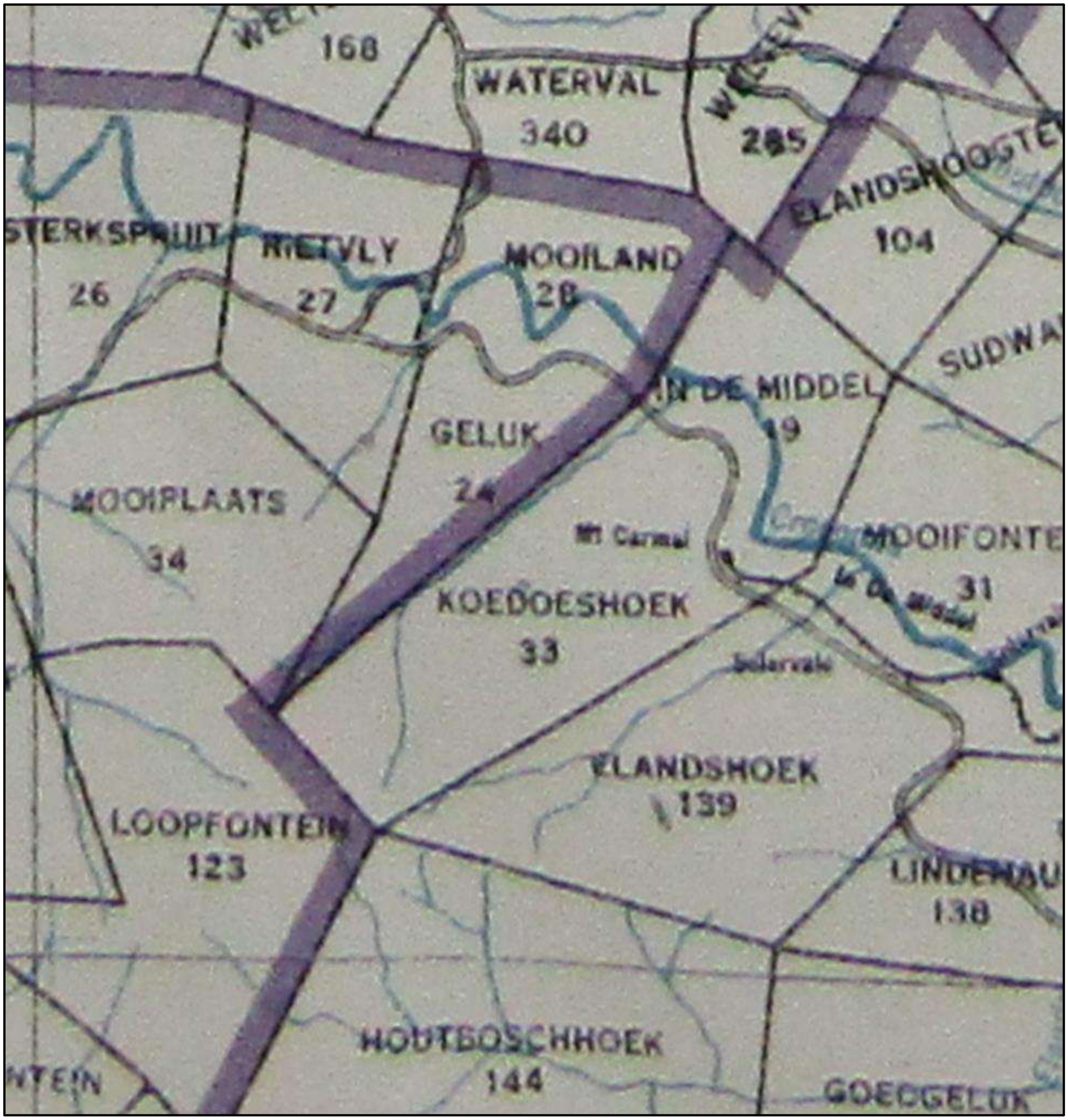

Fig. 4.4. Map of the Kruger National Park, dating approximately to the 1930s.The area under investigation would have formed part of Geluk 24, Belfast district and Koedoeshoek 33, Nelspruit district. The district boundary in purple, can be seen between the two farms (NASA Maps: 3/1254).

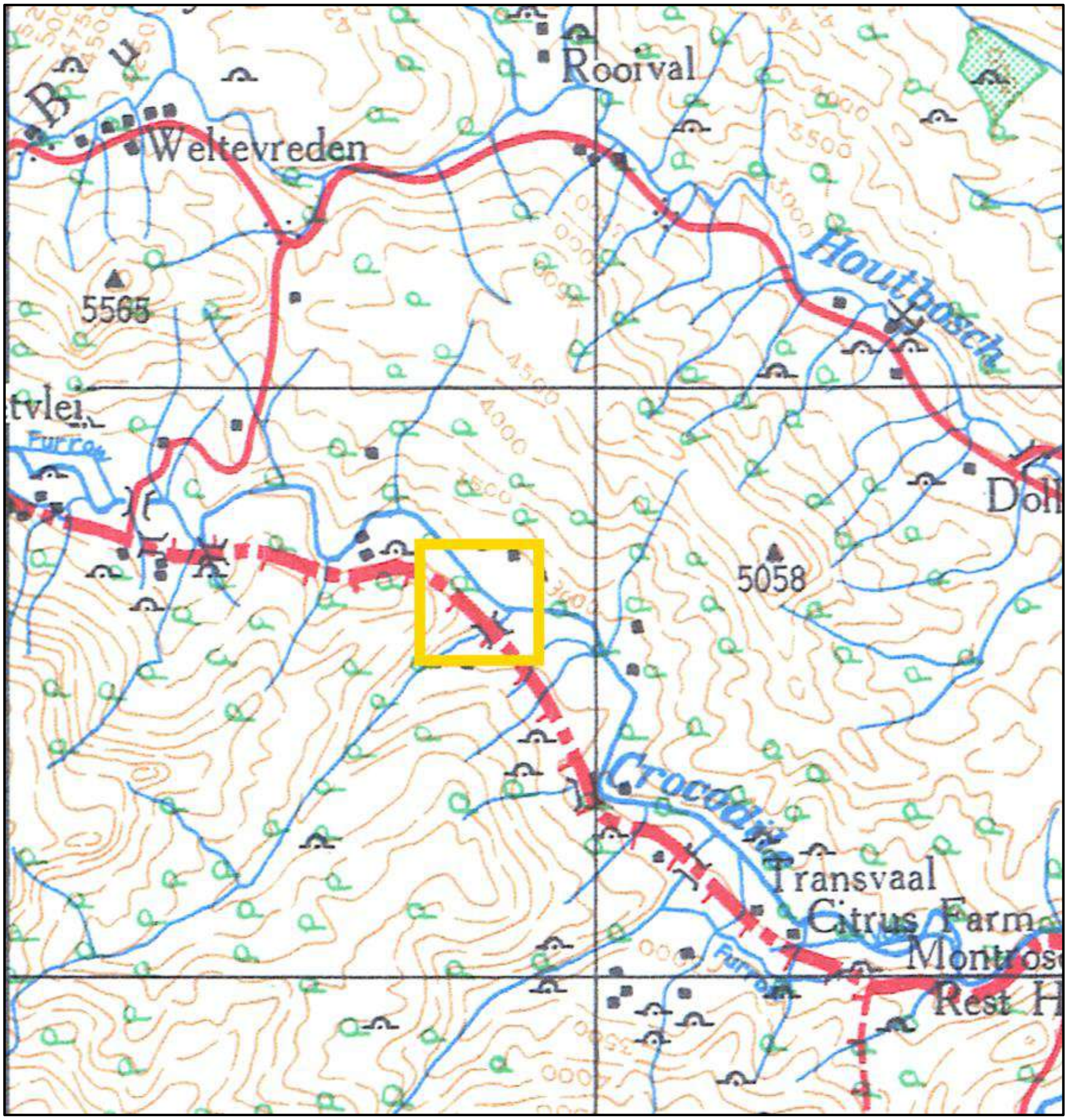

Fig. 4.5. Topographical Map of the Baberton area in 1942. The approximate location of the study area is indicated with a yellow border. Natural bush was the predominant vegetation on the farm. The main road can be seen to the south and the Crocodile River to the north of the project area (Topographical Map, 1942).

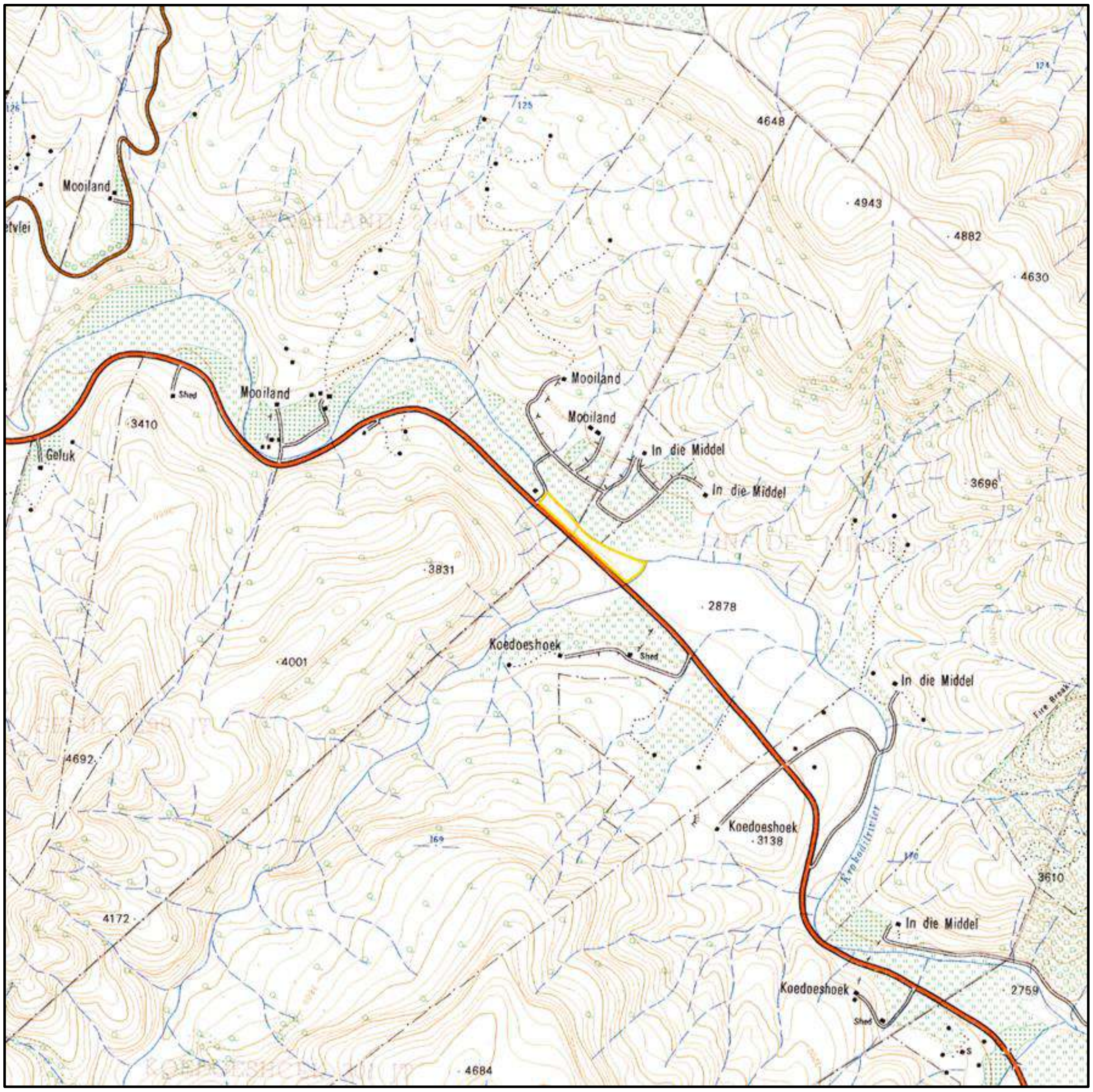

Fig. 4.6. A Topographical Map of the Boshalte area in 1969, showing where the study area is located (yellow border). The Crocodile River forms the north-eastern border, the main road, forms the southwestern border, the north-western border is formed by a road and a tributary of the Crocodile river forms the south-eastern border. No developments or farming activity can be seen in the study area (Topographical Map, 1969).

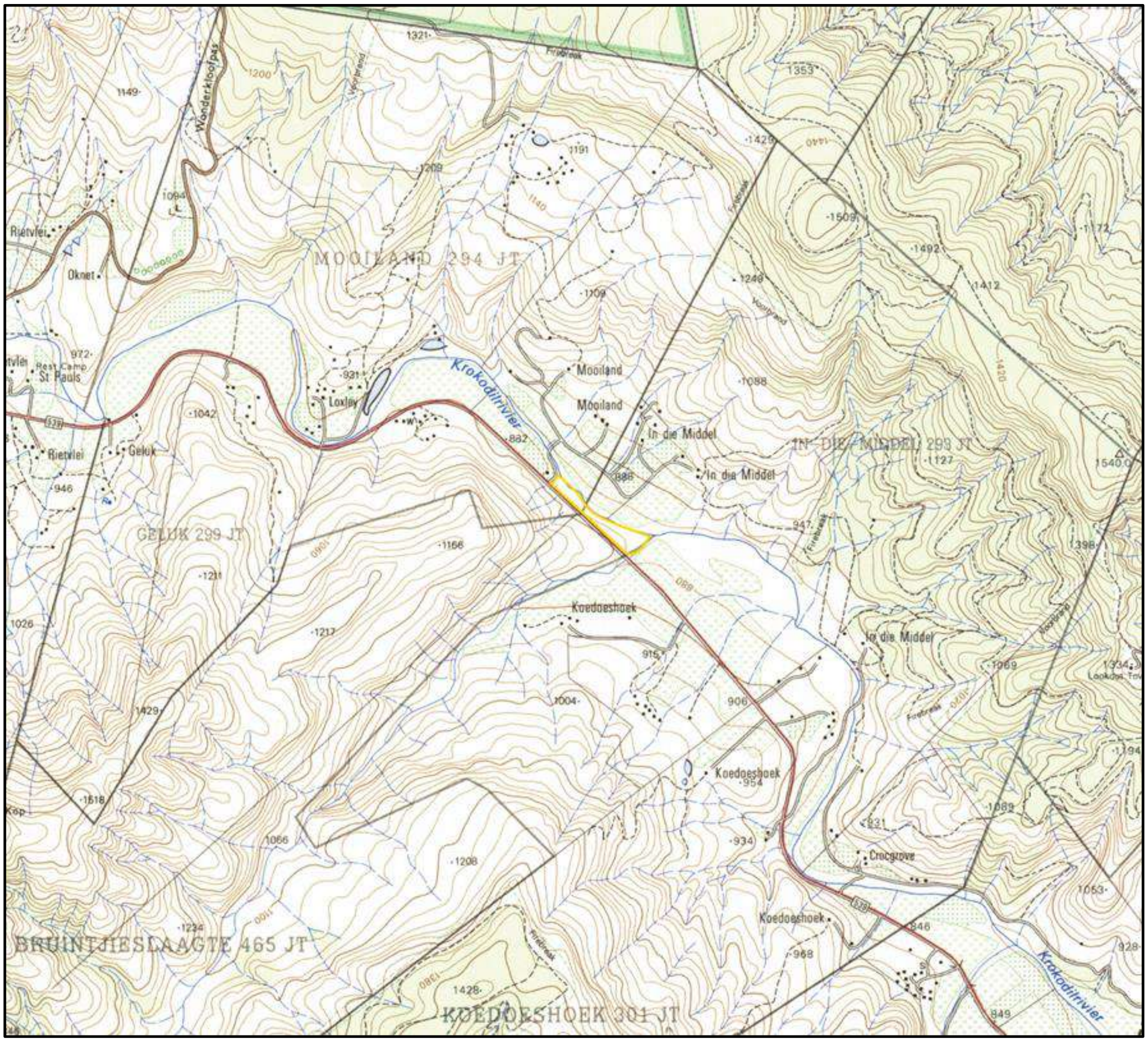

Fig. 4.7. A Topographical Map dated 1984. The study area is indicated with a yellow border. The portion of farm Koedoeshoek 301 JT which formed part of the study area has been subdivided and a new farm, Bruintjieslaagte 465 JT was proclaimed. It would appear that only a small section of the farm Koedoeshoek 301 JT still forms part of the eastern most part of the study area. No developments or farming activity can be seen in the study area (Topographical Map,1984).

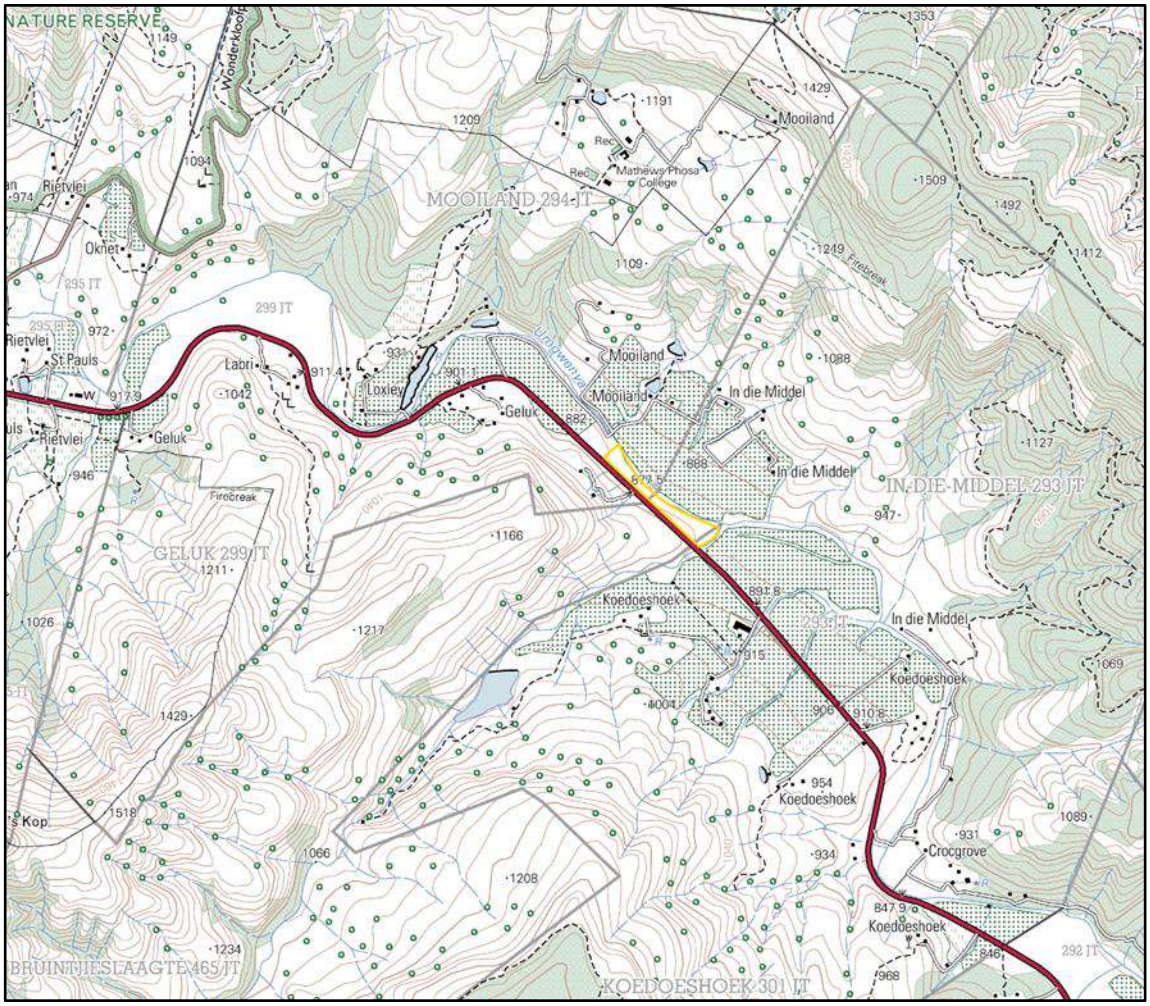

Fig. 4.8. A Topographical Map dated 2010. The study area is indicated with a yellow border. No developments are visible on the property (Topographical Map, 2010).

Fig. 4.9. A Google Earth image showing the approximate location of the study area (yellow border). No developments can be seen on the property (Google Earth, 2020).

4.1.5. Historic overview of the ownership and development of the study area

A number of sources were consulted in the National Archives of South Africa, but on closer inspection very few had bearing on the history of the study area. Based on the maps that were consulted, no developments or structures could be found on the property. All the available maps indicate that, except for the arterial road to the south, the area was undeveloped.

<u>Record of historical landowners:</u>

Some details regarding the historical landowners of Bruintjieslaagte 465 JT, Portion 5 of Geluk 299 JT and Portion 9 of Koedoeshoek 301 JT could be found.

Bruintjieslaagte 465 JT

The following details regarding historical landowners on Bruintjieslaagte 465 JT could be traced on the Windeed Search Engine:

Date	Transferred from	Transferred to
1985	-	M. de Jager Beleggings Pty Ltd
1985	M. de Jager Beleggings Pty Ltd	Bruinbou Pty Ltd
1994	Bruinbou Pty Ltd	J. P. Trust
1997	J. P. Trust	L'Abri Estates CC
1997	L'Abri Estates CC	L'Abri Estates Pty Ltd
2012	L'Abri Estates Pty Ltd	Joubert Familie Trust

(Windeed Search Engine 2021)

Geluk 299 JT

The farm Geluk 24, in the Crocodile River ward, was inspected on 15 September 1868 and measured roughly 2088 morgen. On 19 March 1884, the title deed to the property was awarded to Stephanus Johannes Schoeman (NASA TAB, RAK: 2902).

Date	Portion	Transferred from	Transferred to	Purchase price
1884	Farm	S.J. Schoeman	Edward Button	
1885	Farm	E. Button	The Colonial Gold Mining Co. of SA	£12000
1888	Farm	The Colonial Gold Mining Co of SA	The Gold Estates (Tvl.) Co. Ltd.	£96000
1896	Farm	The Gold Estates (Tvl.) Co. Ltd.	The Gold Estates Tvl. Co. Ltd.	Change of name
1903	Farm	The Gold Estates Tvl. Co. Ltd.	Hendersons Tvl. Est. Ltd.	11676 £1 shares
1909	Farm	Hendersons Tvl. Est. Ltd. (In liquidation)	Henderson Tvl. Estates Ltd.	
1913	Farm	Hendersons Tvl. Est. Ltd. (In liquidation)	Henderson Tvl. Estates Ltd.	
1922	½ of Farm	Henderson Tvl. Estates Ltd.	Johannes Lodewicus Malan	£2349
1923	½ of Farm	Ins. Est. J.L. Malan	Ward Jackson Trust	£1000

(NASA *TAB, RAK: 2902*)

No ownership information could be found for the period 1923 to 1981.

The only portion of the farm Geluk 299 JT which forms part of the study area, is portion 5. The following details regarding recent landowners of portion 5 of the farm Geluk 299 JT could be traced on the Windeed Search Engine:

Date	Transferred from	Transferred to	Purchase price
1981		Jacobus Erasmus Rossouw	Unknown
2006	Jacobus Erasmus Rossouw	Florence Elizabeth Rossouw	Estate

(Windeed Search Engine, 2021)

<u>Koedoeshoek 301 JT</u>

The farm Koedoeshoek 344, in the Crocodile River ward, was inspected on 15 September 1868 and measured roughly 3000 morgen. On 16 July 1869, the title deed to the property was awarded to Leendert Daniel Joubert (NASA TAB, RAK: 2900; NASA TAB, RAK: 2907).

Date	Portion	Transferred from	Transferred to	Purchase price
1869/07/16	Whole of Koedoeshoek 344	State	Daniel Joubert	Unknown
1871/06/6	Western ½ of farm	Daniel Joubert	Dirk Ruiter	£15
14/10/1873	Eastern ½ of farm	Daniel Joubert	Dirk Ruiter	£30
1889	Western ½ of farm	D. Ruiter	Hermanus Cornelis Marthinus Fourie	£300
1892	Western ½ of farm	H. C. M. Fourie	Lodewijk de Jager	£1000
1896/5/5	Eastern ½ of farm	Jan Hendrik Lodewyk Scholtz [illegible] Jan Ruiters	Karel Rood	£1200
1902/12/31	Portion as above	Karel Rood	Witwatersrand Land and Exploration Co Ltd	[illegible]
1906	Western ½ of farm	L. de Jager	Willem de Jager	£2000
1915	Eastern ½ of farm	WW Rand Land Exploration Coy Ltd	African Farms Ltd	£79.999
1920/6/24	Eastern ½ of farm	African Farms Ltd	South African Townships Mining & Finance Co Ltd	

(NASA *TAB, RAK: 2900*; NASA *TAB, RAK: 2907*)

No ownership information could be found for the period 1921 to 1985.

The only portion of the farm Koedoeshoek 301 JT which appears to form part of the study area is portion 9. The following details regarding landowners of portion 9 of Koedoeshoek 301 JT could be traced on the Windeed Search Engine:

Date	**Transferred from**	**Transferred to**
1985	-	M. de Jager Beleggings Pty Ltd
1992	M. de Jager Beleggings Pty Ltd	Crocodile Valley Estates CC
1992	Crocodile Valley Estates CC	Crocodile Valley Estates Pty Ltd
2002	Crocodile Valley Estates Pty Ltd	Joubert Familie Trust

(Windeed Search Engine 2021)

History of land use

In 1920, plans were underway to establish a school on the farm Koedoeshoek 344. The farm owner, Mr De Jager, provided a piece of land for the purpose of a school. Some 22 children were to attend the school, all less than 15 years of age. By December of that year, the Secretary of the Office of the School Board of Lydenburg, wrote to the Secretary of the Department of Education. The necessary forms were attached in application for the appointment of a teacher at the school at Koedoeshoek. No further information is provided, but it seems that everything was in place for the school to be established. If the school was built, it is likely that it was not erected within the study area, as there is no sign of a European-style building on the property (NASA TAB, TOD: 2560 E16694).

In 1968, application was brought for the subdivision of portions 2, 4, 7 and the remainder of portion 4 of Koedoeshoek 301 JT (NASA SAB, CDB: 3/575 TAD9/3/93).

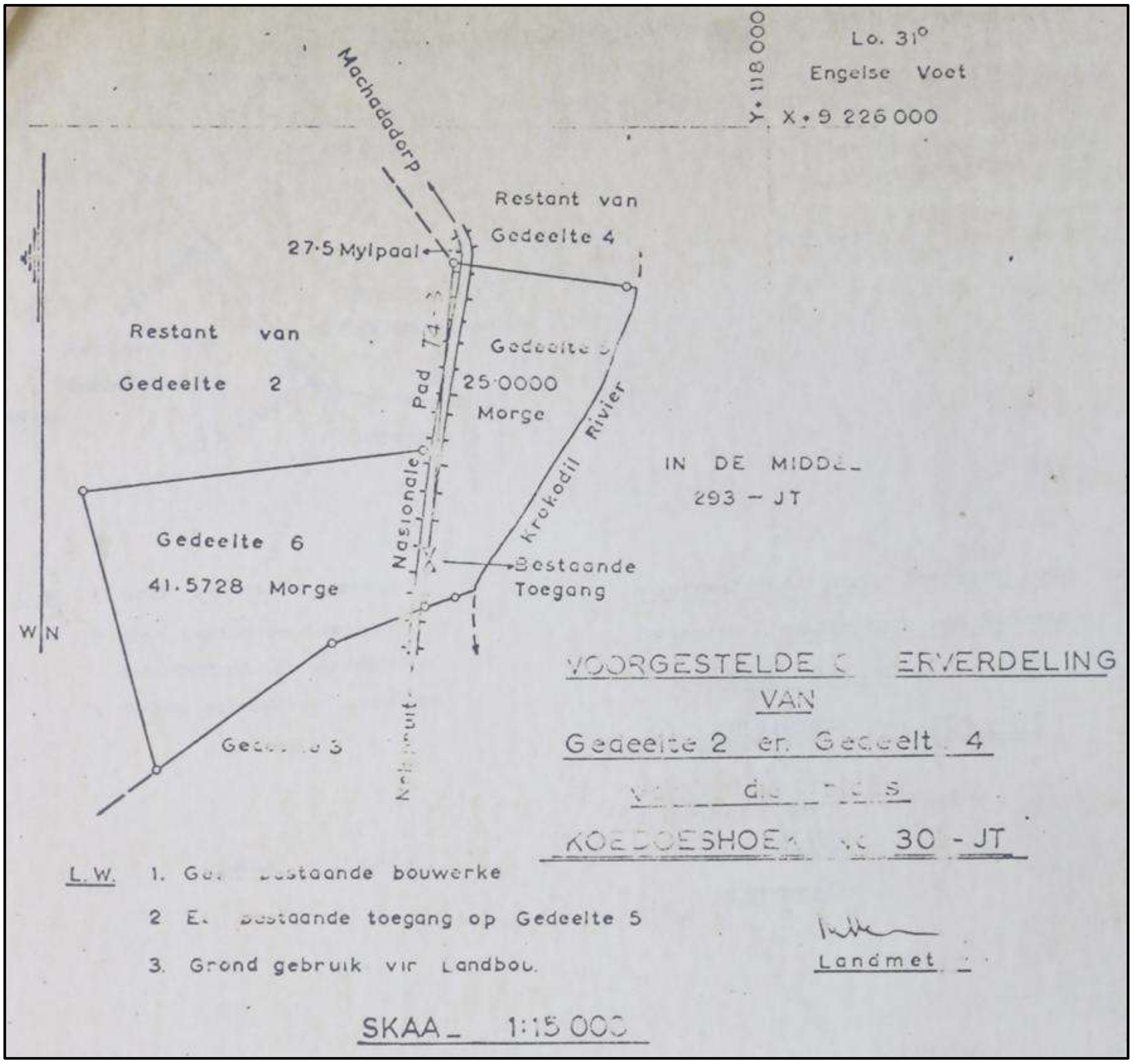

Fig. 4.10. Sketch of the proposed subdivision of portions 2 and 4 of Koedoeshoek 301 JT. (NASA SAB, CDB: 3/575 TAD9/3/93).

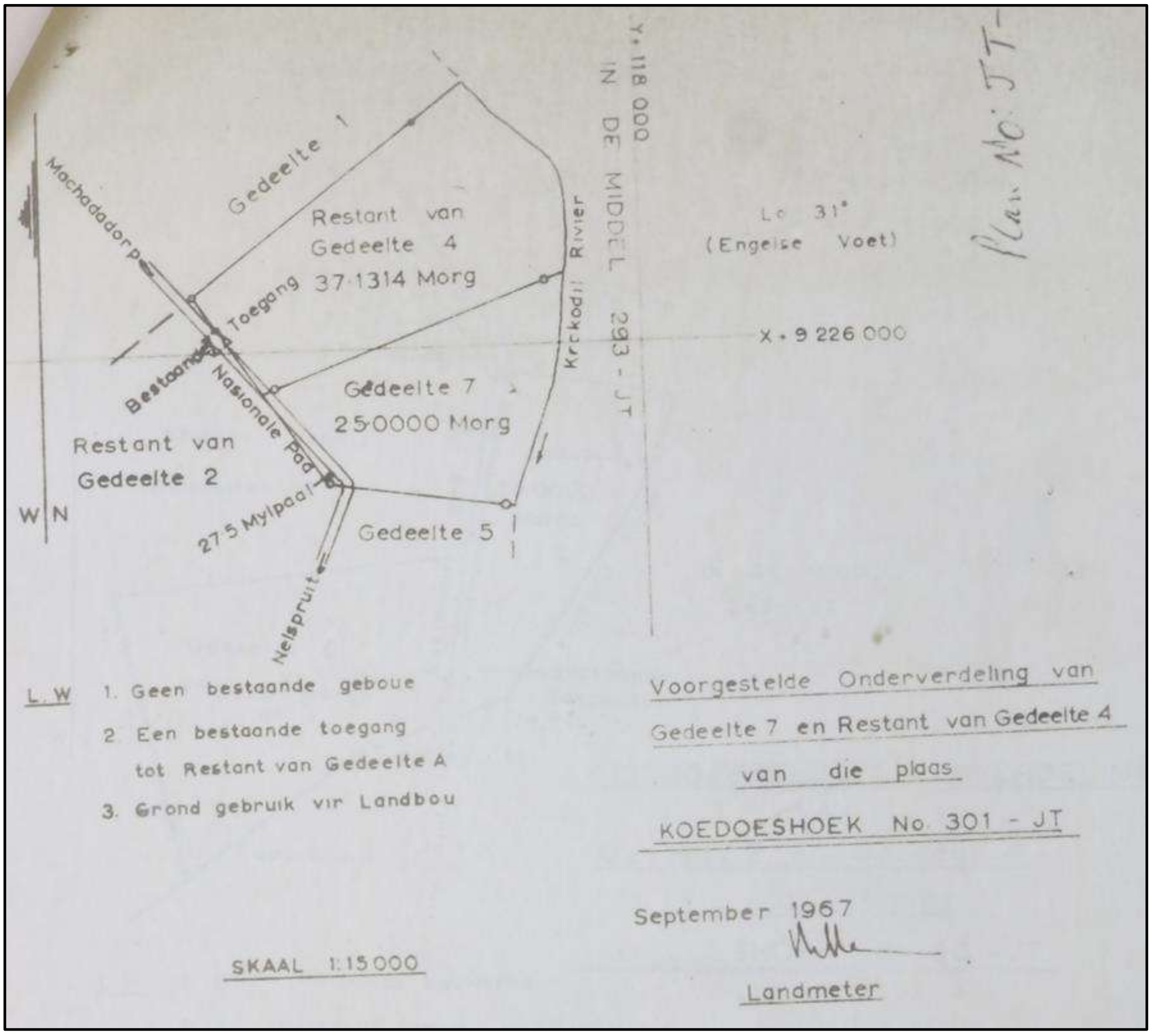

Fig. 4.11. Sketch of the proposed subdivision of portions 7 and the remainder of portion 4 of Koedoeshoek 301 JT (NASA SAB, CDB: 3/575 TAD9/3/93).

Although the only portion of the farm Koedoeshoek 301 JT that appears to be relevant to the study area is portion 9 of Koedoeshoek 301 JT, it is important to note that the conditions of the subdivision for these portions required, inter alia, that:

1. No further subdivision of the land will be allowed.

2. Only one residence may be erected on the property.

3. Land may only be used for residential and farming purposes and that no shop, business, or industry may be conducted therefrom.

4. No development may take place within 300 Cape Foot from the middle of the national road.

5. Any variation in the above may only take place with the written consent in terms of article 1 of Act 21/1940, read together with Act 44/1948 (NASA SAB, CDB: 3/575 TAD9/3/93).

Similar limitations may be applicable to portion 9 of Koedoeshoek 301 JT and this should be investigated further.

4.2. Archaeology

4.2.1. Stone Age

In Mpumalanga Province the Drakensberg separates the interior plateau also known as the Highveld from the low-lying subtropical Lowveld, which stretches to the Indian Ocean. A number of rivers amalgamate into two main river systems, the Olifants River and the Komati River. This fertile landscape has provided resources for humans and their predecessors for more than 1.7 million years (Esterhuizen & Smith in Delius, 2007).

The initial attraction of abundant foods in the form of animals and plants eventually also led to the discovery of and utilisation of various minerals including ochre, iron and copper. People also obtained foreign resources by means of trade from the coast. From 900 AD this included objects brought across the ocean from foreign shores.

The Early Stone Age (ESA)

In South Africa the ESA dates from about 2 million to 250 000 years ago, in other words from the early to middle Pleistocene. The archaeological record shows that as the early ancestors progressed physically, mentally and socially, bone and stone tools were developed. One of the most influential advances was their control of fire and diversifying their diet by exploitation of the natural environment (Esterhuizen & Smith in Delius, 2007).

The earliest tools used by 30odellin date to around 2.5 million years ago from the site of Gona in Ethiopia. Stone tools from this site shows that early hominids had to cognitive ability to select raw material and shape it for a specific application. Many bones found in association with stone tools like these have cut marks which lead scientists to believe that early hominids purposefully chipped cobblestones to produce flakes with a sharp edge capable of cutting and butchering animal carcasses. This supplementary diet of higher protein quantities ensured that brain development of hominids took place more rapidly.

Mary Leaky discovered stone tools like these in the Olduwai Gorge in Tanzania during the 1960s. The stone tools are named after this gorge and are known as relics from the Oldowan industry. These tools, only found in Africa, are mainly simple flakes, which were struck from cobbles. This method of manufacture remained for about 1.5 million years. Although there is continuing debate about who made these tools, two hominids may have been responsible. The first of these was an early form of *Homo* and the second was *Paranthropus robustus*, which became extinct about 1 million years ago (Esterhuizen & Smith in Delius, 2007).

Around 1.7 million years ago, more specialised tools known as Acheulean tools, appeared. These are named after tools from a site in France by the name of Saint Acheul, where they were first discovered in the 1800s. It is argued that these tools had their origin in Africa and then spread towards Europe and Asia with the movement of hominids out of Africa. These tools had longer and sharper edges and shapes, which suggest that they could be used for a larger range of activities, including the butchering of animals, chopping of wood, digging roots and cracking bone. *Homo ergaster* was probably responsible for the manufacture of Acheulean tools in South Africa. This physical type was arguably physically similar to modern humans, had a larger brain and modern face, body height and proportion very similar to modern humans. *Homo ergaster* was able to flourish in a variety of habitats in part because they were dependent on tools. They adapted to drier, more open grassland settings. Because these early people were often associated with water sources such as rivers and lakes, sites where they left evidence of their occupation are very rare. Most tools of these people have been washed into caves, eroded out of riverbanks and washed downriver. An example in Mpumalanga is Maleoskop on the farm Rietkloof where Early Stone Age (ESA) tools have been found. This is one of only a handful such sites in Mpumalanga.

Middle Stone Age (MSA)

A greater variety of tools with diverse sizes and shapes appeared by 250 000 before present (BP). These replaced the large hand axes and cleavers of the ESA. This technological advancement introduces the Middle Stone Age (MSA). This period is characterised by tools that are smaller in size but different in manufacturing technique (Esterhuizen & Smith in Delius, 2007).

In contrast to the ESA technology of removing flakes from a core, MSA tools were flakes to start with. They were of a predetermined size and shape and were made by preparing a core of suitable material and striking off the flake so that it was flaked according to a shape which the toolmaker desired. Elongated, parallel-sided blades, as well as triangular flakes are common finds in these assemblages. Mounting of stone tools onto wood or bone to produce spears, knives and axes became popular during the MSA. These early humans not only settled close to water sources but also occupied caves and shelters. The MSA represents the transition of more archaic physical type (*Homo)* to anatomically modern humans, *Homo sapiens.*

The MSA has not been extensively studied in Mpumalanga but evidence of this period has been excavated at Bushman Rock Shelter, a well-known site on the farm Klipfonteinhoek in the Ohrigstad district. This cave was excavated twice in the 1960s by Louw and later by Eloff. The MSA layers show that the cave was repeatedly visited over a long period. Lower layers have been dated to over 40 000 BP while the top layers date to approximately 27 000 BP (Esterhuizen & Smith in Delius, 2007; Bergh, 1998).

Later Stone Age (LSA)

Early hunter gatherer societies were responsible for a number of technological innovations and social transformations during this period starting at around 20 000 years BP. Hunting of animals proved more successful with the innovation of the bow and link-shaft arrow. These arrows were made up of a bone tip which was poisoned and loosely linked to the main shaft of the arrow. Upon impact, the tip and shaft separated leaving the poisoned arrow-tip imbedded in the prey animal. Additional innovations include bored stones used as digging stick weights to uproot tubers and roots; small stone tools, mostly less than 25mm long, used for cutting of meat and scraping of hides; polished bone tools such as needles; twine made from plant fibres and leather; tortoiseshell bowls; ostrich eggshell beads; as well as other ornaments and artwork (Esterhuizen & Smith in Delius, 2007).

At Bushman Rock Shelter the MSA is also represented and starts at around 12 000 BP but only lasted for some 3 000 years. The LSA is of importance in geological terms as it marks the transition from the Pleistocene to the Holocene, which was accompanied by a gradual shift from cooler to warmer temperatures. This change had its greatest influence on the higher-lying areas of South Africa. Both Bushman Rock Shelter and a nearby site, Heuningneskrans, have revealed a greater use in plant foods and fruit during this period (Esterhuizen & Smith in Delius, 2007; Bergh, 1998).

Faunal evidence suggests that LSA hunter-gatherers trapped and hunted zebra, warthog and bovids of various sizes. They also diversified their protein diet by gathering tortoises and land snails (*Achatina*) in large quantities.

Ostrich eggshell beads were found in most of the levels at these two sites. It appears that there is a gap of approximately 4 000 years in the Mpumalanga LSA record between 9 000 BP and 5 000 BP. This may be a result of generally little Stone Age research being conducted in the province. It is, however, also a period known for rapid warming and major climate fluctuation, which may have led people to seek out protected environments in this area. The Mpumalanga Stone Age sequence is visible again during the mid-Holocene at the farm Honingklip near Badplaas in the Carolina district (Esterhuizen & Smith in Delius, 2007; Bergh, 1998).

At this location, two LSA sites were located on opposite sides of the Nhlazatshe River, about one kilometre west of its confluence with the Teespruit. These two sites are located on the foothills of the Drakensberg, where the climate is warmer than the Highveld but also cooler than the Lowveld (Esterhuizen & Smith in Delius, 2007; Bergh, 1998).

Nearby the sites, dated to between 4 870 BP and 200 BP are four panels, which contain rock art. Colouring material is present in all the excavated layers of the site, which makes it difficult to determine whether the rock art was painted during the mid- or later Holocene. Stone walls at both sites date from the last 250 years of hunter gatherer occupation and they may have served as protection from predators and intruders (Esterhuizen & Smith in Delius, 2007; Bergh, 1998).

4.2.2. Early Iron Age

The period referred to as the Early Iron Age (AD 200-1500 approx.) started when presumably Karanga (north-east African) herder groups moved into the north eastern parts of South Africa. It is believed that these people may have been responsible for making of the famous Lydenburg Heads, ceramic masks dating to approximately 600AD.

Ludwig von Bezing was a boy of more or less 10 years of age when he first saw pieces of the now famous Lydenburg heads in 1957 while playing in the veld on his father's farm near Lydenburg. Five years later von Bezing developed an interest in archaeology and went back to where he first saw the shards. Between 1962 and 1966 he frequently visited the Sterkspruit valley to collect pieces of the seven clay heads. Von Bezing joined the archaeological club of the University of Cape Town when he studied medicine at this institution.

He took his finds to the university at the insistence of the club. He had not only found the heads, but potsherds, iron beads, copper beads, ostrich eggshell beads, pieces of bones and millstones. Archaeologists of the University of Cape Town and WITS Prof. Ray Innskeep and Dr Mike Evers excavated the site where von Bezing found the remains. This site and in particular its unique finds (heads, clay masks) instantly became internationally famous and was henceforth known as the Lydenburg Heads site.

Two of the clay masks are large enough to probably fit over the head of a child, the other five are approximately half that size. The masks have both human and animal features, a characteristic that may explain that they had symbolic use during initiation- and other religious ceremonies. Carbon dating proved that the heads date to approximately 600 AD and was made by Early Iron Age people. These people were Bantu herders and agriculturists and probably populated Southern Africa from areas north-east of the Limpopo river. Similar ceramics were later found in the Gustav Klingbiel Nature Reserve and researchers believe that they are related to the ceramic wares (pottery) of the Lydenburg Heads site in form, function and decorative motive. This sequence of pottery is formally known as the Klingbiel type pottery. No clay masks were found in a context similar to this pottery sequence.

Two larger heads and five smaller ones make up the Lydenburg find. The Lydenburg heads are made of the same clay used in making household pottery. It is also made with the same technique used in the manufacture of household pottery. The smaller heads display the 33odelling of a curved forehead and the back neck as it curves into the skull. Around the neck of each of the heads, two or three rings are engraved horizontally and are filled in with hatching marks to form a pattern. A ridge of clay over the forehead and above the ears indicates the hairline. On the two larger heads a few rows of small clay balls indicate hair decorations. The mouth consists of lips – the smaller heads also have teeth. The seventh head has the snout of an animal and is the only head that represents an animal.

Some archaeological research was done during the 1970's at sites belonging to the Early Iron Age (EIA), location Plaston, a settlement close to White River (Evers, 1977). This site is located on a spur between the White River and a small tributary. It is situated on holding 119 at Plaston.

The site was discovered during house building operations when a collection of pottery sherds was excavated. The finds consisted of pottery shards both on the surface and excavated.

Some of the pottery vessels were decorated with a red ochre wash. Two major decoration motifs occurred on the pots:

- Punctuation, using a single stylus; and
- Broad line incision, the more common motif.

A number of EIA pottery collections from Mpumalanga and Limpopo may be compared to the Plaston sample. They include Silver Leaves, Eiland, Matola, Klingbiel and the Lydenburg Heads site. The Plaston sample is distinguished from samples of these sites in terms of rim morphology, the majority of rims from Plaston are rounded and very few bevelled. Rims from the other sites show more bevelled rims (Evers, 1977:176).

Early Iron Age pottery was also excavated by archaeologist, Prof. Tom Huffman during 1997 on location where the Riverside Government complex is currently situated (Huffman, 1998). This site is situated a few km north of Nelspruit next to the confluence of the Nelspruit and Crocodile River. It was discovered during the course of an environmental impact assessment for the new Mpumalanga Government complex offices. A bulldozer cutting exposed storage pits, cattle byres, a burial and midden on the crest of a gentle slope. Salvage excavations conducted during December 1997 and March 1998 recovered the burial and contents of several pits.

One of the pits contained, among other items, pottery dating to the eleventh century (AD 1070 ± 40 BP). This relates the pottery to the Mzonjani and Broederstroom phases. The early assemblage belongs to the Kwale branch of the Urewe tradition.

During the early 1970s Dr Mike Evers of the University of the Witwatersrand conducted fieldwork and excavations in the Eastern Transvaal. Two areas were studied: the first area was the Letaba area south of the Groot Letaba River, west of the Lebombo Mountains, east of the great escarpment and north of the Olifants River. The second area was the Eastern Transvaal escarpment area between Lydenburg and Machadodorp.

These two areas are referred to as the Lowveld and escarpment respectively. The earliest work on Iron Age archaeology was conducted by Trevor and Hall in 1912. This revealed prehistoric copper-, gold- and iron mines. Schwelinus (1937) reported smelting furnaces, a salt factory and terraces near Phalaborwa. In the same year D.S. van der Merwe located ruins, graves, furnaces, terraces and soapstone objects in the Letaba area.

Mason (1964, 1965, 1967, 1968) started the first scientific excavation in the Lowveld, followed by N.J. van der Merwe and Scully. M. Klapwijk (1973, 1974) also excavated an EIA site at Silverleaves and Evers and van den Berg (1974) excavated at Harmony and Eiland, both EIA sites.

Research by the National Cultural History Museum resulted in the excavation of an EIA site in Sekhukuneland, known as Mototolong (Van Schalkwyk, 2007). The site is characterized by four large cattle kraals containing ceramics, which may be attributed to the Mzonjani and Doornkop occupational phases.

4.2.3. Late Iron Age

The later phases of the Iron Age (AD 1600-1800's) are represented by various tribes including Ndebele, Swazi, BaKoni, and Pedi, marked by extensive stonewalled settlements found throughout the escarpment and particularly around Machadodorp, Lydenburg, Badfontein, Sekhukuneland, Roossenekal and Steelpoort. The BaKoni were the architects of a unique archaeological stone building complex who by the 19th century spoke seKoni which was similar to Sepedi. The core elements of this tradition are stone-walled enclosures, roads and terraces. These settlement complexes may be divided into three basic features: homesteads, terraces and cattle tracks. Researchers such as Mike Evers (1975) and David Collett (1982) identified three basic settlement layouts in this area. Basically these sites can be divided into simple and complex ruins. Simple ruins are normally small in relation to more complex sites and have smaller central cattle byres and fewer huts. Complex ruins consist of a central cattle byre, which has two opposing entrances and a number of semi-circular enclosures surrounding it. The perimeter wall of these sites is sometimes poorly visible. Huts are built between the central enclosure and the perimeter wall. These are all connected by track-ways referred to as cattle tracks. These tracks are made by building stone walls, which forms a walkway for cattle to the centrally located cattle byres. Terracing between enclosures were used for the cultivation of crops such as maize, sorghum and millet. Terraces ensured clearing of the soil surface of rocks for cultivation and in addition served to retain moisture which resulted in better crop yields.

5. Site descriptions, locations and impact significance assessment

A single site (GJS 1) was recorded during the field survey. The site may represent the grave of an individual and it is located outside of and to the south of the study area. This site consists of an engraved slate stone (see figure 5.1.1. and figures 1-4 in Appendix D) located on an elevated hill overlooking the Schoemanskloof. It has inscriptions on it made in two different fonts. One of which reads: *"J H Joubert ZAR C 1883 – 1901".* This may suggest that the stone represents a headstone of a grave.

The capitals "*L J R"* are inscribed above the aforementioned inscription in triangular fashion and in a different, reminiscent of the current Times New Roman, font. It is uncertain what these capitals represent, further research is needed.

A total of five survey orientation locations were documented (SO 1-5) which includes a GPS location and photographs of the landscape at that particular location. Both the located sites and survey orientations are tabled in Appendix B and their photos in Appendix D. A map of their location is also provided in Appendix C.

Tables indicate the ***site significance rating scales and status*** in terms of possible impacts of the proposed actions on any located or identified heritage sites (**Table 5.5 & 5.6).**

Table 5.1. Summary of located sites and their heritage significance

Type of site	Identified sites	Significance
Graves and graveyards	One GJS 1	High LS 3A
Late Iron Age	None	N/A
Early Iron Age	None	N/A
Historical buildings or structures	None	N/A
Historical features and ruins	None	N/A
Stone Age sites	None	N/A

Table 5.2. Significance rating guidelines for sites

Field Rating	Grade	Significance	Recommended Mitigation
National Significance (NS)	Grade 1	High Significance	Conservation, nomination as national site
Provincial Significance (PS)	Grade 2	High Significance	Conservation; Provincial site nomination
Local significance (LS 3A)	Grade 3A	High Significance	Conservation, No mitigation advised
Local Significance (LS 3B)	Grade 3B	High Significance	Mitigation but at least part of site should be retained
Generally Protected A (GPA)	GPA	High/ Medium Significance	Mitigation before destruction
Generally Protected B (GPB)	GPB	Medium Significance	Recording before destruction
Generally Protected C (GPC)	GPC	Low Significance	Destruction

5.1. Description of located sites

Sites:

5.1.1. Site GJS 1.

Location: See Appendix B and D (fig. 1-4).

Description: Site GJS 1 consists of two engraved, flat slate stones lying on a prominent elevated, small plateau located south of the N4 freeway from where it overlooks the Schoemanskloof Valley. It is a strategic vantage point which may have been used during the South African War 1899-1902 (Anglo Boer War) by either Boer or Brit to monitor enemy activity. The stone on the eastern side mostly has random non-descript incisions/ engravings which was possibly made by someone whiling away time during look-out duty. The second stone, located a few meters to the West may represent the headstone of a grave as evidenced by the inscriptions on it. The inscriptions were made in two different fonts. One of which reads: “J H Joubert ZAR C 1883 – 1901”. This may suggest that the stone represents a headstone of a grave. The capitals “L J R” are inscribed above the aforementioned inscription in triangular fashion and in a different, reminiscent of the current Times New Roman, font. It is uncertain what these capitals represent, further research is needed.

Impact of the proposed development/ activity:

The site will not be impacted upon as it is located outside of and far to the south of the proposed project area.

Recommendation:

The site is archaeologically and historically significant and regarded as being of high significance (LS 3A, see tables 5.1 & 5.2.) and protected by heritage legislation. It is recommended that no future impact be made on the site as a result of any activity.

Site GJS 1 view north-west.

Survey orientations:

5.1.2. Site SO 1.

Location: See Appendix B and D (fig. 5).

Description: Survey orientation location.

Impact of the proposed development/ activity: N/A

Recommendation: N/A


Photo east

5.1.3. Site SO 2.

Location: See Appendix B and D (fig. 6).

Description: Survey orientation location.

Impact of the proposed development/ activity: N/A

Recommendation: N/A


Photo south-east

5.1.4. Site SO 3.

Location: See Appendix B and D (fig.7).

Description: Survey orientation location.

Impact of the proposed development/ activity: N/A

Recommendation: N/A


Photo north-east

5.1.5. Site SO 4.

Location: See Appendix B and D (fig.8).

Description: Survey orientation location.

Impact of the proposed development/ activity: N/A

Recommendation: N/A


Photo south

5.1.6. Site SO 5.

Location: See Appendix B and D (fig.9).

Description: Survey orientation location.

Impact of the proposed development/ activity: N/A

Recommendation: N/A

Photo east

TABLE 5.3. General description of located sites and field rating.

Site No.	Description	Type of significance	Degree of significance	NHRA heritage resource & rating
GJS 1	Historic grave	Archaeological sites	Archaeological: High Historic: Fair	Archaeology (Sect. 35). High. **LS 3A**
SO1	Survey orientation location	N/A	Archaeological: N/A Historic: N/A	None
SO2	Survey orientation location	N/A	Archaeological: N/A Historic: N/A	None
SO3	Survey orientation location	N/A	Archaeological: N/A Historic: N/A	None
SO4	Survey orientation location	N/A	Archaeological: N/A Historic: N/A	None
SO5	Survey orientation location	N/A	Archaeological: N/A Historic: N/A	None

TABLE 5.4. Site condition assessment and management recommendations.

Site no.	Type of Heritage resource	Integrity of cultural material	Preservation condition of site	Relative location	Quality of archaeological/ historic material	Quantity of site features	Recommended conservation management
GJS 1	Archaeology/ Historic Grave site	Poor-fair	Poor	Geluk 299 JT	Archaeology: Fair Historically: Fair	1	Avoid if possible & monitor any activities. Permitting in case of destruction
SO 1	N/A	N/A	N/A	Bruintjieslaagte 465 JT; Geluk 299 JT; Koedoeshoek 301 JT	Archaeology: N/A Historically: N/A	-	N/A
SO 2	N/A	N/A	N/A	Bruintjieslaagte 465 JT; Geluk 299 JT; Koedoeshoek 301 JT	Archaeology: N/A Historically: N/A	-	N/A
SO 3	N/A	N/A	N/A	Bruintjieslaagte 465 JT; Geluk 299 JT; Koedoeshoek 301 JT	Archaeology: N/A Historically: N/A	-	N/A
SO 4	N/A	N/A	N/A	Bruintjieslaagte 465 JT; Geluk 299 JT; Koedoeshoek 301 JT	Archaeology: N/A Historically: N/A	-	N/A
SO 5	N/A	N/A	N/A	Bruintjieslaagte 465 JT; Geluk 299 JT; Koedoeshoek 301 JT	Archaeology: N/A Historically: N/A	-	N/A

TABLE 5.5. Significance Rating Scales of Impact

Site No.	Nature of impact	Type of site	Extent	Duration	Intensity	Probability	Score total
GJS 1	None – not located within the project footprint	Historic Grave, Archaeology	Site	N/A	N/A	N/A	-
SO 1	Vegetation clearing	N/A	N/A	Short term	Low	Improbable	2
SO 2	Vegetation clearing	N/A	N/A	Short term	Low	Improbable	2
SO 3	Vegetation clearing	N/A	N/A	Short term	Low	Improbable	2
SO 4	Vegetation clearing	N/A	N/A	Short term	Low	Improbable	2
SO 5	Vegetation clearing	N/A	N/A	Short term	Low	Improbable	2

***Notes:** Short term ≥ 5 years, Medium term 5-15 years, Long term 15-30 years, Permanent 30+ years

Intensity: Very High (4), High (3), Moderate (2), Low (1)

Probability: Improbable (1), Possible (2), Highly probable (3), Definite (4)

TABLE 5.6. Site current status and future impact scores

Site No.	Current Status	Low impact (4-6 points)	Medium impact (7-9 points)	High impact (10-12 points)	Very high impact (13-16 points)	Score Total
GJS 1	Neutral	-	-	-	-	-
SO 1	Neutral	-	-	-	-	-
SO 2	Neutral	-	-	-	-	-
SO 3	Neutral	-	-	-	-	-
SO 4	Neutral	-	-	-	-	-
SO 5	Neutral	-	-	-	-	-

5.2. Cumulative impacts on the heritage landscape

Cumulative impacts can occur when a range of impacts which result from several concurrent processes have impact on heritage resources. The importance of addressing cumulative impacts is that the total impact of several factors together is often greater than one single process or activity that may impact on heritage resources. The single grave site which was recorded (GJS 1) is located to the south and across the N4 from the proposed project footprint. It will not be affected by the proposed agricultural development. Care should however be taken to avoid any future impacts at this location. In terms of the proposed activity within the project footprint area, in the event that any archaeological or skeletal remains are encountered or exposed, all activity should be halted immediately and an archaeologist contacted to intervene and assess the impact.

6. Summary of findings and recommendations

A site which may represent the grave of an individual was located outside of and to the north of the study area. This site was named GJS 1 and consists of an engraved slate stone located on an elevated hill overlooking the Schoemanskloof. It has inscriptions on it made in two different fonts. One of which reads: “J H Joubert ZAR C 1883 – 1901. This may suggest that the stone represents a headstone of a grave. The capitals L J R are inscribed above the aforementioned inscription in triangular fashion and in a different, reminiscent of the current Times New Roman, font. It is uncertain what these capitals represent, further research is needed.

In terms of section 34 of the National Heritage Resources Act (NHRA, 25 of 1999), no significant buildings or structures were located.

In terms of section 35 of the NHRA, no archaeological sites were located.

In terms of section 36 of the NHRA, one gravesite was located. It is however located outside of the proposed development area. Due to vegetation cover in the study area it is possible that some unmarked graves may have been overlooked during the survey.

A total of five survey orientation locations were documented (SO 1-5) which includes a GPS location and photographs of the landscape at that particular location. It is not within the expertise of this report or the surveyor to comment on possible palaeontological remains which may be located in the study area.

The bulk of archaeological remains are normally located beneath the soil surface. It is therefore possible that some significant cultural material or remains were not located during this survey and will only be revealed when the soil is disturbed. Should excavation or large scale earth moving activities reveal any human skeletal remains, broken pieces of ceramic pottery, large quantities of sub-surface charcoal or any material that can be associated with previous occupation, a qualified archaeologist should be notified immediately. This will also temporarily halt such activities until an archaeologist has assessed the situation and made remedial recommendations. It should be noted that if such a situation occurs it may have further financial implications.

6.1. Recommended management measures

Monitoring programmes which should be followed when a “chance find” of a heritage object or human remains occur, include the following:

- The contractors and workers should be notified that archaeological sites might be exposed during the construction work.

- Should any heritage artefacts be exposed during excavation, work on the area where the artefacts were discovered, shall cease immediately and the Environmental Control Officer shall be notified as soon as possible;
- All discoveries shall be reported immediately to an archaeologist or museum, preferably one at which an archaeologist is available, so that an investigation and evaluation of the finds can be made. Acting upon advice from these specialists, the Environmental Control Officer will advise the necessary actions to be taken;
- Under no circumstances shall any artefacts be removed, destroyed or interfered with by anyone on the site; and
- Contractors and workers shall be advised of the penalties associated with the unlawful removal of cultural, historical, archaeological or palaeontological artefacts, as set out in the National Heritage Resources Act (Act No. 25 of 1999).

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Appendix A

Terminology

"Alter" means any action affecting the structure, appearance or physical properties of a place or object, whether by way of structural or other works, by painting, plastering or other decoration or any other means.

"Archaeological" means –

- Material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artifacts, human and hominid remains and artificial features or structures;
- Rock Art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation;
- Wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the Republic, as defined respectively in sections 3, 4 and 6 of the Maritime Zones Act, 1994 (Act No. 15 of 1994), and any cargo, debris or artifacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation; and
- Features, structures and artefacts associated with military history which are older than 75 years and the sites on which they are found;

"Conservation", in relation to heritage resources, includes protection, maintenance, preservation and sustainable use of places or objects so as to safeguard their cultural significance;

"Cultural significance" means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance;

"Development" means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of a heritage authority in any way result in a change to the nature, appearance or physical nature of a place, or influence its stability and future well-being, including –

- construction, alteration, demolition, removal or change of use of a place or a structure at a place;
- carrying out any works on or over or under a place;

- subdivision or consolidation of land comprising, a place, including the structures or airspace of a place;
- constructing or putting up for display signs or hoardings;
- any change to the natural or existing condition or topography of land; and
- any removal or destruction of trees, or removal of vegetation or topsoil;

“Expropriate” means the process as determined by the terms of and according to procedures described in the Expropriation Act, 1975 (Act No. 63 of 1975);

“Foreign cultural property”, in relation to a reciprocating state, means any object that is specifically designated by that state as being of importance for archaeology, history, literature, art or science;

“Grave” means a place of internment and includes the contents, headstone or other marker of such a place, and any other structure on or associated with such place;

“Heritage resource” means any place or object of cultural significance;

“Heritage register” means a list of heritage resources in a province;

“Heritage resources authority” means the South African Heritage Resources Agency, established in terms of section 11, or, insofar as this Act (25 of 1999) is applicable in or in respect of a province, a provincial heritage resources authority (PHRA);

“Heritage site” means a place declared to be a national heritage site by SAHRA or a place declared to be a provincial heritage site by a provincial heritage resources authority;

“Improvement” in relation to heritage resources, includes the repair, restoration and rehabilitation of a place protected in terms of this Act (25 of 1999);

“Land” includes land covered by water and the air space above the land;

“Living heritage” means the intangible aspects of inherited culture, and may include –

- cultural tradition;
- oral history;
- performance;
- ritual;
- popular memory;
- skills and techniques;
- indigenous knowledge systems; and
- the holistic approach to nature, society and social relationships;

“Management” in relation to heritage resources, includes the conservation, presentation and improvement of a place protected in terms of the Act;

“Object” means any moveable property of cultural significance which may be protected in terms of any provisions of the Act, including –

- any archaeological artifact;
- palaeontological and rare geological specimens;
- meteorites;
- other objects referred to in section 3 of the Act;

“Owner” includes the owner’s authorized agent and any person with a real interest in the property and –

- in the case of a place owned by the State or State-aided institutions, the Minister or any other person or body of persons responsible for the care, management or control of that place;
- in the case of tribal trust land, the recognized traditional authority;

“Place” includes –

- a site, area or region;
- a building or other structure which may include equipment, furniture, fittings and articles associated with or connected with such building or other structure;
- a group of buildings or other structures which may include equipment, furniture, fittings and articles associated with or connected with such group of buildings or other structures;
- an open space, including a public square, street or park; and
- in relation to the management of a place, includes the immediate surroundings of a place;

“SAHRA” is an abbreviation for the South African Heritage Resources Agency.

“Site” means any area of land, including land covered by water, and including any structures or objects thereon;

“**Structure”** means any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith.

Appendix B

List of sites

One site was recorded during the survey and named GJS 1. A total of five survey orientation sites were recorded. The sites were named SO 1-5.

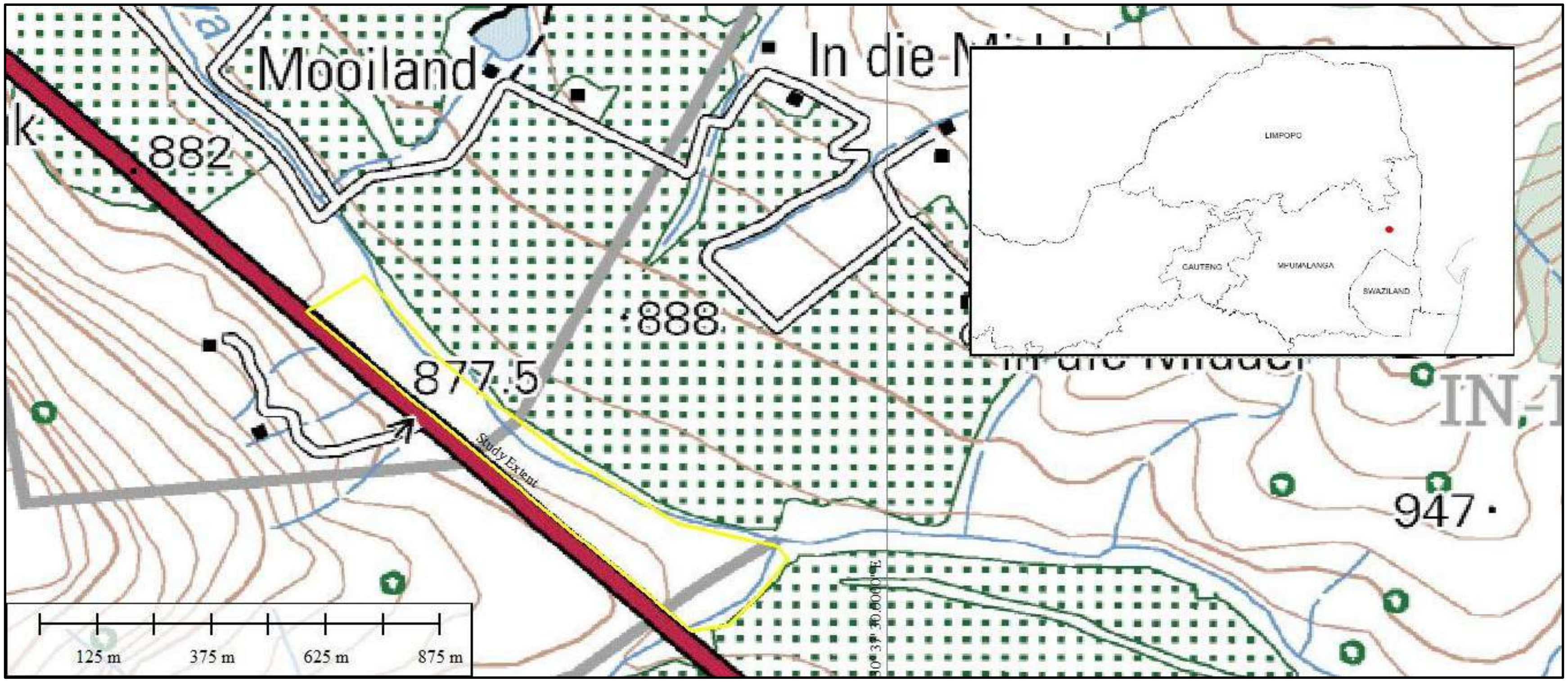
Table A. Located sites.

Site Name	Date of compilation	GPS Coordinates		Photo figure No.
GJS 1	15/02/2021	S25,400743	E030,613370	1-4

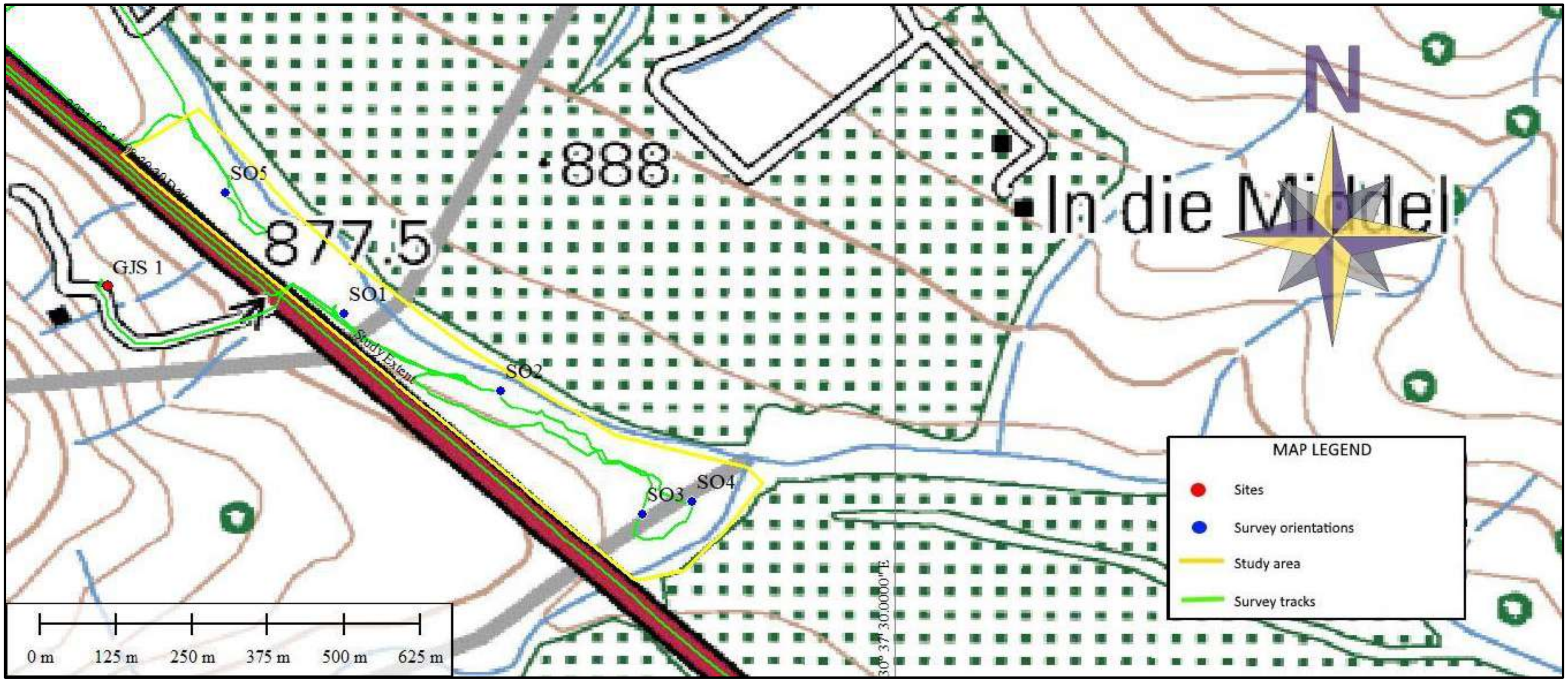
Table B. Survey Orientation Locations.

Site Name	Date of compilation	GPS Coordinates		Photo figure No.
SO 1	15/02/2021	S25,401151	E030,616862	5
SO 2	15/02/2021	S25,402292	E030,619175	6
SO 3	15/02/2021	S25,404116	E030,621267	7
SO 4	15/02/2021	S25,403918	E030,622015	8
SO 5	15/02/2021	S25,399375	E030,615121	9

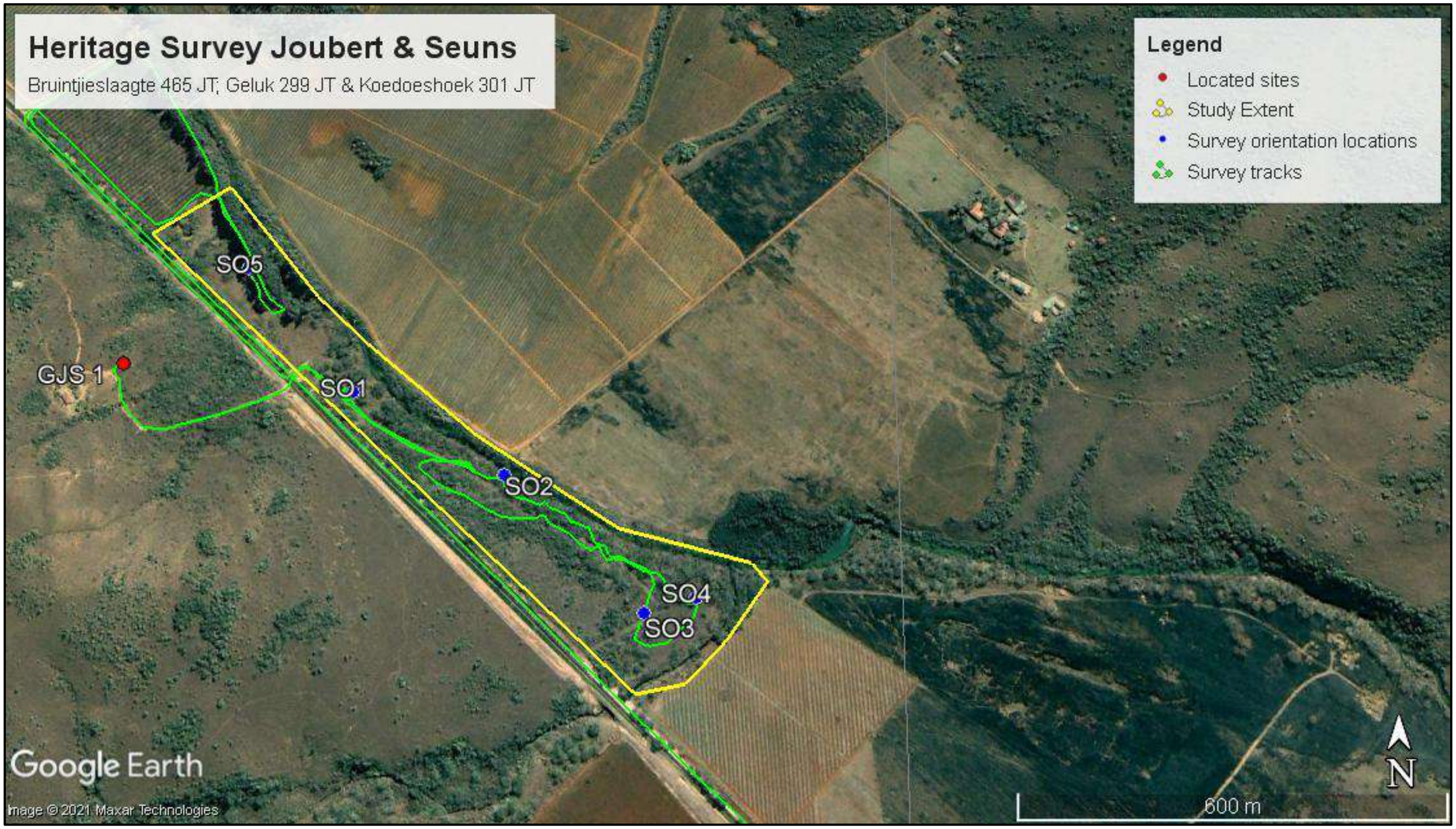
Appendix C



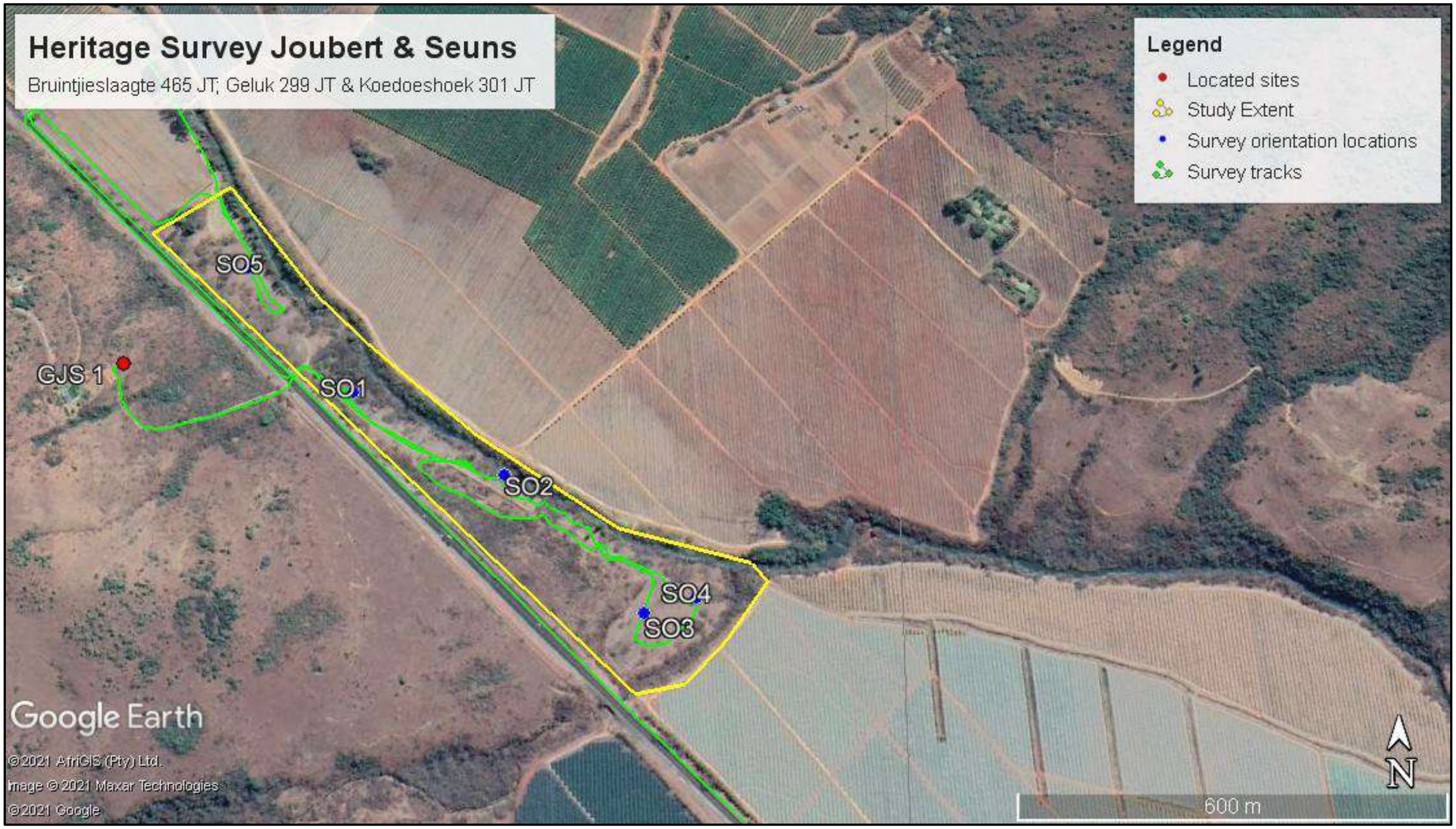
Regional Map, 1:50 000 Topographical Map 2530 BC (2010)



1:50 000 Topographical Map 2530 BC (2010)



Aerial image (Google Earth, 2003)



Aerial image (Google Earth, 2020)

Appendix D

Site Photos

Fig. 1. Site GJS 1. A general view of the site. Photo taken north-west.

Fig. 2. Site GJS 1. A flat slate stone with random inscribed lines which may have been made by somebody whiling away time while keeping a lookout for enemy forces during the Anglo Boer War.

Fig. 3. Site GJS 1. The second inscribed stone which may represent the headstone of a grave. The inscriptions were made in two different fonts. One of which reads: *"J H Joubert ZAR C 1883 – 1901".* This may suggest that the stone represents a headstone of a grave. The capitals *"L J R"* are inscribed above the aforementioned inscription in triangular fashion and in a different, reminiscent of the current Times New Roman, font. It is uncertain what these capitals represent, further research is needed.

Fig. 4. Site GJS 1. A general view towards the north-west from the location of the inscribed grave stone.

Survey Orientation Photos

Fig. 5. Site SO1. Photo taken in a north-western direction.

Fig. 6. Site SO2. Photo taken in a north-western direction only a few meters from the Crocodile River.

Fig. 7. Site SO3. Photo taken in a north-western direction.

Fig. 8. Site SO 4. Photo taken in a southern direction.

Fig. 9. Site SO 5. Photo taken in an eastern direction.

Annexure D: Palaeontological Report

Palaeontological Impact Assessment for the proposed clearing of indigenous vegetation for agriculture on Farms Geluk 299 and Koedoeshoek 301, near Schoemanskloof, Mpumalanga Province

Desktop Study (Phase 1)

For

Henwood Environmental Solutions

23 January 2021

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The Palaeontologist Consultant: Prof Marion Bamford
Qualifications: PhD (Wits Univ, 1990); FRSSAf, ASSAf
Experience: 32 years research; 24 years PIA studies

Declaration of Independence

This report has been compiled by Professor Marion Bamford, of the University of the Witwatersrand, sub-contracted by Henwood Environmental Solutions, Mbombela, South Africa. The views expressed in this report are entirely those of the author and no other interest was displayed during the decision making process for the Project.

Specialist: Prof Marion Bamford

Signature: 

Executive Summary

A palaeontological Impact Assessment was requested for the proposed clearing of indigenous vegetation for agriculture on Farm Geluk 199 and Koedoeshoek 301, about 6km ESE of Schoemanskloof, Mpumalanga Province. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development.

The proposed site lies predominantly on non-fossiliferous Quaternary alluvium and sand but the south western border lies on mudstones and quartzites of the Timeball Hill Formation (Pretoria Group, Transvaal Supergroup) that has been indicated as highly sensitive on the SAHRIS map. From the geological record and publications there is no evidence that this formation is fossiliferous because these rocks are too old for body fossils and of the wrong kind to preserve microfossils. Based on this information it is recommended that no palaeontological site visit is required and, as far as the palaeontology is concerned, the project may continue.

Table of Contents

1. Background

The owner of the adjacent farm properties, Geluk 199 and Koedoesoek 301 situated about 6km east southeast of Schoemanskloof, and on the northern side of the N4 highway, Mpumalanga Province, proposed to clear the indigenous vegetation in order to develop the land for agriculture.

A palaeontological Impact Assessment was requested for this project. To comply with the South African Heritage Resources Agency (SAHRA) in terms of Section 38(8) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), a desktop Palaeontological Impact Assessment (PIA) was completed for the proposed development and is reported herein.

Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (amended 2017)

	A specialist report prepared in terms of the Environmental Impact Regulations of 2017 must contain:	**Relevant section in report**
ai	Details of the specialist who prepared the report	Appendix B
aii	The expertise of that person to compile a specialist report including a curriculum vitae	Appendix B
b	A declaration that the person is independent in a form as may be specified by the competent authority	Page 1
c	An indication of the scope of, and the purpose for which, the report was prepared	Section 1
ci	An indication of the quality and age of the base data used for the specialist report: SAHRIS palaeosensitivity map accessed – date of this report	Yes
cii	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5
d	The date and season of the site investigation and the relevance of the season to the outcome of the assessment	N/A
e	A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 2
f	The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Section 4
g	An identification of any areas to be avoided, including buffers	N/A
h	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 5
j	A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 4

k	Any mitigation measures for inclusion in the EMPr	Section 7, Appendix A
l	Any conditions for inclusion in the environmental authorisation	N/A
m	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 7, Appendix A
ni	A reasoned opinion as to whether the proposed activity or portions thereof should be authorised	N/A
nii	If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	N/A
o	A description of any consultation process that was undertaken during the course of carrying out the study	N/A
p	A summary and copies if any comments that were received during any consultation process	N/A
q	Any other information requested by the competent authority.	N/A

Figure 1: Google Earth map of the sections on Farms Geluk and Koedoeshoek for the proposed clearing of natural vegetation for agricultural development is indicated by the white polygon. Map supplied by HES.

2. Methods and Terms of Reference

The Terms of Reference (ToR) for this study were to undertake a PIA and provide feasible management measures to comply with the requirements of SAHRA.
The methods employed to address the ToR included:

1. Consultation of geological maps, literature, palaeontological databases, published and unpublished records to determine the likelihood of fossils occurring in the affected areas. Sources included records housed at the Evolutionary Studies Institute at the University of the Witwatersrand and SAHRA databases;
2. Where necessary, site visits by a qualified palaeontologist to locate any fossils and assess their importance (*not applicable to this assessment*);
3. Where appropriate, collection of unique or rare fossils with the necessary permits for storage and curation at an appropriate facility (*not applicable to this assessment*); and
4. Determination of fossils' representivity or scientific importance to decide if the fossils can be destroyed or a representative sample collected (*not applicable to this assessment*).

3. Geology and Palaeontology

i. Project location and geological context

The site is in the north eastern part of the Transvaal Basin (Figure 2, Table 2). The Late Archaean to early Proterozoic Transvaal Supergroup is preserved in three structural basins on the Kaapvaal Craton (Eriksson et al., 2006). In South Africa are the Transvaal and Griqualand West Basins, and the Kanye Basin is in southern Botswana. The Griqualand West Basin is divided into the Ghaap Plateau sub-basin and the Prieska sub-basin. Sediments in the lower parts of the basins are very similar but they differ somewhat higher up the sequences. Several tectonic events have greatly deformed the south western portion of the Griqualand West Basin between the two sub-basins.

The Transvaal Supergroup comprises one of world's earliest carbonate platform successions (Beukes, 1987; Eriksson et al., 2006; Zeh et al., 2020). In some areas there are well preserved stromatolites that are evidence of the photosynthetic activity of blue green bacteria and green algae. These microbes formed colonies in warm, shallow seas.

In the Transvaal Basin the Transvaal Supergroup is divided into two Groups, the lower Chuniespoort Group and the upper Pretoria Group (with ten formations; Eriksson et al., 2006). The Chuniespoort Group is divided into the basal Malmani Subgroup that comprises dolomites and limestones and is divided into five formations based on chert content, stromatolitic morphology, intercalated shales and erosion surfaces. The top of the Chuniespoort Group has the Penge Formation and the Duitschland Formation.

In the lower part of the Pretoria Group formations, from the base to the top are the Rooihoogte, Timeball Hill, Boshoek, Hekpoort, Dwaalheuwel, Strubenkop, Daspoort, Silverton and Magaliesberg Formations. There are five formations in the upper Pretoria Group.

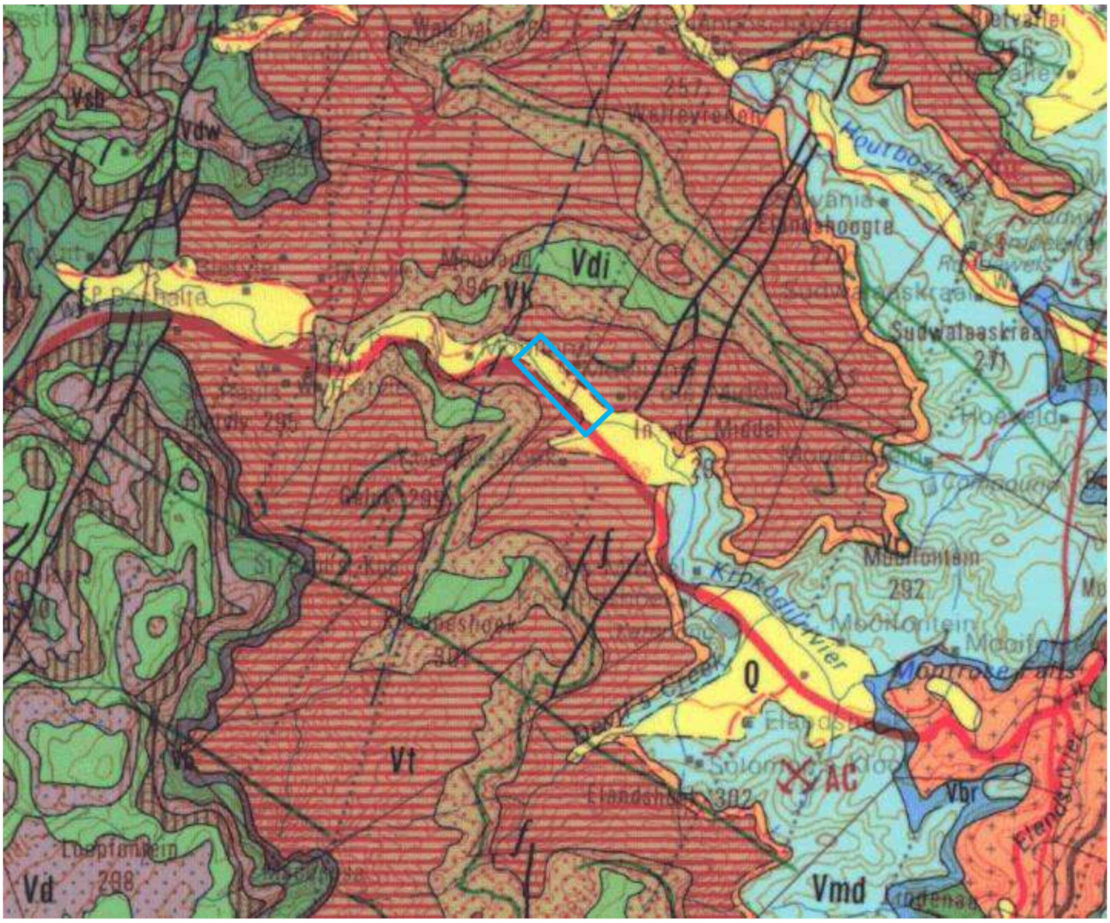

Figure 2: Geological map of the area around the farms Geluk and Koedoeshoek. The location of the proposed project is indicated within the turquoise rectangle. Abbreviations of the rock types are explained in Table 2. Map enlarged from the Geological Survey 1: 250 000 map 2530 Barberton.

Table 2: Explanation of symbols for the geological map and approximate ages (Bekker et al., 2004; Eriksson et al., 2004; Hannah et al., 2006; Rasmussen et al., 2013). SG = Supergroup; Fm = Formation; Ma = million years; grey shading = formations impacted by the project.

Symbol	Group/Formation	Lithology	Approximate Age
Q	Quaternary	Alluvium, sand, calcrete	Neogene, ca 2.5 Ma to present
Vdi	Diabase	Extrusive volcanic dolerite or diabase	Post Transvaal SG
Vt	Timeball Hill Fm Pretoria Group, Transvaal SG	Mudrocks, quartzite, shales	2322-2266 Ma
Vmd	Malmani Subgroup, Chuniespoort Group, Transvaal SG	Dolomite, chert	Ca 2585- 2480 Ma
Vbr	Black Reef Fm, Transvaal SG	Quartzite, conglomerate, shale, basalt	>2585 Ma

The Transvaal sequence has been interpreted as three major cycles of basin infill and tectonic activity with the first deep basin sediments forming the Chuniespoort Group, the second cycle deposited the lower Pretoria Group, and the sediments in this area are from the interim lowstand that preceded the third cycle. These sediments were deposited in shallow lacustrine, alluvial fan and braided stream environments (Eriksson et al., 2012). The third cycle is represented by the upper part of the Pretoria Group (not represented here).

Overlying the Rooihoogte Formation is the Timeball Hill Formation which is composed of thick shales and subordinate sandstones that were deposited in a fluvio-deltaic basin-filling sequence (Eriksson et al., 2006). A number of facies are included in this formation. At the base is black shale facies associated with subsurface lavas and pyroclastic rocks of the Bushy Bend Lava Member. Above these are rhythmically interbedded mudstones/siltstones and fine-grained sandstones that have been interpreted as turbidite deposits (Eriksson et al., 2006). These fine-grained sediments grade up into the medial Klapperkop Quartzite Member that has been interpreted as fluvio-deltaic sandstones which fed the more distal turbidites (ibid). Above this is an upper shale member and rhythmite facies. In the east of the Transvaal Basin the Upper Timeball Hill shales have undergone extensive soft-sediment deformation caused by the onset of tectonic instability that led to the eventual fan deposits of the Boshoek Formation and the flood basalts of the Hekpoort Formation (ibid).

Considerably younger sediments have been deposited along the river courses, in this case they are Quaternary sands and alluvium (Figure 2).

ii. Palaeontological context

The palaeontological sensitivity of the area under consideration is presented in Figure 3. The site for development is predominantly in the Quaternary sands and alluvium. Because these are products of natural weathering and have been transported, they are of no palaeontological significance. Along the southern margin are exposures of the underlying Timeball Hill Formation (Figures 2, 3) that have a high palaeontological sensitivity.

The age of the lower Timeball Hill Formation is constrained at 2322–2316 Ma by Re–Os pyrite geochronology from black shales at its base (Figure 2; Bekker et al., 2004; Hannah et al., 2004). Tuff beds in the upper Timeball Hill Formation gave U–Pb ages of 2256 ± 6 to 2266 ± 4 Ma (Fig. 2; Rasmussen et al., 2013). The Timeball Hill Formation represents deltaic deposition in an intracratonic basin, with clastics sourced from the east to northeast (Coetzee et al., 2006). There are no records of fossils in the Timeball Hill Formation (Eriksson et al., 2006, 2012). The age of the sediments precedes the evolution of body fossils (Plumstead, 1969; Benton, 2005) so only micro-organisms would have evolved. Deepwater, turbidite and tuff beds are not settings that are conducive to the preservation of fossils, particularly small and fragile fossils. The SAHRIS interpretation, based on the Palaeotechnical report of Mpumalanga (Groenewald et al., 2014), is incorrect.

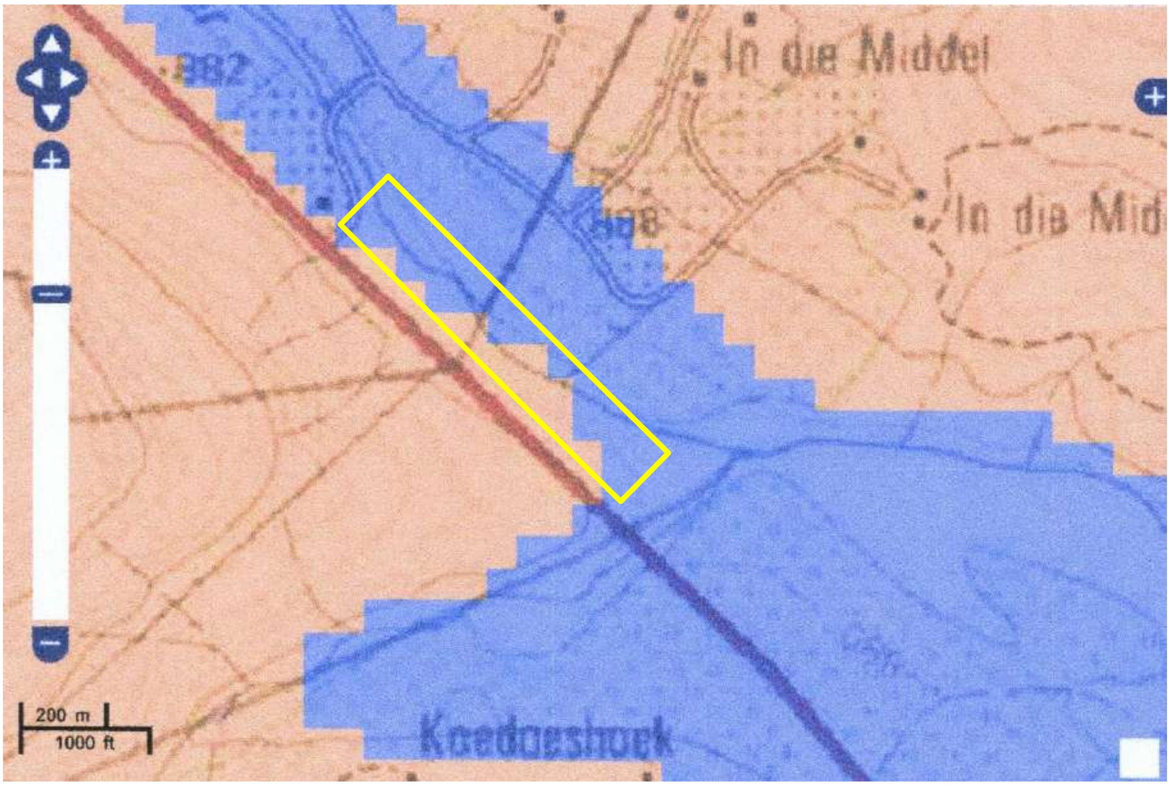

Figure 3: SAHRIS palaeosensitivity map for the site for the proposed clearing of vegetation shown within the yellow rectangle. Background colours indicate the following degrees of sensitivity: red = very highly sensitive; orange/yellow = high; green = moderate; blue = low; grey = insignificant/zero.

From the SAHRIS map above the marginal area, the Timeball Hill Formation, is indicated as highly sensitive (orange) so a desktop study was completed. Most of the area is indicated as low sensitivity (blue) for the Quaternary sands and alluvium, and this is correct.

4. Impact assessment

An assessment of the potential impacts to possible palaeontological resources considers the criteria encapsulated in Table 3:

TABLE 3A: CRITERIA FOR ASSESSING IMPACTS

PART A: DEFINITION AND CRITERIA		
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.

	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national
PROBABILITY (of exposure to impacts)	**H**	Definite/ Continuous
	M	Possible/ frequent
	L	Unlikely/ seldom

TABLE 3B: IMPACT ASSESSMENT

PART B: ASSESSMENT		
SEVERITY/NATURE	**H**	-
	M	-
	L	Ancient deepwater mudrocks and quartzites do not preserve fossils; so far there are no records from the Timeball Hill Fm of any microfossils so it is very unlikely that fossils occur on the site. The impact would be very unlikely.
	L+	-
	M+	-
	H+	-
DURATION	**L**	-
	M	-
	H	Where manifest, the impact will be permanent.
SPATIAL SCALE	**L**	Since only the possible fossils within the area could be microfossils (stromatolites) in the dolomites of other formations, the spatial scale will be localised within the site boundary.
	M	-
	H	-
PROBABILITY	**H**	**-**
	M	**-**
	L	It is extremely unlikely that any fossils would be found in the Quaternary loose sand or in the non-fossiliferous Timeball Hill Fm.

Based on the nature of the project, surface activities may impact upon the fossil heritage if preserved in the development footprint. The geological structures suggest that the rocks are either much too old to contain body fossils and of the wrong kind of deposit (Timeball Hill Formation), or too young and transported (Quaternary). Taking account of the defined criteria, the potential impact to fossil heritage resources is extremely low.

5. Assumptions and uncertainties

Based on the geology of the area and the palaeontological record as we know it, it can be assumed that the formation and layout of the dolomites, sandstones, shales and sands are typical for the country and do not contain fossil plant, insect, invertebrate and vertebrate material. The sands of the Quaternary period would not preserve fossils. The Timeball Hill

Formation is incorrectly indicated as being potentially fossiliferous because the rocks are too old and represent deepwater, turbidite or tuff fall environments

6. Recommendation

Based on experience and the lack of any previously recorded fossils from the area, it is extremely unlikely that any fossils would be preserved in the Quaternary sands and alluvium or in the Timeball Hill Formation deepwater mudrocks or quartzites. The Mpumalanga Palaeotechnical Report is incorrect and forms the basis of the SAHRIS Palaeosensitivity map and should be corrected. Since there is no chance of finding fossils in the project footprint, it is recommended that proposed clearing of vegetation for agriculture may proceed – as far as the palaeontology is concerned.

7. References

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Eriksson, P.G., Bartman, R., Catuneanu, O., Mazumder, R., Lenhardt, N., 2012. A case study of microbial mats-related features in coastal epeiric sandstones from the Palaeoproterozoic Pretoria Group, Transvaal Supergroup, Kaapvaal craton, South Africa; the effect of preservation (reflecting sequence stratigraphic models) on the relationship between mat features and inferred palaeoenvironment. Sedimentary Geology 263, 67-75.

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Appendix B – Details of specialist

Curriculum vitae (short) - Marion Bamford PhD
January 2021

I) Personal details

Surname	:	**Bamford**
First names	:	**Marion Kathleen**
Present employment	:	Professor; Director of the Evolutionary Studies Institute. Member Management Committee of the NRF/DST Centre of Excellence Palaeosciences, University of the Witwatersrand, Johannesburg, South Africa-
Telephone	:	+27 11 717 6690
Fax	:	+27 11 717 6694
Cell	:	082 555 6937
E-mail	:	marion.bamford@wits.ac.za ; marionbamford12@gmail.com

ii) Academic qualifications
Tertiary Education: All at the University of the Witwatersrand:
1980-1982: BSc, majors in Botany and Microbiology. Graduated April 1983.
1983: BSc Honours, Botany and Palaeobotany. Graduated April 1984.
1984-1986: MSc in Palaeobotany. Graduated with Distinction, November 1986.
1986-1989: PhD in Palaeobotany. Graduated in June 1990.

iii) Professional qualifications
Wood Anatomy Training (overseas as nothing was available in South Africa):
1994 - Service d'Anatomie des Bois, Musée Royal de l'Afrique Centrale, Tervuren, Belgium, by Roger Dechamps
1997 - Université Pierre et Marie Curie, Paris, France, by Dr Jean-Claude Koeniguer
1997 - Université Claude Bernard, Lyon, France by Prof Georges Barale, Dr Jean-Pierre Gros, and Dr Marc Philippe

iv) Membership of professional bodies/associations
Palaeontological Society of Southern Africa
Royal Society of Southern Africa - Fellow: 2006 onwards
Academy of Sciences of South Africa - Member: Oct 2014 onwards
International Association of Wood Anatomists - First enrolled: January 1991
International Organization of Palaeobotany – 1993+
Botanical Society of South Africa
South African Committee on Stratigraphy – Biostratigraphy - 1997 - 2016
SASQUA (South African Society for Quaternary Research) – 1997+
PAGES - 2008 –onwards: South African representative
ROCEEH / WAVE – 2008+
INQUA – PALCOMM – 2011+onwards

vii) Supervision of Higher Degrees
All at Wits University

Degree	Graduated/completed	Current
Honours	11	0
Masters	10	4
PhD	11	4
Postdoctoral fellows	10	5

viii) Undergraduate teaching
Geology II – Palaeobotany GEOL2008 – average 65 students per year
Biology III – Palaeobotany APES3029 – average 25 students per year
Honours – Evolution of Terrestrial Ecosystems; African Plio-Pleistocene Palaeoecology; Micropalaeontology – average 2-8 students per year.

ix) Editing and reviewing
Editor: Palaeontologia africana: 2003 to 2013; 2014 – Assistant editor
Guest Editor: Quaternary International: 2005 volume
Member of Board of Review: Review of Palaeobotany and Palynology: 2010 –

Review of manuscripts for ISI-listed journals: 25 local and international journals

x) Palaeontological Impact Assessments

Selected – list not complete:

- Thukela Biosphere Conservancy 1996; 2002 for DWAF
- Vioolsdrift 2007 for Xibula Exploration
- Rietfontein 2009 for Zitholele Consulting
- Bloeddrift-Baken 2010 for TransHex
- New Kleinfontein Gold Mine 2012 for Prime Resources (Pty) Ltd.
- Thabazimbi Iron Cave 2012 for Professional Grave Solutions (Pty) Ltd
- Delmas 2013 for Jones and Wagener
- Klipfontein 2013 for Jones and Wagener
- Platinum mine 2013 for Lonmin
- Syferfontein 2014 for Digby Wells
- Canyon Springs 2014 for Prime Resources
- Kimberley Eskom 2014 for Landscape Dynamics
- Yzermyne 2014 for Digby Wells
- Matimba 2015 for Royal HaskoningDV
- Commissiekraal 2015 for SLR
- Harmony PV 2015 for Savannah Environmental
- Glencore-Tweefontein 2015 for Digby Wells
- Umkomazi 2015 for JLB Consulting
- Ixia coal 2016 for Digby Wells
- Lambda Eskom for Digby Wells
- Alexander Scoping for SLR
- Perseus-Kronos-Aries Eskom 2016 for NGT
- Mala Mala 2017 for Henwood
- Modimolle 2017 for Green Vision
- Klipoortjie and Finaalspan 2017 for Delta BEC
- Ledjadja borrow pits 2018 for Digby Wells
- Lungile poultry farm 2018 for CTS
- Olienhout Dam 2018 for JP Celliers
- Isondlo and Kwasobabili 2018 for GCS
- Kanakies Gypsum 2018 for Cabanga
- Nababeep Copper mine 2018
- Glencore-Mbali pipeline 2018 for Digby Wells
- Remhoogte PR 2019 for A&HAS
- Bospoort Agriculture 2019 for Kudzala
- Overlooked Quarry 2019 for Cabanga
- Richards Bay Powerline 2019 for NGT
- Eilandia dam 2019 for ACO
- Eastlands Residential 2019 for HCAC

- Fairview MR 2019 for Cabanga
- Graspan project 2019 for HCAC
- Lieliefontein N&D 2019 for EnviroPro
- Skeerpoort Farm Mast 2020 for HCAC
- Vulindlela Eco village 2020 for 1World
- KwaZamakhule Township 2020 for Kudzala
- Sunset Copper 2020 for Digby Wells
- McCarthy-Salene 2020 for Prescali
- VLNR Lodge 2020 for HCAC
- Madadeni mixed use 2020 for EnviroPro

xi) Research Output

Publications by M K Bamford up to December 2019 peer-reviewed journals or scholarly books: over 150 articles published; 5 submitted/in press; 10 book chapters.
Scopus h-index = 29; Google scholar h-index = 35; -i10-index = 92
Conferences: numerous presentations at local and international conferences.

xii) NRF Rating

NRF Rating: B-2 (2016-2020)
NRF Rating: B-3 (2010-2015)
NRF Rating: B-3 (2005-2009)
NRF Rating: C-2 (1999-2004)

Annexure F:Soil Sample

Grondontledingsverslag:
Mehlich
Job: CT21-03296
Plaas: groblersdal
Order: 242044A JS
Date: 15-04-2021

Lab No	Verwysings no	pH (H2O)	P Mehlich	K	Na	Ca	Mg	UIT H+	%Ca	%Mg	%K	%Na	SUUR.V	Ca:Mg	(Ca+Mg)/K	Mg:K	S-Waarde	Na:K	CEC	Digtheid	Fe	Mn	Cu	Zn	S	B	C	OM	TCEC	P (Bray1)	Weerstand	NH4-N	NO3-N
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	%	%	%	%	%	1.5 - 4.5	10.0 - 20.0	3.0 - 4.0	cmol(+)/kg			g/cm3	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%		mg/kg	ohm	mg/kg	mg/kg
CT21-03296.001	BLOK 1	5.0	10	196	26	1099	312	0.35	61.0	28.3	5.6	1.2	3.9	2.2	16.1	5.1	8.7	0.2	9.01	1.026	286.0	14.6	4.54	3.47	135.7	0.40	0	0		7			
CT21-03296.002	BLOK 2	5.6	5	107	17	1681	431	0.03	68.3	28.7	2.2	0.6	0.2	2.4	43.7	12.9	12.3	0.3	12.31	0.976	407.1	52.5	4.60	4.20	27.9	0.61	0	0		3			
CT21-03296.003	BLOK 3	5.7	26	181	20	1040	202	0.02	70.1	22.3	6.3	1.2	0.2	3.1	14.8	3.6	7.4	0.2	7.42	1.167	162.1	86.2	2.86	6.19	15.1	0.54	0	0		22			
CT21-03296.004	PROBLEEM	4.8	7	116	11	878	161	0.69	65.1	19.5	4.4	0.7	10.2	3.3	19.2	4.4	6.1	0.2	6.74	1.013	562.0	28.3	5.24	4.96	39.2	0.53	0	0		6			
CT21-03296.005	SHIBEEN BLOK 1	5.0	36	164	35	581	234	0.57	48.6	32.2	7.0	2.6	9.6	1.5	11.5	4.6	5.4	0.4	5.97	1.013	185.5	21.2	2.21	6.76	100.9	0.35	0	0		34			
CT21-03296.006	SHIBEEN BLOK 2	5.2	56	429	14	359	187	0.19	38.4	32.7	23.5	1.3	4.1	1.2	3.0	1.4	4.5	0.1	4.68	0.951	225.7	14.5	1.88	12.97	37.7	0.51	0	0		52			
CT21-03296.007	SHIBEEN BLOK 3	5.8	38	330	14	1096	221	0.01	66.8	22.1	10.3	0.7	0.2	3.0	8.6	2.1	8.2	0.1	8.20	1.022	129.3	98.5	3.91	8.05	21.6	0.46	0	0		33			
CT21-03296.008	GELUK G1	5.9	65	112	9	551	161	0.01	62.5	29.9	6.5	0.9	0.3	2.1	14.2	4.6	4.4	0.1	4.41	1.075	204.4	97.5	8.47	33.28	9.4	0.37	0	0		60			
CT21-03296.009	GELUK G2A	6.2	96	245	11	731	143	0.00	66.4	21.3	11.4	0.9	0.0	3.1	7.7	1.9	5.5	0.1	5.50	1.152	152.0	130.1	9.19	36.45	11.1	0.50	0	0		84			
CT21-03296.010	GELUK G2B+3A	7.2	92	174	11	1444	166	0.00	79.5	15.0	4.9	0.5	0.0	5.3	19.2	3.1	9.1	0.1	9.07	1.135	98.6	128.9	10.57	56.74	10.9	0.65	0	0		79			
CT21-03296.011	GELUK 3B	6.0	78	155	15	937	184	0.00	70.4	22.7	6.0	1.0	0.0	3.1	15.6	3.8	6.7	0.2	6.66	1.099	207.8	93.6	7.63	23.27	9.2	0.44	0	0		71			
CT21-03296.012	GELUK G4	6.5	75	304	13	832	213	0.00	61.7	25.9	11.5	0.9	0.0	2.4	7.6	2.2	6.7	0.1	6.74	1.010	130.8	149.2	6.67	46.28	11.3	0.49	0	0		64			
CT21-03296.013	GELUK 5A	6.6	60	113	8	621	154	0.00	66.2	26.9	6.2	0.8	0.0	2.5	15.1	4.4	4.7	0.1	4.69	1.166	100.3	130.5	6.89	53.82	7.9	0.35	0	0		53			
CT21-03296.014	GELUK G6+7	5.9	120	222	10	729	137	0.01	67.7	20.8	10.6	0.8	0.2	3.3	8.4	2.0	5.4	0.1	5.39	1.024	115.9	92.2	10.92	59.94	10.5	0.45	0	0		116			
CT21-03296.015	GELUK G8	6.7	12	253	20	1558	368	0.00	67.5	26.1	5.6	0.8	0.0	2.6	16.7	4.7	11.5	0.1	11.54	1.042	148.5	150.8	7.40	21.15	14.3	0.82	0	0		10			
CT21-03296.016	GELUK G9	5.9	28	155	19	1206	348	0.01	64.4	30.4	4.2	0.9	0.1	2.1	22.4	7.2	9.4	0.2	9.37	1.145	237.5	97.5	4.76	10.87	11.0	0.49	0	0		23			
CT21-03296.017	GELUK G10	5.8	14	210	12	591	194	0.01	57.3	30.9	10.4	1.1	0.3	1.9	8.5	3.0	5.1	0.1	5.15	1.125	93.1	49.5	4.19	10.16	15.2	0.42	0	0		12			
CT21-03296.018	GELUK G11	7.2	71	333	10	1289	201	0.00	71.7	18.4	9.5	0.5	0.0	3.9	9.5	1.9	9.0	0.0	8.99	1.114	125.5	121.2	8.55	42.58	10.2	0.79	0	0		58			
CT21-03296.019	GELUK G12	7.0	75	146	13	1485	249	0.00	75.0	20.6	3.8	0.6	0.0	3.6	25.3	5.5	9.9	0.2	9.90	1.080	101.0	111.9	9.38	120.77	15.9	0.66	0	0		61			
CT21-03296.020	GELUK G13	5.4	32	308	12	654	137	0.08	61.6	21.1	14.8	1.0	1.5	2.9	5.6	1.4	5.2	0.1	5.31	1.058	108.7	61.9	7.96	20.13	61.7	0.50	0	0		27			
CT21-03296.021	LOXLEY G28A	7.1	34	196	16	1561	188	0.00	78.7	15.6	5.1	0.7	0.0	5.1	18.6	3.1	9.9	0.1	9.92	1.190	125.4	94.3	7.38	10.58	46.5	0.70	0	0		29			
CT21-03296.022	LOXLEY G28B	7.4	106	155	13	1505	177	0.00	79.8	15.4	4.2	0.6	0.0	5.2	22.7	3.7	9.4	0.1	9.43	1.039	112.7	151.0	13.40	72.71	46.1	0.86	0	0		88			
CT21-03296.023	LOXLEY G28C	7.0	26	501	16	1876	308	0.00	70.8	19.1	9.7	0.5	0.0	3.7	9.3	2.0	13.3	0.1	13.25	0.955	77.0	138.8	9.48	21.00	24.9	1.24	0	0		21			
CT21-03296.024	LOXLEY G28C ONDER	5.8	18	500	19	1353	301	0.01	63.8	23.2	12.1	0.8	0.1	2.7	7.2	1.9	10.6	0.1	10.60	0.937	148.5	186.8	8.92	14.36	32.7	0.89	0	0		15			
CT21-03296.025	RIETVLEI REGS	5.7	91	407	16	950	168	0.02	65.4	19.0	14.3	1.0	0.3	3.4	5.9	1.3	7.2	0.1	7.26	1.071	240.6	118.5	5.11	13.55	14.2	0.55	0	0		81			
CT21-03296.026	RIETVLEI LINKS	5.1	32	276	35	1265	349	0.30	61.2	27.6	6.8	1.5	2.9	2.2	13.0	4.1	10.0	0.2	10.34	0.948	386.6	44.6	4.74	8.59	29.4	0.52	0	0		30			
CT21-03296.027	LABRI S1-5	6.9	45	136	8	577	141	0.00	65.2	26.1	7.9	0.7	0.0	2.5	11.6	3.3	4.4	0.1	4.43	1.266	158.1	74.8	5.16	22.02	5.5	0.32	0	0		44			
CT21-03296.028	LABRI MID 1-8	6.2	56	272	14	804	204	0.00	62.3	25.9	10.8	1.0	0.0	2.4	8.2	2.4	6.4	0.1	6.45	1.063	128.9	54.4	5.00	16.49	20.0	0.51	0	0		50			
CT21-03296.029	LABRI A9-13	5.8	23	352	28	1077	297	0.02	60.8	27.5	10.2	1.4	0.2	2.2	8.7	2.7	8.8	0.1	8.85	0.979	88.3	98.1	5.05	8.25	61.7	0.49	0	0		20			
CT21-03296.030	I. SWART LINKS	5.4	18	103	40	1610	609	0.08	59.4	36.8	1.9	1.3	0.6	1.6	49.7	19.0	13.5	0.7	13.55	0.915	464.3	19.8	6.62	7.32	82.6	0.61	0	0		16			
CT21-03296.031	I. SWART NADORCOTS	6.2	13	168	13	1860	323	0.00	74.8	21.3	3.5	0.4	0.0	3.5	27.7	6.1	12.4	0.1	12.44	1.052	96.6	89.1	3.72	4.53	30.2	0.61	0	0		9			
CT21-03296.032	I. SWART REGS	5.7	8	98	34	1826	489	0.02	67.4	29.6	1.8	1.1	0.1	2.3	52.7	16.1	13.5	0.6	13.55	1.029	307.5	27.1	4.54	4.53	51.1	0.52	0	0		7			
CT21-03296.033	MOOILAND 14A	5.5	12	192	13	827	202	0.05	64.7	25.9	7.7	0.9	0.8	2.5	11.8	3.4	6.3	0.1	6.39	0.992	91.0	86.9	9.41	27.44	15.9	0.75	0	0		10			
CT21-03296.034	MOOILAND 14B+B1	6.5	50	135	14	969	242	0.00	67.0	27.4	4.8	0.9	0.0	2.4	19.8	5.7	7.2	0.2	7.23	0.884	113.6	84.4	56.47	75.41	11.2	0.55	0	0		42			
CT21-03296.035	MOOILAND 15 A1 A2 & A4	5.6	19	321	20	946	260	0.03	60.7	27.3	10.5	1.1	0.4	2.2	8.4	2.6	7.8	0.1	7.80	0.962	120.9	73.7	8.81	45.64	49.2	0.80	0	0		14			
CT21-03296.036	MOOILAND 15 A 1,2,3 & 5	6.3	8	393	13	975	243	0.00	61.5	25.1	12.7	0.7	0.0	2.4	6.8	2.0	7.9	0.1	7.93	1.009	70.5	101.4	6.99	10.47	21.9	0.82	0	0		6			
CT21-03296.037	MOOILAND 15B&D	6.6	31	195	16	1217	250	0.00	69.9	23.5	5.7	0.8	0.0	3.0	16.3	4.1	8.7	0.1	8.70	1.032	165.6	69.3	8.11	63.37	23.9	0.78	0	0		26			
CT21-03296.038	MOOILAND 15C	5.1	12	63	15	563	178	0.61	55.1	28.6	3.1	1.2	11.9	1.9	26.6	9.1	4.5	0.4	5.11	0.961	75.9	50.8	2.52	4.35	27.4	0.35	0	0		10			
CT21-03296.039	MOOILAND 16A	5.9	9	102	12	954	170	0.01	73.5	21.5	4.0	0.8	0.2	3.4	23.6	5.3	6.5	0.2	6.49	1.038	128.0	68.9	4.42	9.78	16.1	0.47	0	0		7			
CT21-03296.040	MOOILAND 16C	6.4	35	234	14	1432	336	0.00	67.7	26.1	5.7	0.6	0.0	2.6	16.6	4.6	10.6	0.1	10.58	0.981	153.9	67.1	6.22	59.97	14.8	0.78	0	0		30			
CT21-03296.041	MOOILAND 16B 3+4	6.5	19	214	14	755	215	0.00	61.4	28.7	8.9	1.0	0.0	2.1	10.1	3.2	6.1	0.1	6.15	1.039	102.1	72.3	5.67	20.50	13.6	0.49	0	0		18			
CT21-03296.042	MOOILAND 16 B1 & B2	7.1	26	222	15	1857	268	0.00	76.6	18.1	4.7	0.5	0.0	4.2	20.2	3.9	12.1	0.1	12.12	1.067	171.1	109.7	13.92	52.54	21.6	0.89	0	0		15			
CT21-03296.043	MOOILAND BEESKAMP	6.1	10	42	6	976	230	0.00	70.7	27.4	1.6	0.4	0.0	2.6	63.1	17.6	6.9	0.2	6.90	1.073	164.7	98.8	2.30	2.19	5.3	0.42	0	0		9			