DRAFT ENVIRONMENTAL IMPACT REPORT
APPENDICES: VOLUME NR. 2

LOWS CREEK DAM PROJECT: DEVELOPMENT OF AN INSTREAM STORAGE DAM FOR IRRIGATION PURPOSES ON PORTIONS OF REMAINING EXTENT OF ESPERADO 253 JU AND PORTIONS 1 AND 2 OF ESPERADO ANNEX 222 JU
LOWS CREEK-KAAPMUIDEN AREA, MPUMALANGA.
PROJECT REFERENCE: 1/3/1/16/1E-294

PREPARED BY:

RHENGU ENVIRONMENTAL SERVICES

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APRIL 2021

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ABBREVIATIONS

ASAP	As Soon As Possible
Asl	Above sea level
BEE	Black Economic Empowerment
CBAs	Critical Biodiversity Areas
cm	centimetre
DAFF	Department of Agriculture, Forestry and Fisheries
DARDLEA	Department of Agriculture, Rural Development, Land and Environment Affairs
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
ELU	Existing Lawful Use
EMPr	Environmental Management Programme
ER	Ecological Reserve
ESKOM	Electricity Supply Commission
EWR	Ecological Water Requirement
GPS	Geographical Positioning System
ha	Hectare
HIA	Heritage Impact Assessment
I&AP's	Interested and Affected Parties
IEM	Integrated Environmental Management
IUCMA	Inkomati Usuthu Catchment Management Agency
KNP	Kruger National Park
kPa	kilopascal
LUDS	Land Use Decision Support Tool
m	metre
mm	millimeter
MTPA	Mpumalanga Tourism and Parks Agency

m/s	metre per second
NA	Not Applicable
NEMA	National Environmental Management Act
NHBRC	National Housing Building Regulations Council
OHASA	Occupational Health and Safety Act
OMPr	Operational Management Programme
ONA	Other Natural Areas
PDI	Previously Disadvantaged Individual
PES	Present Ecological State
PPP	Public Participation Process
RES	Rhengu Environmental Services
ROD	Record of Decision
ROW	Right of Way
SABS	South African Bureau of Standards
SAHRA	South African Heritage Resources Agency
sqm	square metre
WULA	Water Use Licence Application

APPENDIX 4.5.3.
BIODIVERSITY AND ECOLOGY STUDY:
TERRESTRIAL AND AQUATIC

ESPERADO FARM: DEVELOPMENT OF AN IRRIGATION STORAGE DAM ON THE LOW'S CREEK.

A specialist ecological study for the Environmental Impact Assessment on the Esperado Farms in the Kaapmuiden area (Mpumalanga)

SPECIALIST STUDY: ECOLOGICAL ASSESSMENT.

DR ANDREW DEACON
November 2020

ESPERADO FARM: DEVELOPMENT OF AN IRRIGATION STORAGE DAM ON THE LOW'S CREEK.

A specialist ecological study for the Environmental Impact Assessment on the Esperado Farms in the Kaapmuiden area (Mpumalanga)

SPECIALIST STUDY: ECOLOGICAL ASSESSMENT.

March 2021

Dr Andrew Deacon (PhD Zoology)

Registered with the South African Council for Natural Scientific Professions
(Registration number: 116951)

Executive Summary

Rhengu Environmental Services were appointed to undertake an Environmental Impact Assessment (EIA) the Esperado Farms in the Kaapmuiden area (Mpumalanga) and this specialist ecological study forms part of the EIA process for the proposed project.

The applicants of the Esperado Farms wish to develop an irrigation storage dam on the Low's Creek near the confluence with the Kaap River. It is proposed to construct the dam on the Farms: Portions of Remaining Extent of Esperado 253 JU and Portions 1 and 2 of Esperado Annex 222JU. GPS Latitude: 25º 35' 30.6″ Longitude: 31º 18' 32.2″

Four options for dam sites were considered, however, following on site evaluations, it was found that three options would flood into neighbouring properties, thus rendering Dam 2 the preferred option.

This project is prepared for a Specialist Study for the EIA of the proposed Low's Creek dam. The Environmental Evaluation refers to the riverine aspects of the project area during the construction- and operational phases for the proposed dam.

This specialist report is based on the EIA guidelines provided in the Mpumalanga Biodiversity Sector Plan (MBSP). The Mpumalanga Tourism and Parks Agency (MTPA), as custodian of the environment in Mpumalanga, is the primary implementing agent of the MBSP for the province.

During the study, a total of three vegetation units consisting of transformed vegetation/habitat and one unit consisting of untransformed vegetation/habitat were identified. These four units are listed below as the following vegetation units and land cover type:

Untransformed vegetation/habitat

1. Untransformed Riverine – Riparian and aquatic

Transformed vegetation/habitat

2. Agriculture - Current cultivation
3. Infrastructure
4. Dams

The fieldwork component of this study was conducted during the period January to August 2020. In the vegetation surveys, a total of 83 indigenous plant species were recorded during fieldwork, as well as 17 exotic species, some declared alien invaders. A list of plants of special concern that have distribution ranges and habitat preferences that overlap with the study area (Grid: 2531CB) were compiled from the MTPA threatened species database in order to recognise these important species in the field. None of these were recorded during the surveys, however four protected trees were observed in the project area.

Aquatic macro-invertebrates were sampled according to the SASS5 method. Habitat scores for these invertebrates were moderate and categorized as "Fair", mostly due to the lack of deep-water habitats and fast flows. However, the presence of shallow riffles and good overhanging vegetation, reflected well in the macro-invertebrate scores, resulting in "Good" SASS scores and a relative high number of families.

Eleven fish species will be able to reach the sampling site in the Low's Creek study area, which means that they currently can migrate up to the proposed dam site during periods of high flow, and probably can pass through the system higher up in the catchment. The relative integrity score of 91% at this reach in the Low's Creek was placed within the limits of an ecological state category Class A/B (>87.4 and <92.01%), which means this reach is rated as "Unmodified, or approximate natural conditions closely."

During surveys of the frog species (January to August 2020), 9 of the 19 expected species were encountered in the Low's Creek project area. Most of the expected species will be present in the riverine habitat of the Low's Creek drainage system since the rest of the surrounding area is transformed by agriculture. Using distribution maps and habitat quality, no endemic or threatened frog species are expected to occur in the Low's Creek project

area.

Ten of the 62 expected reptile species were recorded in the riverine habitat of the project area during surveys. According to the South African Reptile Atlas, there are 3 endemic reptile species, one threatened species (Nile crocodile) and one South African Threatened or Protected Species (Southern African python) expected to be present in the region.

A total of 52 out of 203 expected riverine bird species were observed in the Low's Creek project area during the study. Using comparisons with expected bird lists, a total of 11 bird species expected to be found in the area are listed as "Species of Special Concern".

If available habitat types in the Low's Creek riverine area are evaluated, only 51 mammal species are likely to occur in the project area. During the 2020 surveys, signs and/or sightings of 8 mammal species were recorded or reported by the staff on the farm. Seven of the species which have distribution ranges overlapping with the project area, and suitable habitat available, are listed as Species of Special Concern, most of which are considered threatened.

Critical Biodiversity Areas:

By overlaying the BGIS Critical Biodiversity Areas map onto the Low's Creek Project Area, we found that the project area falls into the following sensitive areas:

- Terrestrial:
    - Ecological Support Area: Protected area buffer
    - Vulnerable Ecosystem status: Granite Lowveld

Most of the area has been totally transformed by agriculture ("Heavily Modified"), with only small patches of Other Natural Areas in between. However, the entire farm is situated in an ESA: Protected Area Buffer (Boondocks Bushveld Reserve). According to the desired management objectives for an ESA: Protected Area Buffers, these buffers are areas around protected areas where changes in land-use may affect the ecological functioning or tourism potential of the adjacent protected area. The purpose of buffer zones is to reduce the impacts of undesirable land-uses on the environment and to provide opportunities for tourism.

The potential impact of the project on the biodiversity of the study area are assessed under one broad impact, namely:

Impeding or diverting the flow of water in a watercourse: The construction of a dam covering 6.5 ha with a storage capacity of 193 000 cubic metres in the channel of the Low's Creek river.

The potential impacts of the project on the biodiversity of the study area are assessed under the following broad categories, namely:

Activity 1. The dam basin – clearing vegetation, manipulating soil layers, construction of coffer walls, operating and rehabilitation, construction of the dam wall.
Activity 2. Riparian corridor and adjacent land – influencing riparian habitats and associated biodiversity, as well as areas adjacent to the riparian zone.
Activity 3. River flow – downstream flows.
Activity 4. River flow – water quality.
Activity 5. Erosion and siltation.
Activity 6. Impacts of dam wall.
Activity 7. Alien invasive vegetation.

Reasoned opinion

The construction of an in-stream dam will always be viewed as a contentious issue due to the following aspects:

- the completed dam wall interferes with the flow in the river;
- the wall acts as a migration barrier to aquatic animals;
- when the dam basin fills with water, the water inundates a relative large area of natural riverine habitat and terrestrial landscape;
- the large, unnatural body of water (very little flow present in the dam) undergoes

physical-chemical changes in time, and when released, the quality and quantity of downstream flows will have an impact on the receiving environment.

In order to mitigate for the anticipated impacts of the proposed dam on the environment, the listed adverse influences should be managed to such a degree that the overall ecology in the project area will still be functional.

Most of the impacts can be mitigated to a certain degree. However, clearing the dam basin and filling the dam are impacts that cannot be mitigated fully as a relatively large surface area is inundated and eliminated from the ecosystem footprint, therefore the significance of this action is still listed in a “High” category.

A very important impact to mitigate will be the flow in the area downstream of the dam. Should the Ecological Water Requirements (EWR) releases from the dam be implemented successfully and maintained according to the flows set for a B category river, the downstream ecology is expected to function effectively. It must be added that the dam wall will be built in the Low’s Creek drainage line only about 300m upstream of the confluence of the Low’s Creek with the Kaap River. Therefor the releases from the dam will add flow to the Kaap River system and improve environmental flows in this river.

The change of water quality and sediment regimes in the dam could pose a threat to the downstream environment, however, due to the rather small basin, water will not remain in the dam long enough to deteriorate to a level that will impact adversely on the receiving Kaap River, especially if flows in the Kaap River are maintained. Additionally, multiple sluices in the dam wall will be able to release water from different levels in the thermocline and therefore mix the water being released in order for the temperature of the layers to not impact on the downstream ecology.

The dam would be a migration barrier for fish swimming from the Kaap River up the Low’s Creek. To overcome this obstacle, a fish-way (fish ladder) has been designed for the dam overflow and the successful concept will allow migrating fish to swim up the Low’s Creek, to negotiate over the dam wall during their migration and disperse further upstream into the Low’s Creek catchment.

By re-establishing a 25m buffer around the periphery of the dam high level mark will probably establish a secondary riparian zone around the banks of the dam, which will link up with the original upstream and downstream riparian corridors of the dam.

By implementing all the mitigation measures and managing the system as prescribed on a continuous basis, all the impacts will be addressed to a satisfactory level. Therefore, it is proposed that the dam construction and operation of the project should be authorised with the provision that the mitigation measures prescribed in this document be included in the EMPr.

General Requirements for EAPs and Specialists including Content of Specialist Reports in terms of Appendix 6 of the EIA Regulations, 2014

	Specialist reports and reports on specialist processes Checklist	STATUS
	Requirements for Specialist Reports Appendix 6 of Amendments to the environmental impact assessment regulations, 2014 (Government Notice No 326, 7th April 2017), promulgated in terms of National Environmental Management Act, 1998 (Act No. 107 of 1998).	Reference to section of specialist report or justification for not meeting requirement
1	A specialist report prepared in terms of these Regulations must contain—	
(a) i	the specialist who prepared the report; and	The title page of this report.
(a) ii	the expertise of that specialist to compile a specialist report including a curriculum vitae;	Section 1.6 Details of the Author; Appendix 2 of this report.
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix 1 of this report: Details of specialist and the declaration of interest following this section.
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	1.3 Terms of Reference.
(cA)	an indication of the quality and age of base data used for the specialist report;	1.4 Database Review
(cB)	a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	5.4 Assessment of impacts 5.3 Land-use planning and Decision-making. 5.3.4 Land-use guidelines 5.3.5 Desired management Objective
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	2. Methodology - Baseline Data
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	2. Methodology
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	5.2 Sensitivity mapping. 5.5 Conditions for inclusion in the environmental authorisation
(g)	an identification of any areas to be avoided, including buffers;	5.3.5 Desired management Objective
(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;	5.3 Land-use planning and Decision-making: 5.3.3 Buffer zones 5.3.5 Protected area buffers

	Specialist reports and reports on specialist processes Checklist	STATUS
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	1.5 Assumptions, Limitations and Knowledge gaps
(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) or activities;	5.4 Assessment of impacts
(k)	any mitigation measures for inclusion in the EMPr	5.4. Impact Assessment
(l)	any conditions for inclusion in the environmental authorisation	5.5 Conditions for inclusion in the environmental authorisation.
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation	5.6 Monitoring requirements
(n)	a reasoned opinion -	
.i	as to whether the proposed activity, activities or portions thereof should be authorised;	5.7.2 Reasoned opinion
(iA)	regarding the acceptability of the proposed activity or activities; and	5.7.2 Reasoned opinion
.ii	if the opinion is that the proposed activity, activities, 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;	5.7.1 Summary of mitigation measures
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	5.7.3 Consultation process
(p)	a summary and copies if any comments that were 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

DECLARATION:

I, Andrew Richard Deacon, declare that I –

- act as an independent specialist consultant in the field of ecological science;
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- have and will not have any vested interest in the proposed activity proceeding;
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report;
- and will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not.

ANDREW RICHARD DEACON

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Abbreviations

ADU	Animal Demographic Unit
AQV	Aquatic vegetation
ASPT	Average Score per Taxon
BGIS	Biodiversity Geographic Information System
BODATSA	Botanical Database of Southern Africa
°C	Degrees Celsius
CARA	Conservation of Agricultural Resources Act
CBA	Critical Biodiversity Areas
cm	Centimetre
C-Plan	Conservation Plan
Dr	Doctor
DWA	Department of Water Affairs (post-2010)
DWAF	Department of Water Affairs and Forestry (pre-2010)
DWS	Department of Water and Sanitation (since May 2014))
E	East
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
e.g.	For example
ECO	Environmental Control Officer
EFR	Environmental Flow Requirements
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMF	Environmental Management Frameworks
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
EN	Endangered
ESA	Ecological Support Area
EWR	Ecological Water Requirement
FAII	Fish Assemblage Integrity Index
FEPA	Freshwater Ecosystem Priority Areas
FRAI	Fish Response Assessment Index
FROC	Frequency of Occurrence
GDP	Gross Regional Product
GGP	Gross Geographic Product
GIS	Geographic Information System
GPS	Global Positioning System
ha	Hectares
HCR	Habitat Cover Ratings
HQI	Habitat Quality Index
IHAS	Integrated Habitat Assessment System
IUCN	International Union for Conservation of Nature
km	Kilometre
km^2	Kilometre square
KNP	Kruger National Park
LUDS	Land-Use Decision Support Tool
m	Metre
m^2	Square metre
m^3	Cubic metre
m^3s	Cubic metre per second
mamsl	Metres above mean sea level
MAP	Mean annual precipitation
max. temp.	Maximum temperature

MBCP	Mpumalanga Biodiversity Conservation Plan
MBSP	Mpumalanga Biodiversity Sector Plan
MCDA	Multi Criteria Decision Analysis
MIRAI	Macro-invertebrate Response Assessment Index
mm	Millimetre
MNCA	Mpumalanga Nature Conservation Act
MTPA	Mpumalanga Tourism and Parks Agency
MV	Marginal vegetation
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEMBA	National Environmental Management & Biodiversity Act
nMAR	Natural Mean Annual Runoff
NP	National Park
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
ONA	Other Natural Areas
PAR	Register of Protected Areas
PES	Present Ecological State
PESEIS	Present Ecological State, Ecological Importance and Ecological Sensitivity
PhD	Doctor of Philosophy
POSA	Plants of Southern Africa
Pr. Sci. Nat	Natural Scientific Professionals
RHP	River Health Programme
S	South
SA	South Africa
SAIAB	South African Institute for Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SARCA	South African Reptile Conservation Assessment
SASS5	South African Scoring System version 5
SCC	Species of Conservation Concern
SHI	Site Fish Habitat Integrity Index
SIC	Stones in current
SOOC	Stones out of current
Sqm	Square metre
SSC	Species of Special Concern
TOPS	Threatened or Protected Species
VEGRAI	Riparian Vegetation Response Assessment Index
WMA	Water Management Area

1. Introduction

Rhengu Environmental Services were appointed to undertake an Environmental Impact Assessment on the Esperado Farms in the Kaapmuiden area (Mpumalanga). This specialist ecological study forms part of the EIA process for the proposed project (Figure 2).

This project and the report below, is based on the EIA guidelines provided in the Mpumalanga Biodiversity Sector Plan (MBSP, 2014). The Mpumalanga Tourism and Parks Agency (MTPA), as custodian of the environment in Mpumalanga, is the primary implementing agent of the MBSP for the province.

This report addresses the findings of the field surveys as well as a desktop review of the potentially occurring threatened flora and fauna in the proposed development footprint.

1.1 Project Description

The applicants of the Esperado Farms wish to develop an irrigation storage dam in the Low’s Creek near the confluence with the Kaap River and approximately 12 kilometres south of the town Kaapmuiden, Mpumalanga (Figure 1). It is proposed to construct the dam on the Farms: Portions of Remaining Extent of Esperado 253 JU and Portions 1 and 2 of Esperado Annex 222JU. GPS Latitude: 25º 35’ 30.6″ Longitude: 31º 18’ 32.2″

Four options for dam sites are being considered with the preferred site illustrated in the map below (Figure 4). Following on site evaluations it was found that the other three options would flood into neighbouring properties.
The Low’s Creek Dam project specifics include:

Construct an in-stream irrigation storage dam (Figure 5).

- Dimensions of the proposed dam:
  - Category 2 Dam:
    - Wall Height 11.4m;
    - Wall Length 245m;
    - Cover an area of 6.5 ha and have a storage capacity of 193 000 cubic metres.
    - Maximum full supply water depth will be 8m.
- Construction of a pump house;
- Development costs are in the region of R8 million (Dam construction, pump house and pipelines).

The development of this storage facility will allow the applicants/farmers to manage the water supply to the orchards in a sustainable manner reducing the risk of poor supply versus demand especially during the dry seasons. The water will be stored as per the existing entitlements registered against the farms and no new water will be used for this process (Rhengu Environmental Services, 2020).

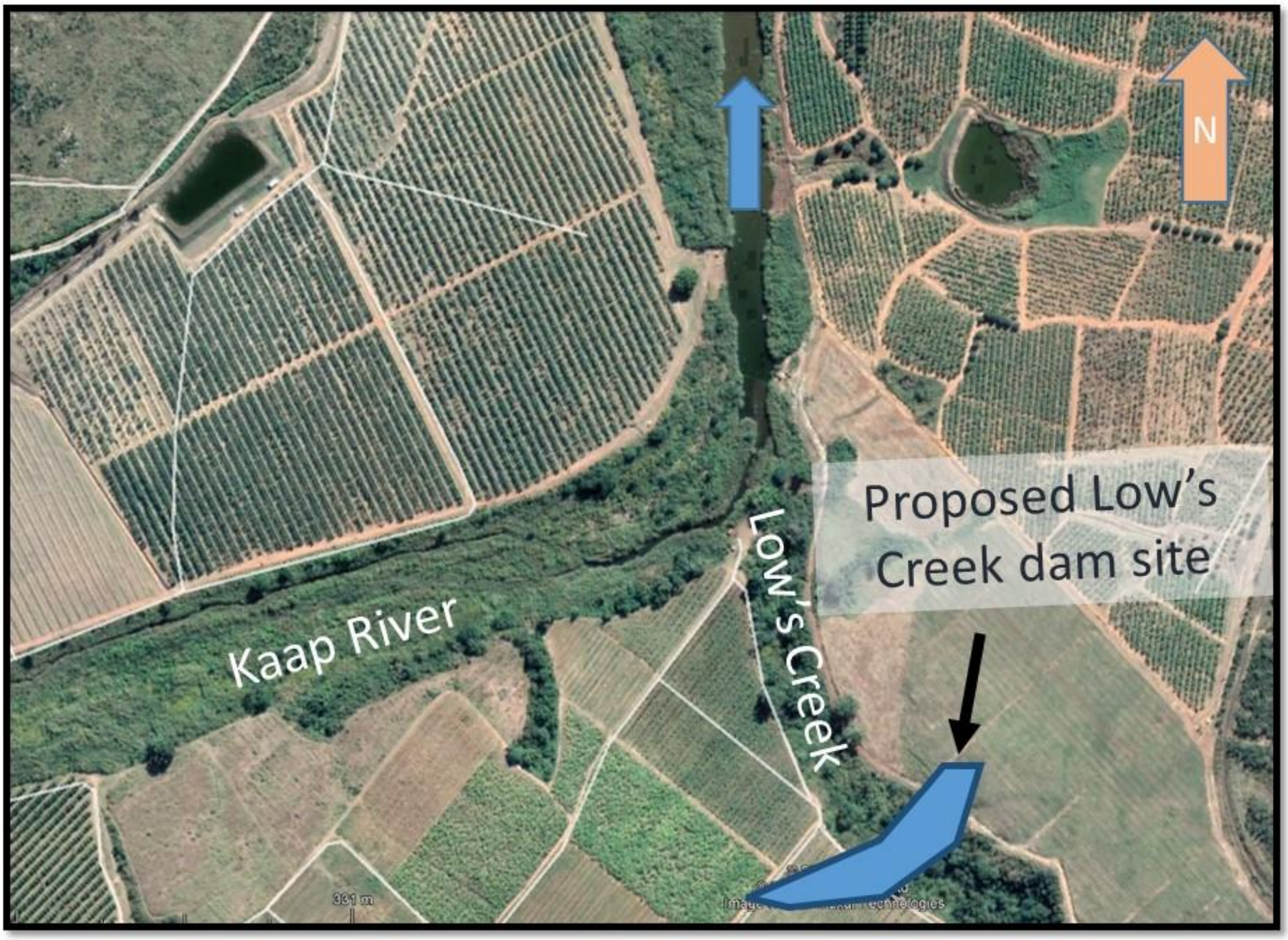


Figure 1: The proposed Low's Creek Dam site at the confluence of the Low's Creek and Kaap River.

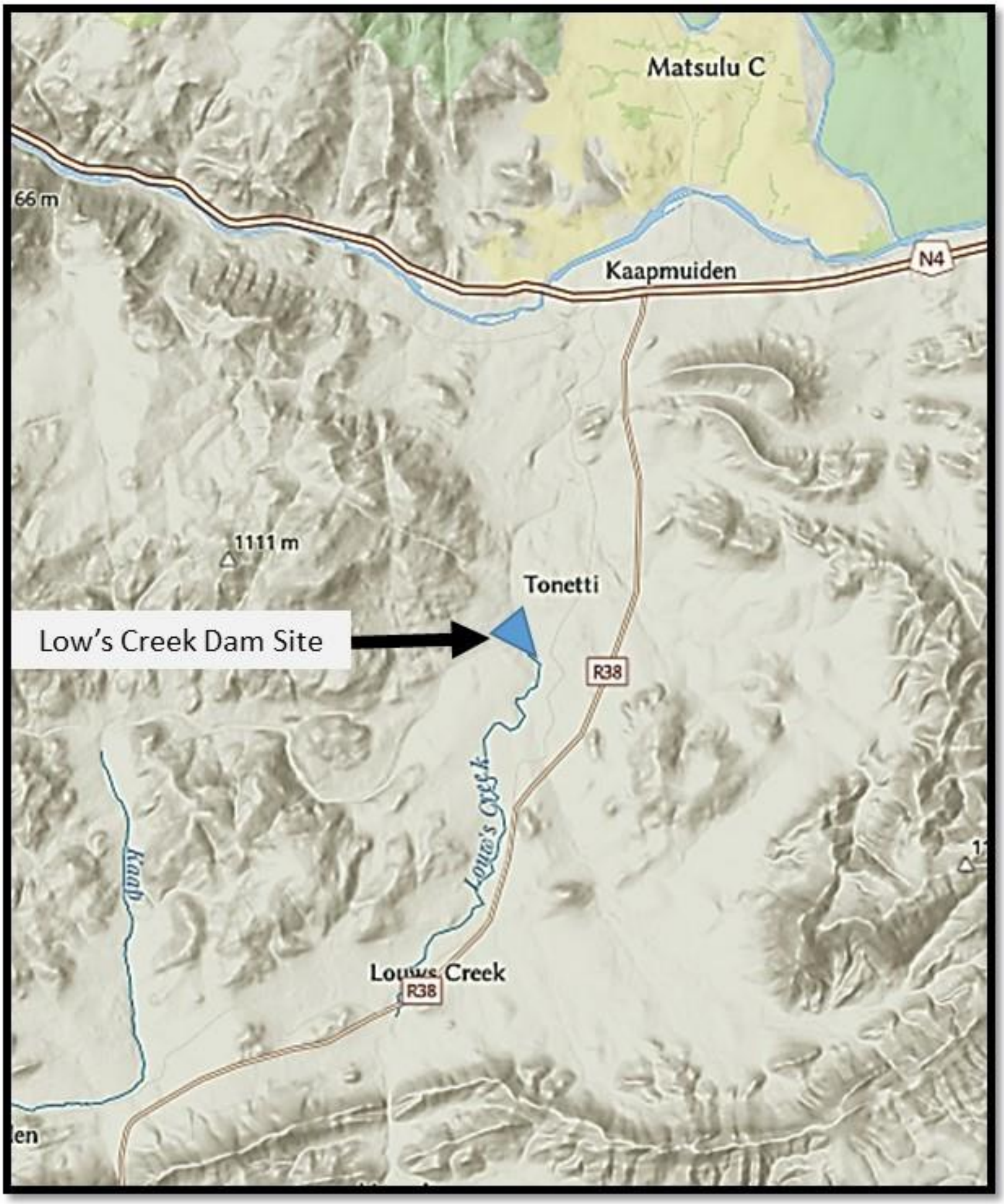


Figure 2: The Low's Creek Dam site, illustrating the surrounding towns and topography.

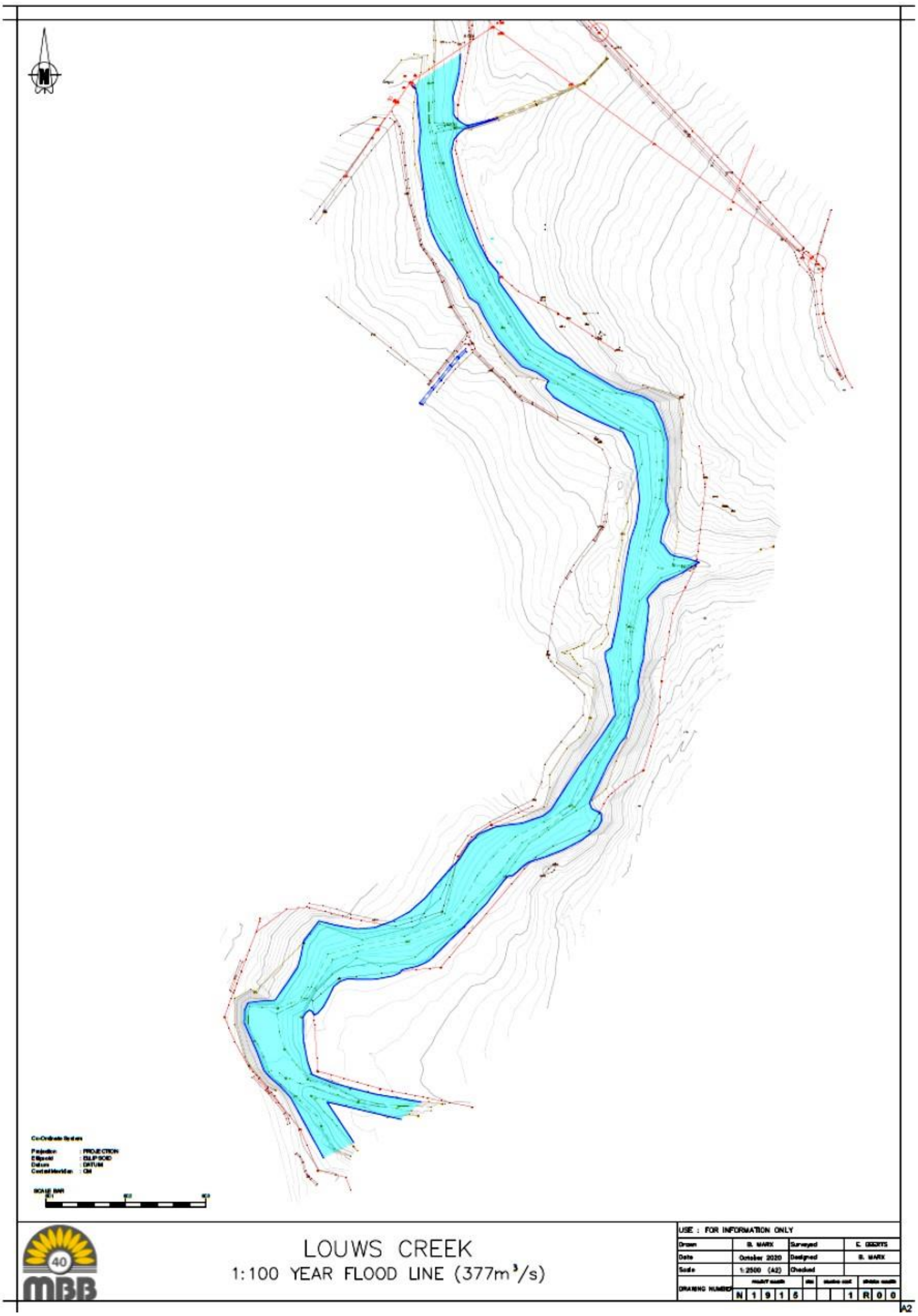


Figure 3: The Low's Creek Dam site, illustrating 1:100-year flood line.

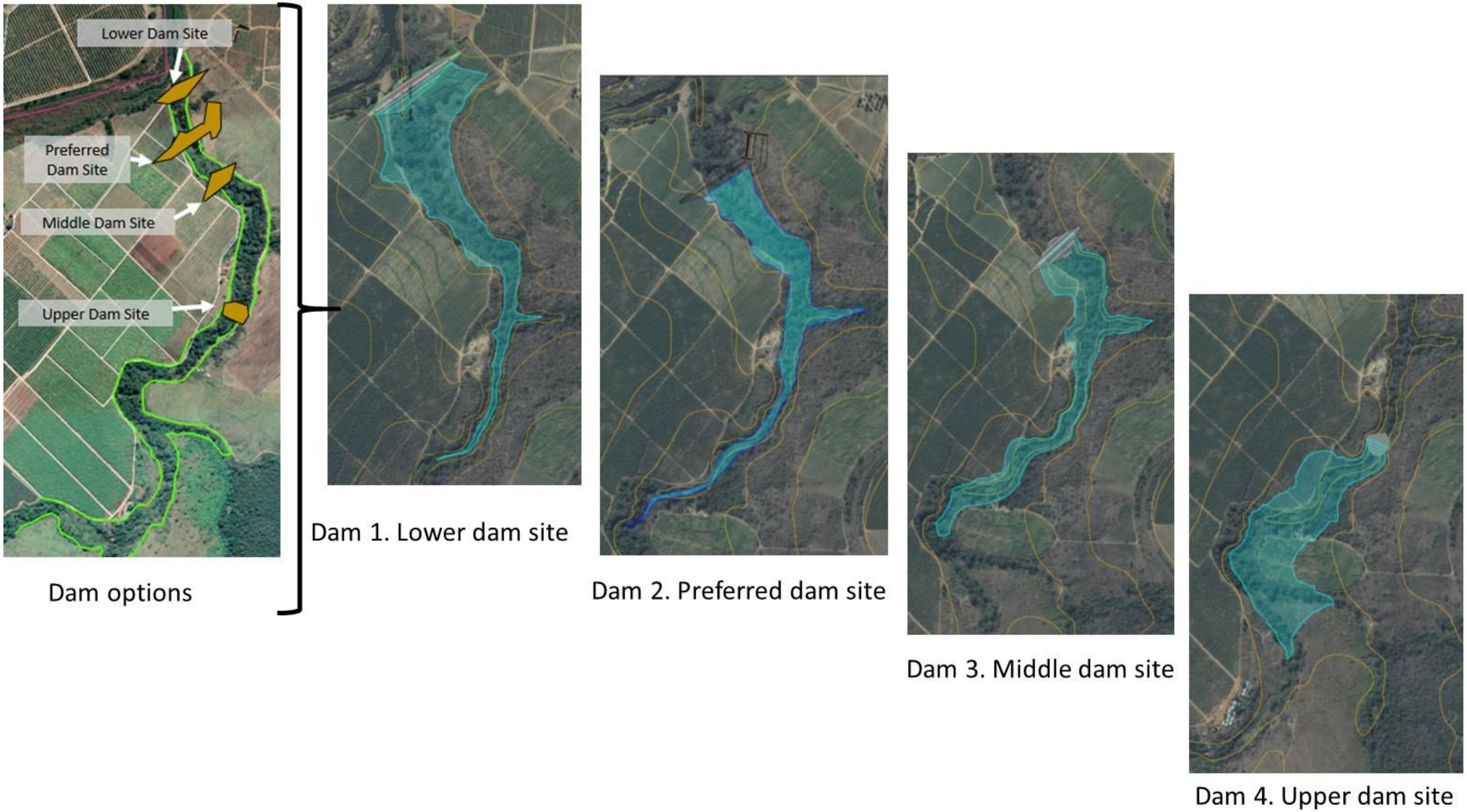


Figure 4: A diagrammatic view of four different dam options (Dam 1 to 4) of the proposed Low’s Creek Dam location on the Farm Esperado.

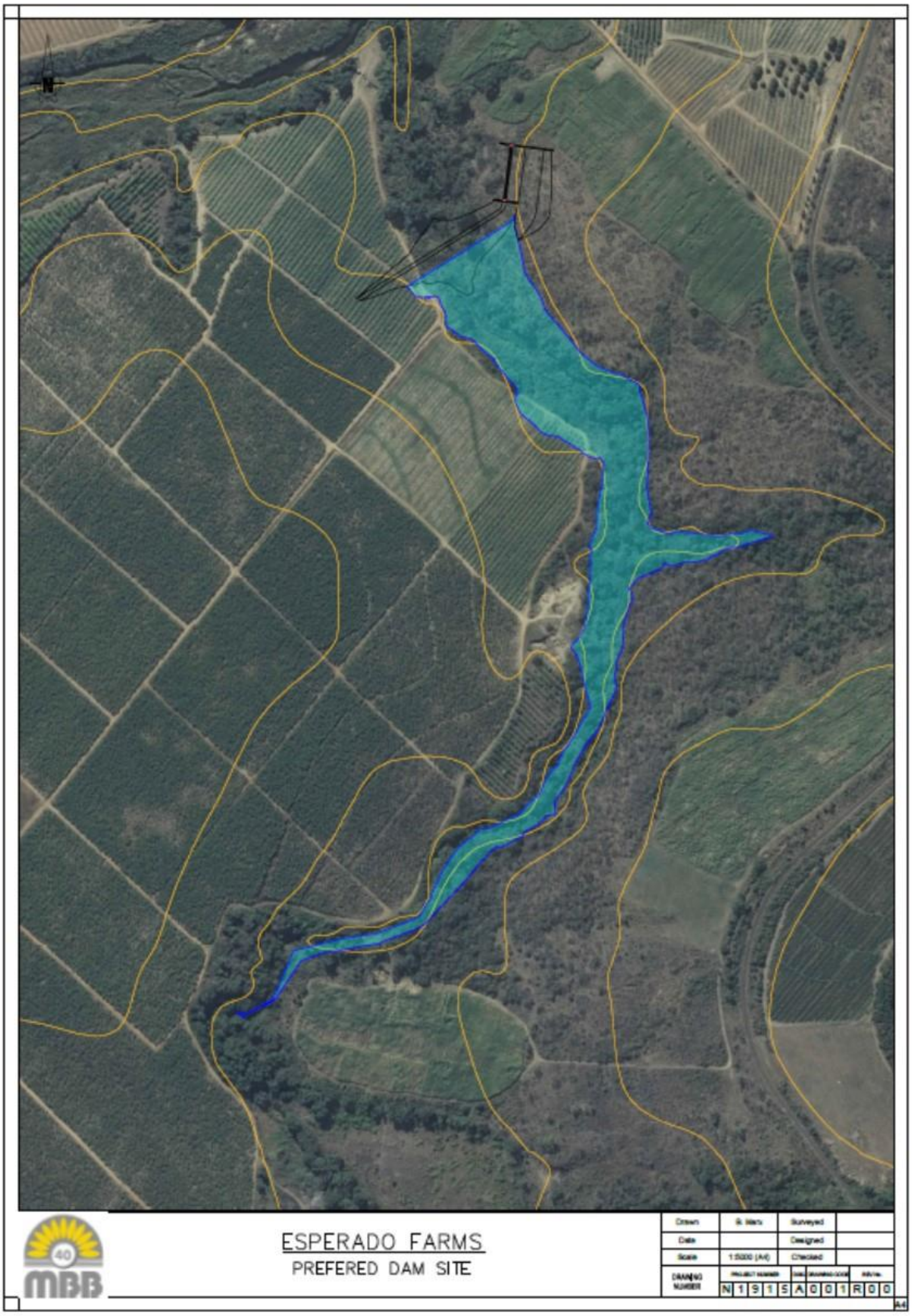


Figure 5: Dam 2: The preferred option of the proposed Low’s Creek Dam location on the Farm Esperado.

1.2 Legislative requirements

The new Environmental Impact Assessment Regulations came into effect on the 4 December 2014. These regulations were amended in 2017 and with this in mind it is proposed that the procedure as described in Chapters 4 and 6 of Notice 326 and Listed in Government Gazette No. 40772, published on 7 April 2017 is followed. Notice is given in terms of Regulation 41 of this notice to carry out the following activities:

Property Description and Location:

Low's Creek Dam Project on the Farms: Portions of Remaining Extent of Esperado 253 JU and Portions 1 and 2 of Esperado Annex 222JU. GPS Latitude: 25º 35' 24″ Longitude: 31º 18' 30″. (Low's Creek near the confluence with the Kaap River)
In terms of Government Notices **327, 325** and **324,** an **Environmental Impact Assessment** is required in terms of the following listed activities that the applicant wishes to implement:

Government Notice: 327 of 7 April 2017 Gazette Number: 40227:

Activity 12: The development of-
(iv) dams, where the dam infrastructure and water surface area exceeds 100sqm in size, where such development occurs - (a) within a water course or (c) …………within 32m of a water course.
Activity 19: The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles, or rock, of more than 10 cubic metres from-(i) a watercourse.
Activity 27: 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
(ii) maintenance purposes undertaken in accordance with a maintenance management plan.

Government Notice: 325 of 7 April 2017 Gazette Number: 40227:

Activity 16: The development of a dam where the highest part of the dam wall is 5 metres high or higher and or where the high-water mark covers an area of 10 ha or more.

Government Notice: 324 of 7 April 2017 Gazette Number: 40227:

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.
Activity 14: The development of- (i) dams, where the dam infrastructure exceeds 10sqm in size, or (ii) infrastructure or structures with a physical footprint of 10 sqm or more.

1.3 Terms of Reference

This project is prepared for a Specialist Study for the EIA of the proposed Low's Creek dam. The Environmental Evaluation refers to the riverine aspects of the project area during the construction- and operational phases for the proposed dam.
Aquatic- and riparian surveys are proposed for the riverine habitats in the vicinity of the proposed development. The Mpumalanga Parks Board document for minimum requirements for an EMPr when applying for authorization for an activity that may have a detrimental effect on the environment, requires the following for aquatic ecosystems (streams, rivers and dams):

> An Aquatic specialist should assess the condition of the proposed development and its impact on the aquatic environment. The following recognized bio-parameters and methods must be used.
> - Aquatic invertebrates (South African Scoring System version 5 — SASS5).
> - Fish communities (Fish Response Assessment Index (FRAI))
> - Riparian vegetation (Riparian Vegetation Index — VEGRAI) and riparian fauna
> - Riparian delineation

This project activities will also include the following services/specialist components:

- This specialist ecological study will form part of the **Environmental Impact Assessment** process of the proposed de-bushing of the project area.
- **Literature review**: Applicable documentation will be studied and reviewed. Extensive background studies regarding species distribution, habitat preference and species status will be updated where applicable.
- A site survey will be conducted to determine the **current state** of the biodiversity environment on site. Selected specialist ecological studies will be conducted in this area (including aquatic, terrestrial and amphibian fauna assessments) to determine the potential impact of the proposed activity (Power line, canals, roads, buildings, etc.). Predictive inventories of fauna will be compiled for expected species assemblages and then correlated with the aspects of habitat present in the study area.
- The characterization of the biotic integrity of riverine ecosystems in the project area. General **Habitat Assessment**: GPS readings; photographs; watershed features; aquatic- and riparian vegetation; substrate; etc.
- Ecological Reserve Assessment: **Flow and sediment regimes** at appropriate flows to be established by a qualified person, using natural Mean Annual Runoff (nMAR) and natural monthly flows from the Inkomati Water Availability study.

- **Aquatic biota:**
  - Aquatic macro-invertebrate habitat availability: Invertebrate Habitat Assessment System (IHAS Version 2): Used in conjunction with the SASS5 protocol.
  - Ichthyofauna (FRAI): Using the Fish Response Assessment Index (FRAI) methodology (replacing the FAII).

- Vegetation: Identification and delineation of wetlands and riparian areas. A Wetland Delineation report for the riparian corridor including the scientific determined buffers. All these features require GPS boundaries, so that they could be overlain on a site plan.

- Evaluate the sensitivity of the habitat for biota surveyed in both the terrestrial- and aquatic habitats, on site; emphasis will be placed on Species of Special Concern that may be influenced by the proposed activity - Identify the potential presence of plant and animal (terrestrial and aquatic) species of conservation importance: threatened, IUCN red data listed, NEMBA protected, endemic, Mpumalanga Province requirements, SANBI listings, etc.

- Provide a general biodiversity sensitivity map for the project area. This should include any proposed buffer zones and “no-go” zones for development with their scientific determined buffers in place.

- Ground-truth the desktop level findings with reference to the provincial C-Plan and provide an opinion regarding the conservation status and actual conditions in situ; ecosystem services provided by the systems on-site should be addressed.

- Management aspects:
  - Identification and quantification of risks to biodiversity.
  - The development of management criteria for each risk.

- Recommend mitigation methods regarding probable impacts. Indicate in the report any opportunities, constraints and fatal flaws in the study and the project, including gaps in available information and make recommendations going forward.

1.4 Database Review - an indication of the quality and age of base data used for the specialist report:

The following sources of information provided important information for the area as a whole:

Biota:
- Conservation-important biota listed for the quarter-degree grid 2531CB in the Mpumalanga Tourism & Parks Agency's (MTPA) (2020).
- Mpumalanga Species of Conservation Concern 2018.
- Protected species as listed under the Mpumalanga Nature Conservation Act (MNCA) (No. 10 of 1998), or the National Environmental Management: Biodiversity Act Threatened or Protected Species (NEMBA ToPS) (No. 10 of 2004).

Plants:
- List of all protected tree species, Government gazette, 2019.
- MTPA Minimum Criteria Guideline
- Vegetation map for South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2006).
- Riparian delineation and habitat evaluation was undertaken according to the DWAF Guidelines (2005) and DWAF updated manual (2008).
- Plants of South Africa (POSA) data from the South African National Biodiversity Institute (SANBI) (2020).
- SANBI Red List of South Africa 2020.
- Buffer Zone Tools (Macfarlane and Bredin, 2017).

Aquatic Macro-invertebrates
- Level I Ecoregion and the geomorphological zone, according to the method of Dallas (2007).
- SASS5 sampling technique (Dickens and Graham 2002).
- Aquatic habitat assessment (Kleynhans & Louw, 2008).

Fish:

- Fish distribution data sourced from the South African Institute for Aquatic Biodiversity (SAIAB), the Mpumalanga Tourism and Parks Agency (MTPA) 2020.
- Red Data: IUCN, 2019.
- Aquatic ecosystem classification, Ollis *et al*. (2013).
- MTPA Minimum Criteria Guideline.
- Fish reference Frequency of Occurrence (FROC) database (Kleynhans, Louw, & Moolman, 2007).
- Fish Response Assessment Index (FRAI) (Kleynhans 1999; Kleynhans *et al*. 2005).

Frogs:

- Red Data: IUCN, 2019.
- Du Preez, L. & Carruthers, V. 2009.
- Frog atlas project (Minter *et al* 2004).
- Detailed frog distribution records (Jacobsen 1989).

Reptiles:

- Reptile Atlas Project - Animal Demographic Unit (ADU). 2010.
- Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland: Bates, et al, 2014.
- Red Data: IUCN, 2019.

Birds:

- Red Data: IUCN, 2019.
- Harrison, et al. 1997.
- MTPA Minimum Criteria Guideline
- Important bird areas of southern Africa (Barnes, K.N. (ed.), 1998)

Mammals:

- Red list: Child *et al*, 2016.
- Red Data: IUCN, 2019.
- MTPA Minimum Criteria Guideline.

Rivers

- Desktop Present Ecological State, Ecological Importance and Ecological Sensitivity per sub-Quaternary reaches in South Africa (DWS 2014).
- Ecoregion - Water Resource Classification System (DWS, 2005).
- Ecological Flow Requirements (EFR) using the Desktop Reserve Model (Hughes and Hannart 2003).
- DWS PESEIS documents (DWS, 2014).
- Identification and delineation of wetland and riparian areas – DWS 2005 and 2008, MacKenzie and Rountree, 2007.

General

- Google Earth coverage dated September 2020.
- MTPA. 2014. Mpumalanga Biodiversity Sector Plan Handbook.
- Mpumalanga LUDS maps (BGIS, 2015). Land-Use Decision Support Tool (LUDS) (2020).
- National Web based Environmental Screening Tool (2020).
- Protected areas: https://www.environment.gov.za/ Register of Protected Areas (PAR).
- DWS Risk Matrix Impact Assessment method (GN 509).

1.5 Assumptions, Limitations and Knowledge gaps

Assumptions, Limitations and Knowledge gaps associated with this study include the following: The assumption has been made that:

- Project proponents will always strive to avoid and mitigate potentially negative project related impacts on the environment, with impact avoidance being considered the most successful approach, followed by mitigation. It further assumes that the project proponents will seek to enhance potential positive impacts on the environment.
- Red List species are, by their nature, usually very rare and difficult to locate. Compiling the list of species that could potentially occur in an area is limited by the paucity of collection records that make it difficult to predict whether a species may occur in an area or not. The methodology used in this assessment is designed to reduce the risks of omitting any species.
- The lists of fauna for the site are based on those observed at the site as well as those likely to occur in the area based on their distribution and habitat preferences. Due to the nature and habits of most faunal taxa it is unlikely that all species would have been observed during a site assessment of limited duration. Therefore, site observations are compared with literature studies where necessary.
- Animal species, especially birds, are mostly highly mobile and often migrate seasonally. Any field assessment of relatively short duration is therefore unlikely to record anything more than the most common species that happen to be on site at the time of the survey. Such field surveys are generally a poor reflection of the overall diversity of species that could potentially occur on site.
- The author is not involved with the decision regarding the construction of the dam related to the permit/license requirements of the National Water Act, 1998 (Act No. 36 of 1998).

1.6 Details of the Author

Dr Andrew Deacon (PhD Zoology) worked as a researcher at Scientific Services, South African National Parks (SANParks, 1989 - 2012). He was initially employed as an Aquatic ecologist to coordinate the multidisciplinary KNP Rivers Research Programme, but later was tasked to manage the monitoring and research programmes for small vertebrate ecology in 15 South African National Parks (including Addo-, Kalahari- and Kruger NP).

As a recognised scientist in the fields of Ichthyology and Terrestrial Ecology, he is currently engaged as a specialist consultant regarding ecological studies. He was involved in numerous research programmes and projects, and produced EIA specialist reports (aquatic or terrestrial ecology) for 82 projects. Additionally, he also participated in Aquatic ecosystem projects, Environmental Water Requirement Studies and Faunal and ecosystems monitoring projects.

Apart from multiple environmental projects in South Africa, he has worked on assignments in the Democratic Republic of the Congo, Zambia, Mozambique, Zimbabwe, Namibia and Swaziland. He completed: Wetland Introduction and Delineation Course – Centre for Environmental Management: University of the Free State. He is a registered Professional Natural Scientist (Pr. Sci. Nat.) in the fields of Ecological Science (Reg. no. 116951).

2. Methodology

Methods and approach

This project and report are based on the guidelines provided in the Mpumalanga Biodiversity Sector Plan Handbook (MTPA, 2014). According to the MBSP, “it is important to note that all decisions regarding land-use applications in Mpumalanga are going to be evaluated by the authorities using the CBA maps and data, so it makes sense to consider these proactively, either prior to, or during, the EIA process.”

The methods used in this report were undertaken in accordance with to the MTPA Minimum Criteria Guideline with special emphasis on Protected Species.

Baseline Data

Baseline data were collected during a field surveys (1-2 days per survey) undertaken during the following periods:

- January 2020
- February 2020
- June 2020
- July 2020
- August 2020

During the field survey detailed ecological data were collected and the following fields were covered:

2.1 Vegetation

Specialist assessment of vegetation for the project

In accordance with the accepted proposal for this study, the botanical specialist study presented in the current report was to assess the footprint of the Low’s Creek development. The scope of work will include the Terrestrial- and Riparian Components as per the MTPA Minimum Criteria Guideline with special emphasis on Protected Species, including GPS coordinates for encountered species to facilitate obtaining the necessary permits.

Minimum requirements guidelines from the Mpumalanga Tourism and Parks Agency:

1. A map indicating the total area (ha) of disturbance/transformation on the property, including the proposed development.
2. A map indicating vegetation communities and sensitive areas on the property. The map should include the delineation of a 30m buffer zone around any sensitive areas.
3. A map indicating all surrounding land use on adjacent properties.
4. A list of threatened plants species (Red Data Listed) that may potentially occur in the area should be submitted.
5. A floristic survey should be conducted during the growing season with at least two visits undertaken. Visits during other seasons will be determined by the flowering and fruiting times of species that do not occur during the summer season.
6. The MTPA should be supplied with a list of all plant taxa encountered during the surveys. The following should be investigated: threatened species (Red Data Listed), important medicinal species, protected species (Mpumalanga Conservation Act, 1989) as well as endemic taxa.
7. Plants that have been surveyed and which may be of conservation importance should be identified down to species level.
8. The MTPA should be supplied with a detailed list of all threatened species, including their locality information as well as details regarding date, GPS location and spatial resolution.

9. A list of threatened species that could potentially occur but were not found during site visits should be provided separately. In respect of each such species an opinion on the likelihood of that species occurring on the site and the reason for that opinion should be provided.
10. A list of alien plant species occurring on the property should be provided.
11. The invasion extent of category 1 & 2 plants (CARA: Act 43 of 1983, Regulation 15) should be investigated.
12. Any existing or planned eradication programs of alien vegetation should be indicated in the report.
13. Relocation plans of plants of conservation importance should be included and this relocation should be undertaken by specialists that have expertise in the area of environmental concern (EIA Guideline Document).

Desktop

Vegetation communities and general land use patterns were identified prior to fieldwork using satellite imagery on Google Earth. Conservation-important plant species listed for the quarter-degree grid 2531CB in the Mpumalanga Tourism & Parks Agency's (MTPA) threatened species database, as well as the Plants of South Africa (POSA) data from the South African National Biodiversity Institute (SANBI), were used to produce a list of the most likely occurring species, which were searched for during fieldwork.

Conservation-important plants include those listed as species of conservation concern by the SANBI Red List of South Africa or protected species as listed under the Mpumalanga Nature Conservation Act (MNCA) (No. 10 of 1998), or the National Environmental Management: Biodiversity Act Threatened or Protected Species (NEMBA ToPS) (No. 10 of 2004).

Fieldwork

In accordance with the accepted proposal for this study, the botanical specialist study presented in the current report was to assess the footprint of the Low’s Creek proposed development.

Vegetation communities identified in the desktop phase were ground-truthed during field visits. The project area as well as the surrounding environment was surveyed on foot and dominant plant species were listed according to each of the vegetation communities.

The study area was broadly stratified into major classes on the basis of gradient, aspect, terrain units (e.g., crest, mid-slope and foot slope), rock cover, soils, land-use and vegetation physiognomy.

A total of 5 sites were surveyed and floristic data is summarised in Table 22. Environmental parameters recorded at each stand included the following:

- locality coordinates using a Global Positioning System (GPS) receiver;
- terrain unit (midslope, foot slope, etc.).
- estimated percentage surface rock cover; and
- any visible disturbances (e.g., grazing, fire, old lands).

This floristic classification was used only to guide the identification of the robust ‘vegetation units’ described in this report, which are based on qualitative and semi-quantitative floristic and habitat data gathered at the sites surveyed during the study.

Parameters such as geology, topography, etc. were also obtained from the relevant topographical-, geological- and soils maps.

For the purposes of this study, the most recent version of the Mpumalanga Biodiversity Conservation Plan (MBCP) map of ecological sensitivity was obtained from the Mpumalanga Tourism and Parks Agency, and the boundaries of the study area were superimposed on this map.

The MBCP divides the entire province into the following categories of importance in terms of biodiversity conservation value: 'Irreplaceable', 'Highly Significant', 'Important and Necessary', 'Least Concern' and 'No Natural Habitat Remaining'. **No** 'Irreplaceable' or 'Important and Necessary' areas occur within the study area.

2.1.1 Riparian delineation

It is important to differentiate between wetlands and riparian habitats. Riparian zones are not wetlands, however, depending on the ecosystem structure, wetlands can also be classified as riparian zones if they are located in this zone (e.g., valley bottom wetlands). Although these distinct ecosystems will be interactive where they occur in close proximity it is important not to confuse their hydrology and eco-functions.

Riparian delineations are performed according to *"A practical field procedure for identification and delineation of wetlands and riparian areas"* as amended and published by the Department of Water Affairs and Forestry (2005); (Henceforth referred to as DWAF Guidelines (2005).

Aerial photographs and land surveys were used to determine the different features and riparian areas of the study area. Vegetation diversity and assemblages were determined by completing survey transects along all the different vegetation communities identified in the riparian areas.

Riparian areas are protected by the National Water Act (Act 36 of 1998), which defines a riparian habitat as follows:

> *"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."*

Riparian areas include plant communities adjacent to and affected by surface and subsurface hydrologic features, such as rivers, streams, lakes, or drainage ways. Due to water availability and rich alluvial soils, riparian areas are usually very productive.
Tree growth rate is high and the vegetation is lush and includes a diverse assemblage of species. The delineation process requires that the following be taken into account:

- Topography associated with the watercourse;
- Vegetation;
- Alluvial soils and deposited material.

A typical riparian area according to the DWAF Guidelines (2005) is illustrated in Figure 6.
In addition to the DWAF Guidelines (2005) and DWAF updated manual (2008), the unpublished notes: *Draft riparian delineation methods prepared for the Department of Water Affairs and Forestry, Version 1* (Mackenzie & Rountree, 2007) were used for classifying riparian zones encountered on the property according to the occurrence of nominated riparian vegetation species.

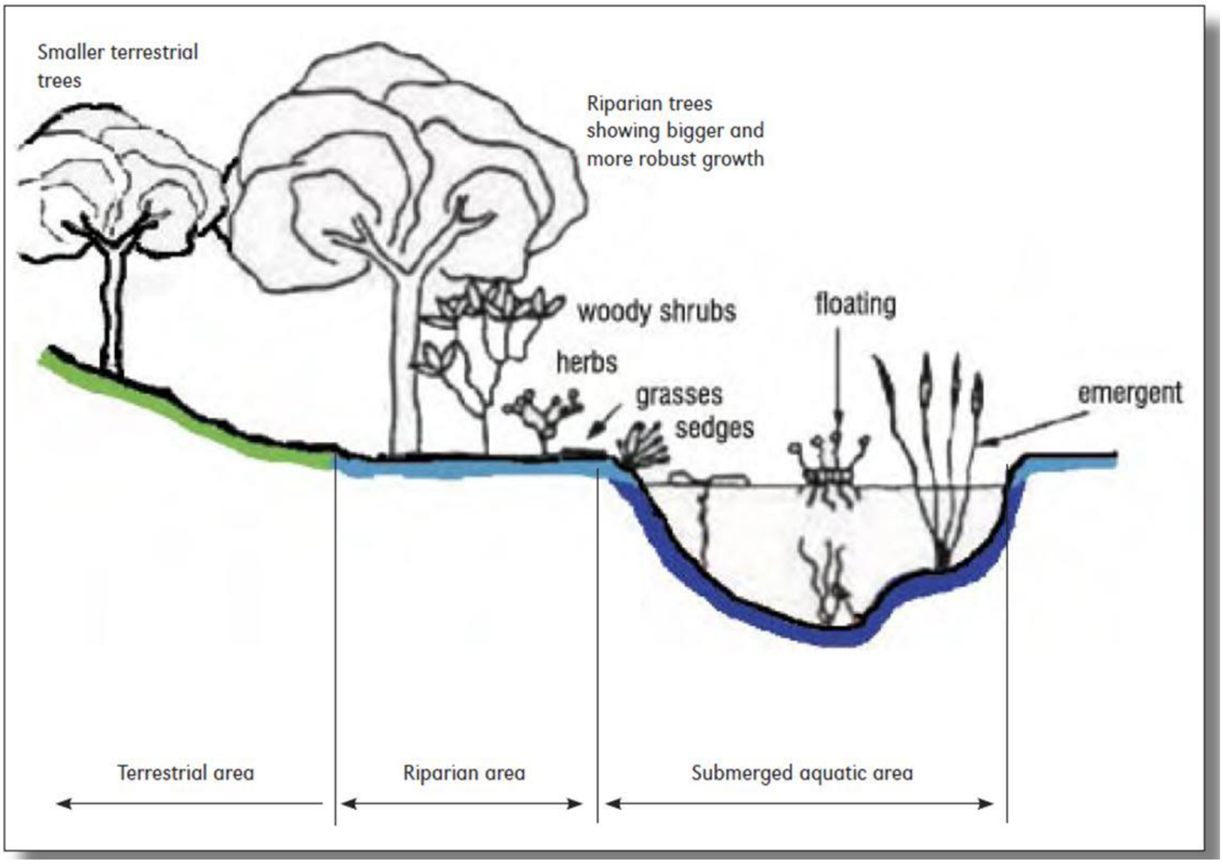


Figure 6: A cross section through a typical riparian area (DWAF Manual, 2008).

2.1.2 Buffers

Aquatic buffer zones are typically designed to act as a barrier between human activities and sensitive water resources thereby protecting them from adverse negative impacts. Buffer zones associated with water resources have been shown to perform a wide range of functions, and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity (Macfarlane et al, 2015). These functions include:

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic- and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

Due to their positioning adjacent to water bodies, buffer zones associated with streams and rivers will typically incorporate riparian habitat. Riparian habitat, as defined by the NWA, includes the physical structure and associated vegetation of the areas associated with a watercourse.

These areas are commonly characterised by alluvial soils (deposited by the current river system) and 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 (Macfarlane et al, 2015).

However, the riparian zone is not the only vegetation type that lies in the buffer zone as the zone may also incorporate stream banks and terrestrial habitat depending on the width of the aquatic impact buffer zone applied. A diagram indicating how riparian habitat typically relates to aquatic buffer zones defined in this guideline is provided in Figure 7.

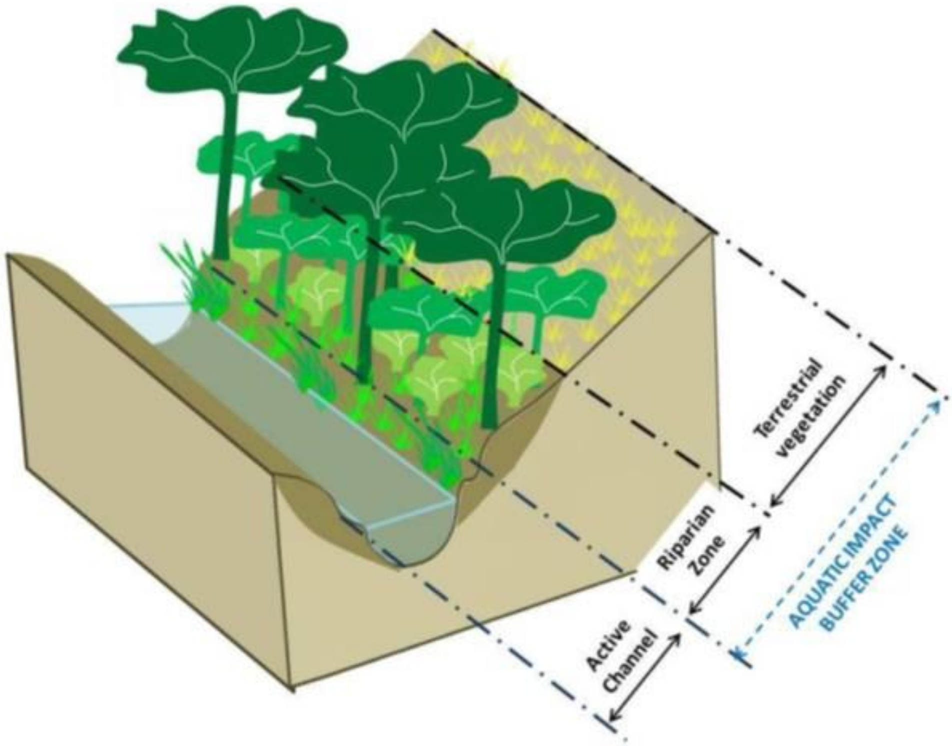


Figure 7: Schematic diagram indicating the boundary of the active channel and riparian habitat, and the areas potentially included in an aquatic impact buffer zone (Macfarlane et al, 2015).

Once an aquatic impact buffer zone has been determined, management measures need to be tailored to ensure buffer zone functions are maintained for effective mitigation of relevant threat/s. Management measures must therefore be tailored to ensure that buffer zone functions are not undermined. Aspects to consider include:

- Aquatic impact buffer zone management requirements.
- Management objectives for the aquatic impact buffer zone; and
- Management actions required to maintain or enhance the aquatic impact buffer zone in line with the management objectives. Activities that should not be permitted in the aquatic impact buffer zone should also be stipulated.

Determining appropriate management and monitoring of buffer zones

A series of Excel based Buffer Zone Tools have been developed to help users determine suitable buffer zone requirements (Macfarlane and Bredin, 2017). These include a rapid desktop tool for determining potential aquatic impact buffer zone requirements together with three site-based tools for determining buffer zone requirements for rivers, wetlands and estuaries. Central to these tools is a buffer model, which is populated automatically from the data capture sheets provided. This is based on best available science and is used to generate buffer zone recommendations as part of the assessment process. The Overview of the stepwise assessment process for buffer zone determination (Macfarlane and Bredin, 2017) is illustrated if Figure 8.

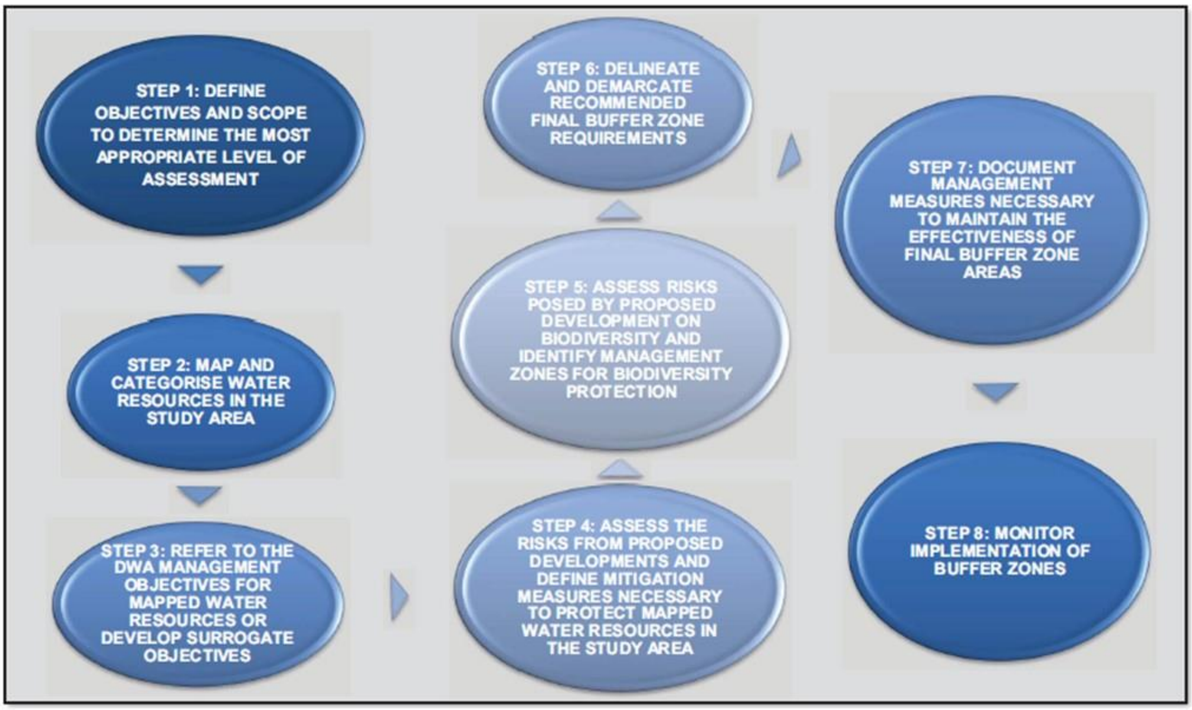


Figure 8: Overview of the stepwise assessment process for buffer zone determination (Macfarlane and Bredin, 2017).

Once a final buffer zone area has been determined, appropriate management measures should be documented to ensure that the water quality enhancement and other buffer zone functions, including biodiversity protection, are maintained or enhanced. Key aspects addressed include:

- Demarcating buffer zones.
- Defining suitable management measures to maintain buffer functions.
- Reviewing the need to integrate protection requirements with social- and development imperatives.
- Monitoring to ensure that buffer zones are implemented and maintained effectively.

2.1.3 Riparian Vegetation Index — VEGRAI)

The general components of the VEGRAI are specified as following:

- It is a practical and rapid approach to assess changes in riparian vegetation condition.
- It considers the condition of the different vegetation zones separately but allows the integration of zone scores to provide an overall index value for the riparian vegetation zone as a unit.
- The vegetation is assessed based on woody and non-woody components in the respective zones and according to the different vegetation characteristics which include, inter alia:
  - Cover
  - Abundance
  - Recruitment
  - Population structure
  - Species composition
- It provides an indication of the causes for riparian vegetation degradation.
- It is impact based. This means that the reference condition will only be broadly defined and based on the natural situation in the absence of impacts. Where possible, however, reference conditions should be derived based on reference sites or sections.

The index is based on the interpretation of the influence of riparian vegetation structure and function on in-stream habitat.

Although biodiversity characteristics are used in assessing the riparian vegetation condition, it is not a biodiversity assessment index *per se.*

For this study the Level 3 VEGRAI will be used as Level 3 is applied by the River Health Programme (RHP) and for rapid Ecological Reserve purposes. This level will be aimed at general aquatic ecologists.

2.2 Specialist assessment: Aquatic Studies

Aquatic Ecosystem Classification

Aquatic ecosystems were classified according to a hierarchical system described by Ollis *et al*. (2013).

Aquatic biota surveys

Macro-invertebrates and fish are good indicators of river health. By making use of established and accepted survey methods (SASS5 for invertebrates and FRAI-based surveys for fish) and incorporating the habitat aspects, a proper basis for biological diversity can be obtained.

The different components of the proposed development and its impact on the aquatic environment will be assessed for the river in the project area. The following recognised bio-parameters and methods will be used:

- Aquatic invertebrates: South African Scoring System version 5 (SASS5).
- Fish communities: Fish Response Assessment Index (FRAI). Applicable fish habitat assessments such as the Habitat Cover Ratings (HCR) and Site Fish Habitat Integrity Index (SHI) will be used to assess the habitat potential and condition for fish assemblages.

2.2.1 Aquatic invertebrate assessment

Benthic macro-invertebrate communities of the selected sites were investigated according to the South African Scoring System, version 5 (SASS5) approach. An invertebrate net (30cm x 30cm square with 0.5mm mesh netting) was used for the collection of the organisms. The available biotopes at each site were identified on arrival. Each of the biotopes was then sampled separately and by different methods. Sampling of the biotopes was done as follows:

- **Stones in current (SIC):** Movable stones of at least cobble size (3 cm diameter) to approximately 20 cm in diameter, within the fast and slow flowing sections of the river. Kick-sampling is used to collect organisms in this biotope. This is done by placing the net on the bottom of the river, just downstream of the stones to be kicked, in a position where the current will carry the dislodged organisms into the net. The stones are then kicked over and against each other to dislodge the invertebrates (kick-sampling) for ± 2 minutes.
- **Stones out of current (SOOC):** Where the river is calm, such as behind a sandbank or ridge of stones or in backwaters. Collection is again undertaken using the kick-sampling method, except in this case the net is swept across the area sampled to catch the dislodged biota. Approximately 1 m^2 is sampled in this way.
- **Sand:** These include sandbanks within the river, small patches of sand in hollows at the side of the river or sand between the stones at the side of the river where flow was slow, or no flow was recorded. This biotope is sampled by stirring the substrate, shuffling or scraping of the feet is done for half a minute, whilst the net is continuously swept over the disturbed area.
- **Gravel:** Gravel typically consists of smaller stones (2-3 mm up to 3 cm). Sampling similar to that of sand.
- **Mud:** It consists of very fine particles, usually as dark-coloured sediment. Mud usually settles to the bottom in still or slow flowing areas of the river. Sampling similar to that of sand.
- **Marginal vegetation (MV):** This represents the overhanging grasses, bushes, twigs and reeds from the riverbank. Sampling is undertaken by holding the net perpendicular to the vegetation (half in and half out of the water) and sweeping back and forth in the vegetation (± 2m of vegetation).
- **Aquatic vegetation (AQV):** Rooted, submerged or floating waterweeds such as *Potamogeton*, *Aponogeton* and *Nymphaea*. Sampled by pushing the net (under the water) against and amongst the vegetation in an area of approximately one square meter.

The organisms sampled in each biotope were identified and their relative abundance is also noted on the SASS5 datasheet. Habitat assessments, according to the habitat types sampled, were performed due to the fact that changes in habitat can be responsible for changes in SASS5 scores.

This was achieved by applying the SASS orientated habitat assessment indices. The indices used are the Integrated Habitat Assessment System (IHAS) score sheet and the Habitat Quality Index (HQI).

The SASS5 method was used to establish the macro-invertebrate integrity in all three of the main habitat assemblages: stones, vegetation and sand/mud/gravel. The associated habitat types were determined with the Invertebrate Habitat Assessment System (IHAS) and the Habitat Quality Index (HQI).

Although the SASS5 method was used as prescribed by DWS, it must be kept in mind that this method was designed for water quality purposes. Therefore, the macro-invertebrate integrity scores may vary throughout the year as water quality changes, due to flow variation, as should be the case in the pre- and post-construction phases of the monitoring project.

Aquatic invertebrates were sampled using a standard SASS net and identified to at least family level according to the SASS5 sampling technique (Dickens and Graham 2002). 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 on the Level I Ecoregion and the geomorphological zone, according to the method of Dallas (2007) (Figure 9). The quality of each instream habitat where macro-invertebrates were sampled was assessed in terms of the suitability for aquatic macro-invertebrates 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.

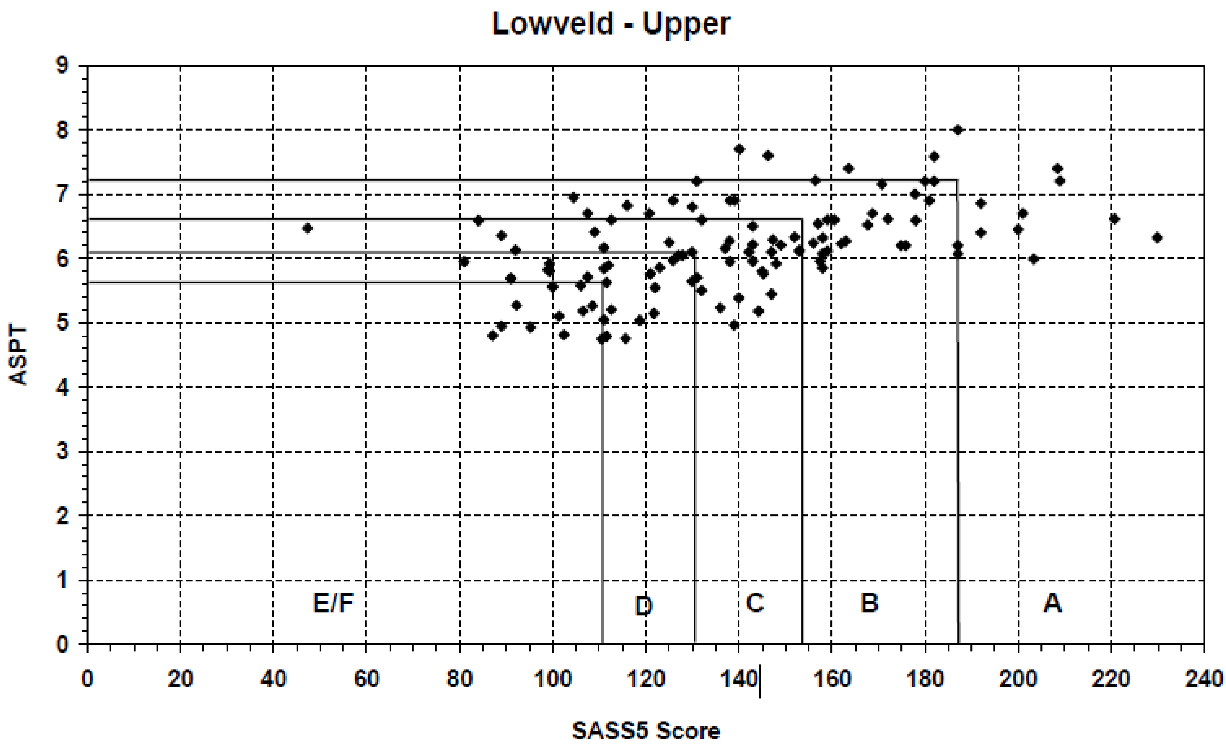


Figure 9. Guidelines used to delineate the Present Ecological State Categories in terms of SASS5 biomonitoring results in the upper portions of the Lowveld Ecoregion (Dallas 2007).

2.2.2 Fish communities - Fish Response Assessment Index (FRAI)

The biotic assessment method uses a series of fish community attributes related to species composition and ecological structure to evaluate the quality of an aquatic biota. Data on distribution, richness, length frequency and abundance will be collected. The sampling methods include fish traps, seine nets, mosquito nets and electro-fishing.

Table 1: Main steps and procedures in the calculation of the FRAI

STEP	PROCEDURE
River section earmarked for assessment	As for study requirements and design
Determine reference fish assemblage: species and frequency of occurrence	Use historical data & expert knowledge Model: Use eco-regional and other environmental information Use expert fish reference frequency of occurrence database if available
Determine present state for drivers	Hydrology Physico-chemical Geomorphology or Index of habitat integrity
Select representative sampling sites	Field survey in combination with other survey activities
Determine fish habitat condition at site	Assess fish habitat potential Assess fish habitat condition
Representative fish sampling at site or in river section	Sample all velocity depth classes per site if feasible Sample at least three stream sections per site
Collate and analyse fish sampling data per site	Transform fish sampling data to frequency of occurrence ratings
Execute FRAI model	Rate the FRAI metrics in each metric group Enter species reference frequency of occurrence data Enter species observed frequency of occurrence data Determine weights for the metric groups Obtain FRAI value and category Present both modelled FRAI and adjusted FRAI.

Fish segment identification, species tolerance ratings, abundance ratings, frequency of occurrence and health status techniques are applied during this survey to determine the integrity of the fish communities.

On arrival at the site a basic on-site visual appraisal is made of the habitat types available on that particular day at that particular flow. A site diagram is compiled indicating the different habitat types and the various components thereof. Sampling takes place in each of the different habitat types. These different habitat types are sampled separately using different methods.

a) Electro-shocking

Electro-shocking commences in the downstream component of the habitat. One person uses a backpack electro-shocker for shocking, using a scoop net to catch the stunned fish. The researcher progresses upstream, keeping the fish caught in a bucket until that particular habitat is surveyed. Each habitat shocked is timed. It is necessary to take care (as far as possible) when shocking so as not to disturb the remainder of the habitat still to be surveyed. As each habitat is completed the fish species caught, are identified, recorded and released back into their respective habitat types.

Any fish species that cannot be identified at the time is preserved in 10% formalin (in a sample bottle with label inside) for later identification by experts. The data sheet is completed for that particular habitat – recording every fish, its age class (adult, sub-adult, juvenile) and whether any fish is diseased (e.g., visible ecto-parasites). Each habitat type is recorded (e.g., shoot, riffle or pool etc.), as well as the width, depth, substrate, the extent sampled, the percentage of algae on substrate, whether there was any vegetation and the turbidity. The flow of that particular habitat is classified into one of five flow classes (no flow, slow flow, medium flow, fast and very fast flow).

The electro shocking device is used to sample certain habitats: shoots, riffles, rapids, shallow- medium depth pools in stream and off stream, runs and back waters.

b) Cast net

A cast net (a weighted circular net that is thrown into the water) is used in pool type or slower flow and deeper habitat types. As with method (a) all aspects of the habitat type are recorded including the fish species, numbers, age class and health. The number of throws efforts per habitat is also recorded.

2.2.3 Water Resources Analysis

A water resources analysis or Yield Analysis is required to assess how much water can be abstracted from a river or dam on a sustainable basis. The term *sustainable* has different connotations to different users and is defined for the purpose of this evaluation as follows:

- The amount of water that can be abstracted at the specified level of assurance. Irrigation use within the Kaap River catchment is typically in the order of 70%, and even lower in the lower Kaap.
- The EWR must be met as a priority over other water users.

The Water Resources Modelling Platform (Mallory et al, 2013) was used for this analysis. This is a time series simulation model which operates at a monthly time step. The model simulates river flow, reservoir storage and water use at a monthly time step over the period 1920 to 2016.

2.3 Specialist assessment of terrestrial fauna for the Low's Creek Dam project

Terrestrial fauna, desktop studies and literature review

A detailed desktop study on all faunal species recorded in the past was completed and includes a description of red data and protected status according to the IUCN red data list and the National Environmental Management Biodiversity Act (TOPS List). All applicable literature was reviewed and extensive background studies regarding species distributions, habitat preferences and species status were updated accordingly (Appendices 5-8).

The potential occurrence of threatened species was also evaluated from historical records, available literature, habitat availability and personal experience. The fauna species lists thus represent the majority of species occurring in the study area and provide a solid basis from which the project can continue to develop a comprehensive species list. The following detailed desktop studies and baseline animal assessment were conducted:

- Identification of all animal species expected to be present according to desktop studies of all relevant animal groups, namely birds; herpetofauna (amphibians and reptiles); and mammals. Potential occurrence of fauna in the study area was predicted based on knowledge of known habitat requirements of local fauna species.
- Lists of conservation-important mammals, birds, reptiles and frogs potentially occurring within the proposed agricultural development were prepared using data from the MTPA's threatened species database and applicable literature. The above data was captured mostly at a quarter-degree spatial resolution but was refined by excluding species unlikely to occur within the study area, due to unsuitable habitat characteristics (e.g., altitude and land-use).
- Identification of all red data protected and conservation important species per animal group and the compilation of distribution maps and GPS coordinates where recorded.
- Design management and monitoring programs to successfully monitor and manage all red data and protected and/or conservation important species.
- The assessment includes a review of all relevant literature, completion of field surveys, production of specialist reports and development of management recommendations.

The current status of the faunal environment and an evaluation of the extent of site-related effects were determined using selected ecological indicators. At the same time all rare and endangered species, protected species, sensitive species and endemic species (conservation important faunal species) were identified and used to update and supplement existing studies. Ideally faunal surveys should cover the summer season, stretching from October to February. Surveys was conducted during January, February, June, July and August (all in 2020). The survey included the following faunal groups:

Amphibians, reptiles, birds and mammals were surveyed in pre-selected units. Emphasis was placed on fauna with high conservation value and their probability of occurrence in the unit. These include meticulous searches on fixed transects in all the representative biotopes to assess the presence/absence of amphibians, reptiles, birds and mammals species. Where necessary, special methods were implemented to augment the possibility of finding species, including traps, nocturnal spotlight searches and identifying tracks and scats. Special emphasis is placed on finding threatened species.

Minimum requirements guidelines from the Mpumalanga Tourism and Parks Agency:
Mammals/Birds

1. The Mpumalanga Biobase Report should be consulted for obtaining background on the conservation value of land and areas of sensitivity within the Mpumalanga Province. This report is obtainable from the Mpumalanga Tourism and Parks Agency (MTPA).
2. A list of all potential species should be submitted. The following should be highlighted for threatened (Red Data) species.
    i. International Red Data status (Latest version of IUCN Red Data List)
    ii. National Red Data status (Latest version)
    iii. Endemic status of each species
    iv. Protection status of each species (Mpumalanga Nature Conservation Act 10 of 1998)
3. A full survey to determine species richness should be undertaken. The time of year to conduct surveys should depend on the activity pattern of the species. The survey area should not be restricted to the proposed site of development but should include all habitat types over the entire property as well as adjacent areas. These surveys should be performed by specialists with expertise in the area of environmental concern (EIA Guideline document).
4. A list of all species recorded during the survey should be supplied to the MTPA. Species data (GPS point locality, species name and date) should be forwarded to the MTPA.
5. Where total destruction is going to take place:
    i. Specified faunal species must be captured and relocated to suitable habitat in the area.
    ii. The operations must be handled by specialists with expertise in the area of environmental concern (GIS Guideline document).
    iii. Species data (GIS point locality, species name and date) must be forwarded to the MTPA.
6. Maps indicating:
    i. Areas of sensitivity
    ii. Areas already disturbed/transformed and size (ha)
    iii. Proposed development and size
    iv. Land-use on surrounding properties.
    v. Location of important species as well as roosting and hibernation sites e.g., caves of ecological importance, in relation to the proposed development.
7. Recommendations on buffer zones will only be made once comprehensive species lists have been received and reviewed in the EMPr/Scoping Reports.
8. A list of threatened species that can potentially occur but were not found during site visits or surveys should be provided. In respect of each such species an opinion on the likelihood of that species, occurring on the site and the reason for that opinion should be provided.
9. A list of exotic/introduced vertebrate species occurring on the property should be provided.
10. An ethically accepted plan for the eradication or removal of any exotic/introduced species posing a threat to indigenous species should be included in the report.
11. Any existing and/or planned actions to prevent free movement/roaming of domestic animals such as dogs, cats, goats and pigs should be provided.

Field surveys and habitat evaluation.

Terrestrial vertebrate surveys

- **Amphibian surveys**

Visual encounter surveys and audio monitoring are appropriate techniques for both inventory and monitoring of amphibian species. Both visual and auditory surveys were conducted along all transects, in plots, along streams and around ponds. Most amphibians are detectable in this manner. To ensure a comprehensive inventory, all possible microhabitats were also searched, namely: soil, water, tree trunks, and beneath rocks, during both the day and at night.

- **Reptile surveys**

The most practical way to monitor reptiles, over large areas, is to sample along transects and systematically search encountered refuge areas. Transects were surveyed in different habitat types and all “cover” objects within a specified distance of the line turned over and checked. One particular strength of such transect monitoring is that it can be used to relate reptile abundance to habitat variables, such as vegetation and cover. The main objective of the survey is not to find as many reptiles as possible, but to get a reliable estimate of available habitat and quality of shelter and to compare these with expected reptiles and their required suite of habitat types.

- **Bird surveys**

Transects are probably the most widely used method of estimating the number of bird species in terrestrial habitats. Traditionally, observers will move along a fixed route undertaking surveys and recording the birds they see on either side of the route. For small birds, which are usually relatively numerous, a transect width of 10m on either side of the route (or 20-30m in open habitats) was found to be suitable for this study.

Transects were placed in such a way that all dominant soil and associated habitat types were adequately covered. Birds outside the transect band or those flying over were noted. Surveys always commenced at first light when avian activity was at its peak.

Bird calls are equally important in bird surveys and especially important during point counts in rugged terrain and dense bush where visual observations are limited. Point surveys can also be used within wide open areas where birds can be spotted from a distance, for example pans and grassland flats.

- **Mammal surveys**

The same line-transects were surveyed on foot to monitor diurnal mammal species. Each sighting as well as the related vegetation features was recorded to establish habitat preferences. All major habitat types were assessed.

For smaller mammals such as rodents and insectivores, Sherman traps were set out near the transect lines, while pitfall traps for collecting vertebrates were discontinued due to the time-consuming effort and low success rates. Visual sightings, as well as all signs of mammal presence (tracks and scats) were used as indicators of presence for some species.

- **Habitat surveys**

Representative habitat transects within the study area were surveyed. Macro- and micro-habitat surveys were executed to assess the quality of habitat and its potential to support various faunal species.

In assessing the habitat profiles in conjunction with the distribution data per species, accurate information on the probability of the species occurring in the relevant biotopes was obtained. A list of expected species for the different biotopes in the survey area was compiled and compared with the fauna observed during monitoring surveys.

The information obtained from the micro-habitat surveys was used to enhance the prediction abilities of the process. To this end, quality and quantity of habitat aspects provide an indication of species abundance, while presence or absence of habitat aspects indicates the probability of species occurrence. Habitat quality classifications could be a useful indication of resource utilisation (especially in adjacent areas).

The quality of baseline data is considered reasonable and appropriate for the purposes of this report.

2.4 Impact Assessment methodology

2.4.1 Mpumalanga Biodiversity Sector Plan (MBSP) and Threatened Ecosystems

It is important to note that all decisions regarding land-use applications in Mpumalanga are going to be evaluated by the authorities using the CBA maps and data (Figure 10 and 11), so it makes sense to consider these proactively, either prior to, or during, the EIA process (MBSP Handbook, 2014).

The following are extracts from the MBSP Handbook (2014) provided as background to our approach: “Environmental assessment is used to determine the broad ‘environmental fit’, and ecological sustainability of proposed land-use changes. It also establishes the biodiversity context within which a change in land-use is being contemplated and against which its likely impacts (both site-based and cumulative) must be assessed. CBA maps and their associated land-use guidelines provide a proactive and scientific basis for assessing the potential impacts of proposed land-uses and play an important role in providing a biodiversity-sensitive perspective in this process.”

Preliminary systematic biodiversity plans will help ascertain whether any habitat modification will contribute to cumulative impacts and compromise biodiversity targets for specific ecosystems or species, or by contributing to habitat fragmentation and degradation of ecological processes.

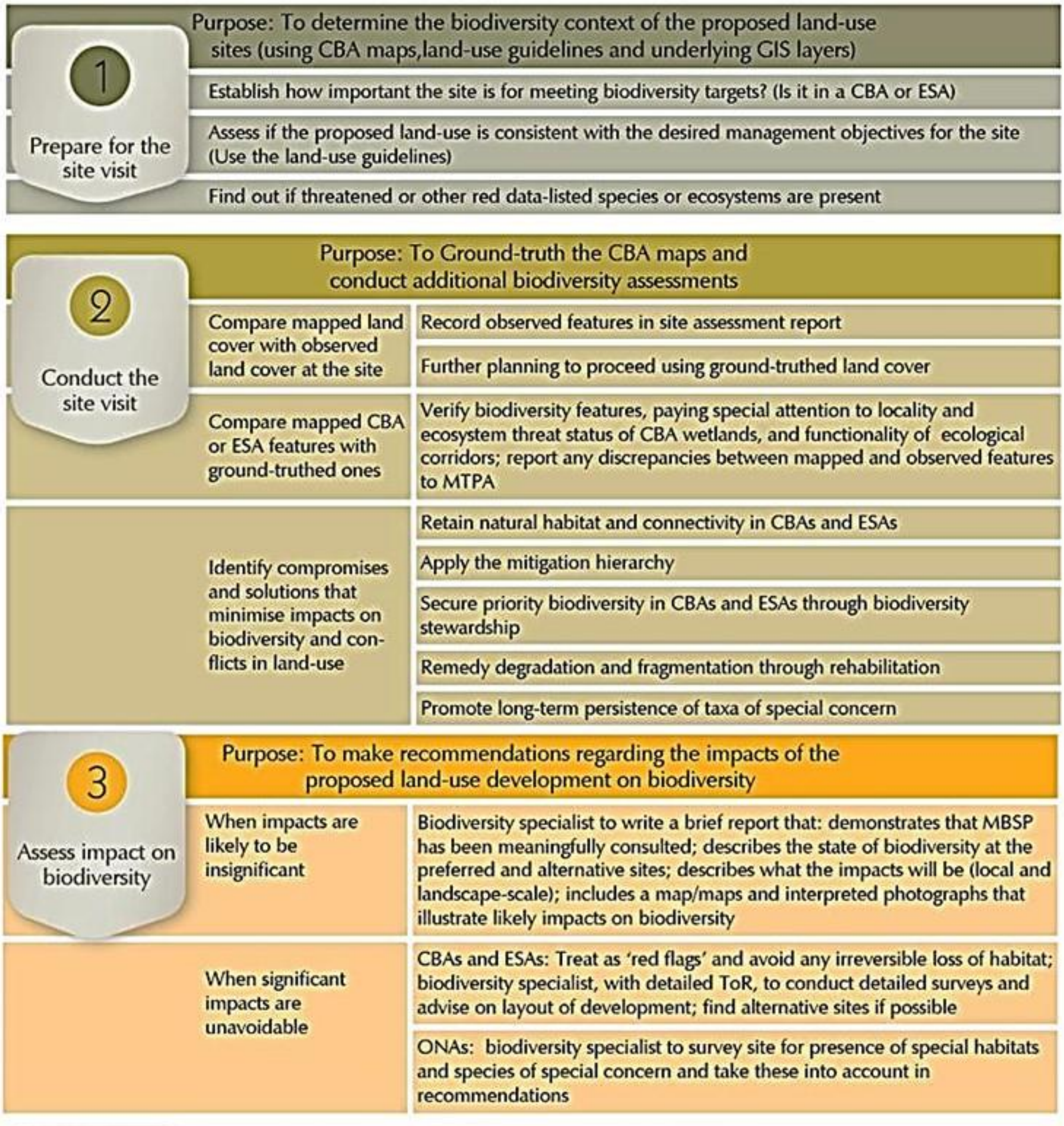


Figure 10**:** A summary of the first three steps to be followed in using the CBA maps proactively in an environmental impact assessment.

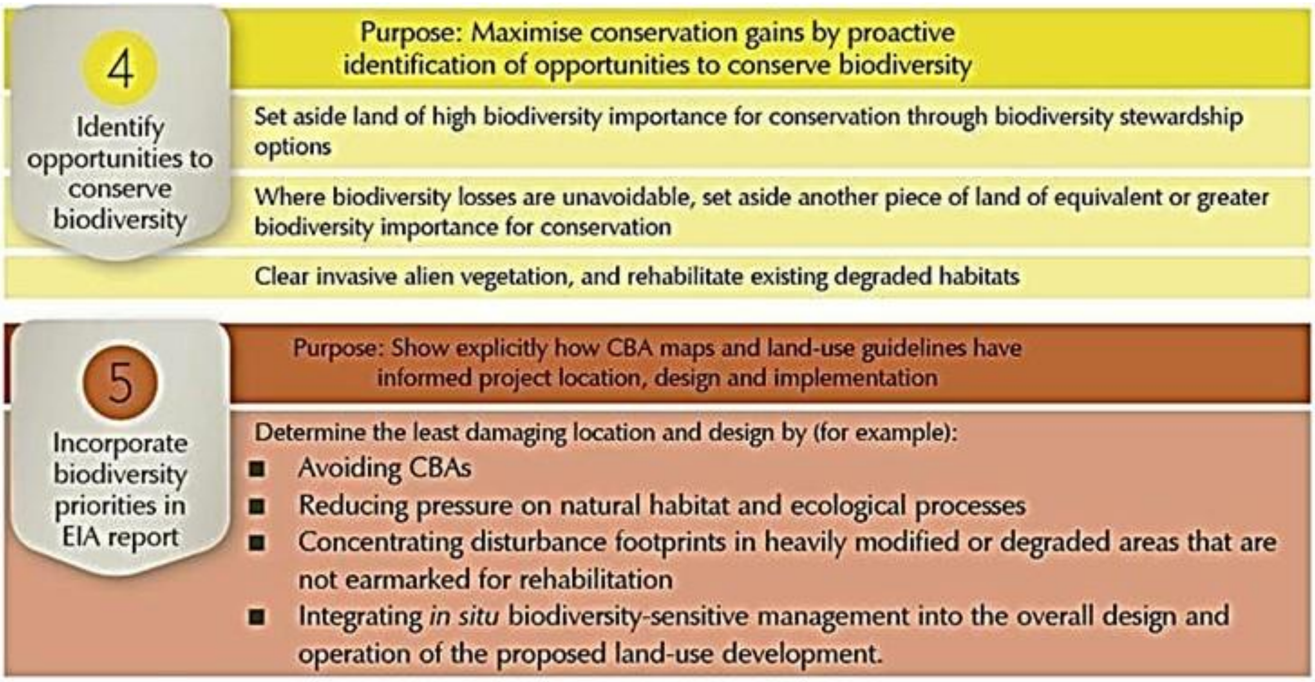


Figure 11: A summary of steps 4 and 5 to be followed in using the CBA maps proactively in an environmental impact assessment.

Explanation of the Mitigation hierarchy

Identify the best practical environmental options by avoiding loss of biodiversity and disturbance to ecosystems, especially in CBAs, by applying the mitigation hierarchy and the land-use guidelines (Figure 12).

Figure 12: The Mitigation Hierarchy consists of 4 steps: avoid and prevent, minimise, rehabilitate and offset.

Spatial data sets that indicate Critical Biodiversity Areas

To establish how important the site is for meeting biodiversity targets, a number of resources and tools are used as prescribed by the Mpumalanga Biodiversity Sector Plan (MBSP) (Mpumalanga Biodiversity Sector Plan, 2014). Specifically, the Land-Use Decision Support Tool (LUDS) and the MBCP are extensively used to compile the LUDS Report (BGIS, 2016). LUDS was developed to facilitate and support biodiversity planning and land-use decision-making at a national and provincial level. Its primary objective is to serve as a guideline for biodiversity planning but should not replace specialist ecological assessments.

Critical Biodiversity Areas (CBAs) are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. If these areas are not maintained in a natural or near-natural state, then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.

Land-Use Decision Support Tool (LUDS)

To establish how important the site is for meeting biodiversity targets, it is necessary to answer the following three simple but fundamentally important questions:

- How important is the site for meeting biodiversity objectives (e.g., is it in a **Critical Biodiversity Areas** (CBA) or Ecological Support Area (ESA)?
- Is the proposed land-use consistent with these objectives or not (to be checked against the land-use guidelines)?
- Does the sensitivity of this area trigger the requirements for assessing and mitigating environmental impacts of developments, or in terms of the listed activities in the EIA regulations?

2.4.2 Habitat sensitivity assessment

Much of the current conservation effort in South Africa is focused on promoting land-use practices that reconcile development opportunities and spatial planning at a landscape scale, with the over-arching goal of maintaining and increasing the resilience of ecosystems. This 'landscape approach' to biodiversity conservation involves working within and beyond the boundaries of protected areas to manage biodiversity within a mosaic of land-uses (MBSP: Lötter et al, 2014).

Initially an ecological sensitivity map of the project area was produced by integrating the information collected on-site with the available ecological and biodiversity information available in the literature and various relevant reports. This includes delineating the different vegetation and habitat units identified in the field and assigning sensitivity values to the units based on their ecological properties. Additionally, values and potential presence of vegetation and fauna species diversity, as well as species of conservation concern, were evaluated.

A three-step methodology was used to identify ecosystems:

• Step 1: Identify clusters of very high Irreplaceability planning units from the systematic biodiversity plan
• Step 2: Delineate ecosystems using ecological, topographical and/or geological features
• Step 3: Assess the threat value (high to low) for each ecosystem based on data Included In the systematic biodiversity planning process, to categorise as critically endangered, endangered or vulnerable respectively.

Five, broad-scale botanical biodiversity 'sensitivity' categories were identified and were developed for practical mapping purposes (Table 2). They are intended as a summary of the perceived botanical biodiversity value and sensitivity, of mapped broad-scale vegetation and land-cover type units.

Based on the assessment, the sensitivity of the project footprint can be divided into five categories of sensitivity: Very high, High, Moderate, Low and Negligible. The purpose of producing a habitat sensitivity map is to provide information on the location of potentially sensitive biodiversity features in the study area, including areas of natural vegetation, habitat types supporting important biodiversity features or high diversity, areas supporting important ecological processes and habitat suitable for any species of conservation concern.

An explanation of the different sensitivity classes is given in Table 2. Areas containing untransformed natural vegetation of conservation concern, high diversity or habitat complexity, Red List organisms or systems vital to sustaining ecological functions are considered potentially sensitive. In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to potentially have low sensitivity.

Table 2: Explanation of sensitivity ratings.

Sensitivity	**Factors contributing to sensitivity**	**Example of qualifying features**
VERY HIGH	Indigenous natural areas that are highly positive for any of the following: • Presence of threatened species (Critically Endangered, Endangered, Vulnerable) and/or habitat critical for the survival of populations of threatened species. • High conservation status (low proportion remaining intact, highly fragmented, habitat for species that are at risk). • Protected habitats (areas protected according to national/provincial legislation, e.g., National Forests Act, Draft Ecosystem List of NEMBA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act) And may also be positive for the following: • High intrinsic biodiversity value (high species richness and/or turnover, unique ecosystems) • High value, ecological goods & services (e.g., water supply, erosion control, soil formation, • carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value)	• CBA areas. • Remaining areas of vegetation type listed in Draft Ecosystem List of NEMBA as Critically Endangered, Endangered or Vulnerable. • Protected forest patches. • Confirmed presence of populations of threatened species.

	• Low ability to respond to disturbance (low resilience, dominant species very old).	
HIGH	Indigenous natural areas that are positive for any of the following: • High intrinsic biodiversity value (moderate/high species richness and/or turnover). Presence of habitat highly suitable for threatened species (Critically Endangered, Endangered, Vulnerable species). • Moderate ability to respond to disturbance (moderate resilience, dominant species of intermediate age). • Moderate conservation status (moderate proportion remaining intact, moderately fragmented, habitat for species that are at risk). • Moderate to high value ecological goods & services (e.g., water supply, erosion control, soil formation, carbon storage, pollination, refugia, food production, raw materials, genetic resources, cultural value). And may also be positive for the following: Protected habitats (areas protected according to national / provincial legislation, e.g., National Forests Act, Draft Ecosystem List of NEMBA, Integrated Coastal Zone Management Act, Mountain Catchment Areas Act, Lake Areas Development Act).	• Habitat where a threatened species could potentially occur (habitat is suitable, but no confirmed records). • Confirmed habitat for species of lower threat status (near threatened, rare). • Habitat containing individuals of extreme age. • Habitat with low ability to recover from disturbance. • Habitat with exceptionally high diversity (richness or turnover). • Habitat with unique species composition and narrow distribution. • Ecosystem providing high value ecosystem goods and services.
MEDIUM-HIGH	Indigenous natural areas that are positive for one or two of the factors listed above, but not a combination of factors.	• Corridor areas. • Habitat with high diversity (richness or turnover). • Habitat where a species of lower threat status (e.g. (near threatened, rare) could potentially occur (habitat is suitable, but no confirmed records).
MEDIUM	Other indigenous natural areas in which factors listed above are of no particular concern. May also include natural buffers around ecologically sensitive areas and natural links or corridors in which natural habitat is still ecologically functional.	
MEDIUM-LOW	Degraded, secondary or disturbed indigenous natural vegetation.	
LOW	No natural habitat remaining.	

A Biodiversity Sector Plan can be used to guide conservation action (such as identifying priority sites for expansion of protected areas), or to feed spatial biodiversity priorities into planning and decision-making in a wide range of cross-sectoral planning processes and instruments such as provincial- and municipal integrated development plans and spatial development frameworks, land-use management schemes, environmental management frameworks and environmental management plans (Table 40) (MBSP: Lötter et al, 2014).

2.4.3 Impact Assessment and mitigation

2.4.3.1 Impact Rating Methodology

It is the goal of the impact assessment process to determine the significance of potential environmental impacts associated with the proposed development. The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. Each impact was evaluated individually, however the possibility of a cumulative impact was also considered and evaluated accordingly.

The potential impacts or risks associated with the proposed development were assessed based on the following criteria:

- **Applicable phase:** Construction, Operational, (Decommissioning)
- **Nature of impact:** Provides a description of the expected impacts (Negative, neutral or positive)

The criteria used to determine impact consequence are presented in the table below.

Table 3: Criteria used to determine the consequence of the impact

Rating	Definition of Rating	Score
A. Extent - the area over which the impact will be experienced		
Site	Confined to the site, or part thereof	1
Local	Effect limited to 3 to 5km of the site	2
Regional	Effect will have an impact on a regional scale.	3
B. Intensity - the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. Duration - the timeframe over which the impact will be experienced and its reversibility		
Short-term	Up to 2 years	1
Medium-term	2 - 15 years	2
Long-term	>15 years	3

The scores are then combined (A+B+C) to determine the Consequence Rating (Table 4).

Table 4: Calculation of the consequence score.

Combined Score (A+B+C)	3-4	5	6	7	8-9
Consequence Rating	Very low	Low	Medium	High	Very high

The probability of the impact occurring needs to be considered in order for the final significance rating to be informed by the specific context.

Table 5: Probability Classification.

Probability - the likelihood of the impact occurring	
Improbable	<40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	>70%- 90% chance of occurring
Definite	>90% chance of occurring

The significance of the impact is attained by cross-referencing probability against consequence, as is listed below.

- **Significance:**
    - Low: Where the impact will have a relatively small effect on the environment and will not have an influence on the decision
    - Medium: Where the impact can have an influence on the environment and the decision and should be mitigated
    - High: Where the impact definitely has an impact on the environment and decision regardless of any possible mitigation

Table 6: Status and Confidence classification.

Status of Impact	
Indication whether the impact is adverse (negative) or beneficial (positive)	+ ve
	- ve
Confidence of Assessment	
The degree of confidence in predictions based on available information, the EAP's judgement and/or specialist knowledge.	Low
	Medium
	High

The impact significance rating should be considered by authorities in their decision-making process based on the implications of ratings ascribed below:

- **INSIGNIFICANT**: the potential impact is negligible and **will not** have an influence on the decision regarding the proposed activity/development.
- **VERY LOW**: the potential impact is very small and **should not** have any meaningful influence on the decision regarding the proposed activity/development.
- **LOW**: the potential impact **may not** have any meaningful influence on the decision regarding the proposed activity/development.
- **MEDIUM**: the potential impact **should** influence the decision regarding the proposed activity/development.
- **HIGH**: the potential impact **will** affect the decision regarding the proposed activity / development.
- **VERY HIGH**: The proposed activity should only be approved under special circumstances.

Significance post mitigation: Describes the significance after mitigation.
Mitigation: Provides recommendations for mitigation measures

3. Description of the study area

3.1 Present Ecological State of the study area

This report covers an area on the Farms: Portions of Remaining Extent of Esperado 253 JU and Portions 1 and 2 of Esperado Annex 222JU in the Kaapmuiden area, Mpumalanga. The study area is located within the quarter degree grid 2531CB. The site is located within the Ehlanzeni District Municipality, Mpumalanga Province.

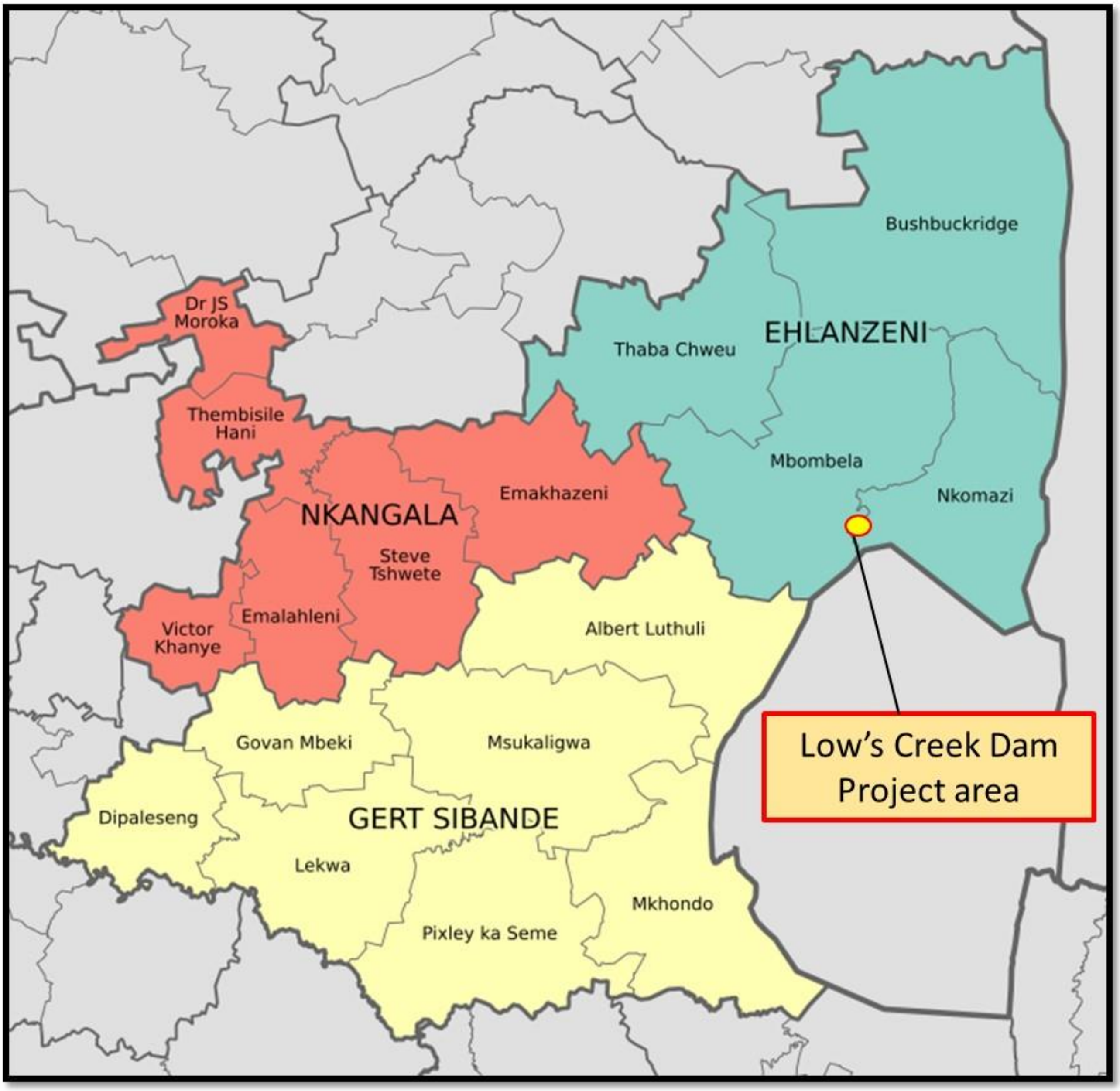


Figure 13: Location of the Low's Creek Dam Project area.

Local Municipality

Umjindi Local Municipality which is the focus of this report falls under the Ehlanzeni District Municipality in the Komati River catchment of the Inkomati WMA. There are a number of towns and rural villages that make up the Municipality. The Ehlanzeni District Growth and Development Plan is of relevance and it describes the importance of the Maputo Development Corridor as it provides Ehlanzeni specifically Mbombela with the status of economic development node.

According to Statistics South Africa's September 2005 labour force survey, Agriculture was the fourth highest formal employer in the province: 11.5% of the province's formal employment. Forestry and other agricultural activities provide jobs far in excess of their contributions to Provincial GGP – the sector comprises 6.1% of total GGP yet provides 18.1% of the employment opportunities in the Province. Although resources in this sector are constrained, agriculture holds significant employment potential for the Province.

The Nkomazi Local Municipality is characterised by farms, manufacturing and tourism, as the main source of employment and economic activity. The employment sector or industries in which the people of Nkomazi are involved shows that the Agriculture Sector employs 22%. (Nkomazi Local Municipality, 2013). In the Mpumalanga Province the agriculture sector contributes about 14% to the economic activity. Associated land uses in the area include agriculture, nature conservation, cattle ranching, game breeding, tourist facilities and hunting" (Nkomazi Local Municipality, 2013).

Farming

Giovanna Secco, one of the last remaining Italian settlers in the Low's Creek region, turned Low's Creek into a hub of papaya and macadamia production. They started working on Kudu Farm in Low's Creek on January 1, 1970. Having used the opportunity to buy farms as they came up for sale, the family have not only been able to expand the papaya production, but pioneered the macadamia nut industry in Low's Creek. With the first macadamia trees planted in 1998, they were told macadamias wouldn't work in Low's Creek as the climate is not conducive. Nearly a decade later, production was at a level where Giovanna could set up their own processing factory, Ivory Macadamias.

With a great concern for offering quality nuts, the family took the decision to market macadamias under the Ivory Macadamias label locally. They are one of the few producers who do so, as 98% of the nuts are exported. They decided to sell their own nuts locally to ensure good local quality. They supply the nougat industry, produce macadamia paste, oil and roasted nuts.

The map in Figure 14 illustrates the current development in the area surrounding the Dam Project site. About 85% of the surface area is transformed by cultivation, while 5% consists of old lands. The rest of the area can be considered Other Natural Areas, which includes drainage lines and outcrops where farming is not feasible.

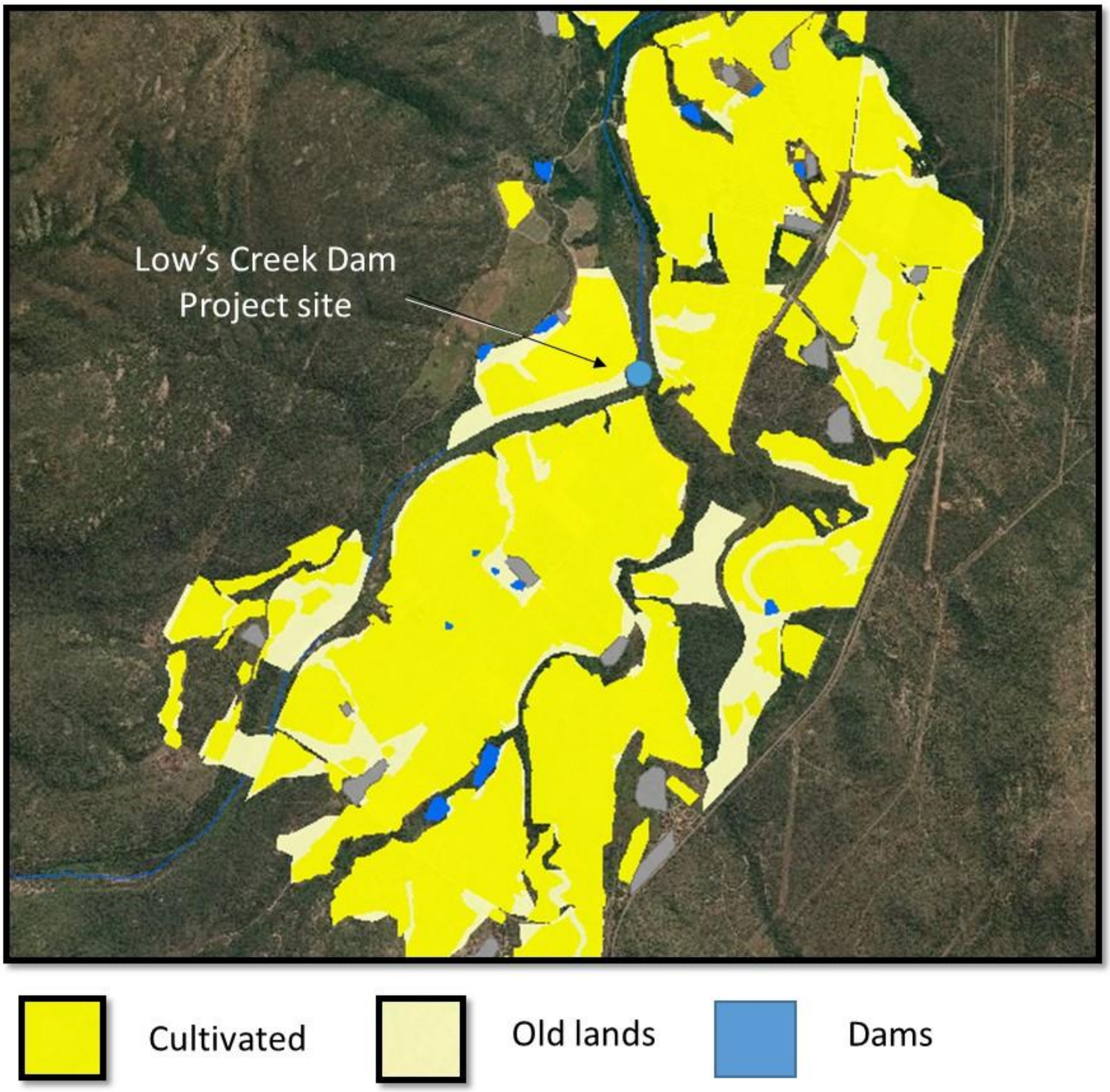


Figure 14: The land cover for the Low's Creek project area obtained from the Mpumalanga LUDS maps (BGIS, 2015).

3.2 Physiography of the study area

Ecoregion and River Characteristics

The vegetation type of the project area consists of **Granite Lowveld** (**SVI 3**; Mucina & Rutherford, 2006).

- **Distribution**: A north-south belt on the plains east of the escarpment from Thohoyandou in the north, with an eastward extension to Mica and Hoedspruit to the area east of Bushbuckridge. Substantial parts are found in the Kruger National Park spanning areas east of Orpen Camp southwards through Skukuza and Mkuhlu, including undulating terrain west of Skukuza to the basin of the Mbyamiti River. Altitude 250-700 m.

- **Vegetation & Landscape Features:** Consists of tall shrubland with few trees to moderately dense low woodland on deep sandy uplands. Also includes dense thicket to open savanna in the bottomlands and a dense herbaceous layer on fine-textured soils.

- **Geology & Soils:** From north to south, the Swazian Goudplaats Gneiss, Makhutswi Gneiss and Nelspruit Suite (granite gneiss and migmatite), and further south still, the younger Mpuluzi Granite (Randian) form the major basement geology of the area. Archaean granite and gneiss weather into sandy soils in the uplands and clayey soils with high sodium content in the lowlands.

- **Conservation:** Vulnerable but Least Concern according to the MBSP Handbook. Target 19%. Some 17% statutorily conserved in the Kruger National Park. About the same amount conserved in private reserves, mainly the Selati, Klaserie, Timbavati, Mala Mala, Sabi Sand and Manyeleti Reserves. More than 20% already transformed, mainly by cultivation and by settlement development. Erosion is *low* to moderate.

- The vegetation type represents tall shrubland with few trees to moderately dense low woodland on the deep sandy uplands. Dense thicket to open savanna occurs in the bottomlands. The dense herbaceous layer contains the dominant *Digitaria eriantha*, *Panicum maximum* and *Aristida congesta* on fine-textured soils, while brackish bottomlands support *Sporobolus nitens, Urochloa mosambicensis* and *Chloris virgata*. At seep lines where convex topography changes to concave, a dense fringe of *Terminalia sericea* occurs with *Eragrostis gummiflua* in the undergrowth.

Catchment and Wetland Setting

The farm Esperado 253 JU is situated in the Crocodile River Sub-Water Management Area which form part of the Inkomati drainage system. The project site is located in quaternary catchment X23G and the Low's Creek runs through the farm (Figure 17).

Ecoregion 4.04: North Eastern Highlands (Figures 15 and 16)

This is a mountainous area characterised by closed hills and mountains with moderate to high relief and vegetation comprising North-Eastern Highveld Grassland and Lowveld Bushveld types. Patches with Afromontane Forest are scattered throughout the region (Kleynhans et al., 2005).

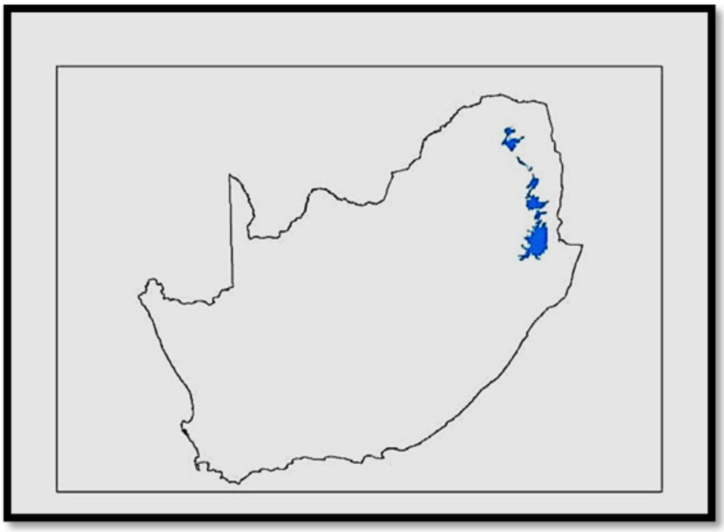


Figure 15: Preliminary Level I River Ecoregional classification System for South Africa: Ecoregion 4.04: North Eastern Highlands

Generally, this ecoregion can be regarded as transitional between the Lowveld and the Northern Escarpment. Towards the south, larger rivers such as the Great Usutu and Pongolo have some of their sources here, while perennial tributaries commonly contribute to the flow of larger rivers along the length of the region.

- Mean annual precipitation: Moderate to high.
- Coefficient of variation of annual precipitation: Moderate to very low.
- Drainage density: Generally medium
- Stream frequency: Low/medium to medium high
- Slopes <5%: Varies from <20% to 25 – 50%.
- Median annual simulated runoff: Moderate/high to high.
- Mean annual temperature: Cool to moderate

Size = 16140.3 km^2

Table 7: Main attributes of the North Eastern Highlands Ecoregion.

MAIN ATTRIBUTES	NORTH EASTERN HIGHLANDS
Terrain Morphology: Broad division (dominant types in bold) (Primary)	**Plains; Moderate Relief** Open Hills, Lowlands, Mountains; Moderate to High Relief Closed Hills, Mountains; Moderate and High Relief
Vegetation types (dominant types in bold) (Primary)	Mixed Bushveld; Mixed Lowveld Bushveld; **Sour Lowveld Bushveld;** Natal Lowveld Bushveld (limited) **North Eastern Mountain Grassland:** Patches Afromontane Forest
Altitude (m a.m.s.l) (primary)	300-1300 (1300-1500 limited)
MAP (mm) (modifying)	400 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 30
Rainfall concentration index	50 to >65
Rainfall seasonality	Early to mid-summer
Mean annual temp. (°C)	16 to 22
Mean daily max. temp. (°C): February	24 to 32
Mean daily max. temp. (°C): July	18 to>22
Mean daily min. temp. (°C): February	14 to 20
Mean daily min temp. (°C): July	2 to 10
Median annual simulated runoff (mm) for quaternary catchment	20 to >250

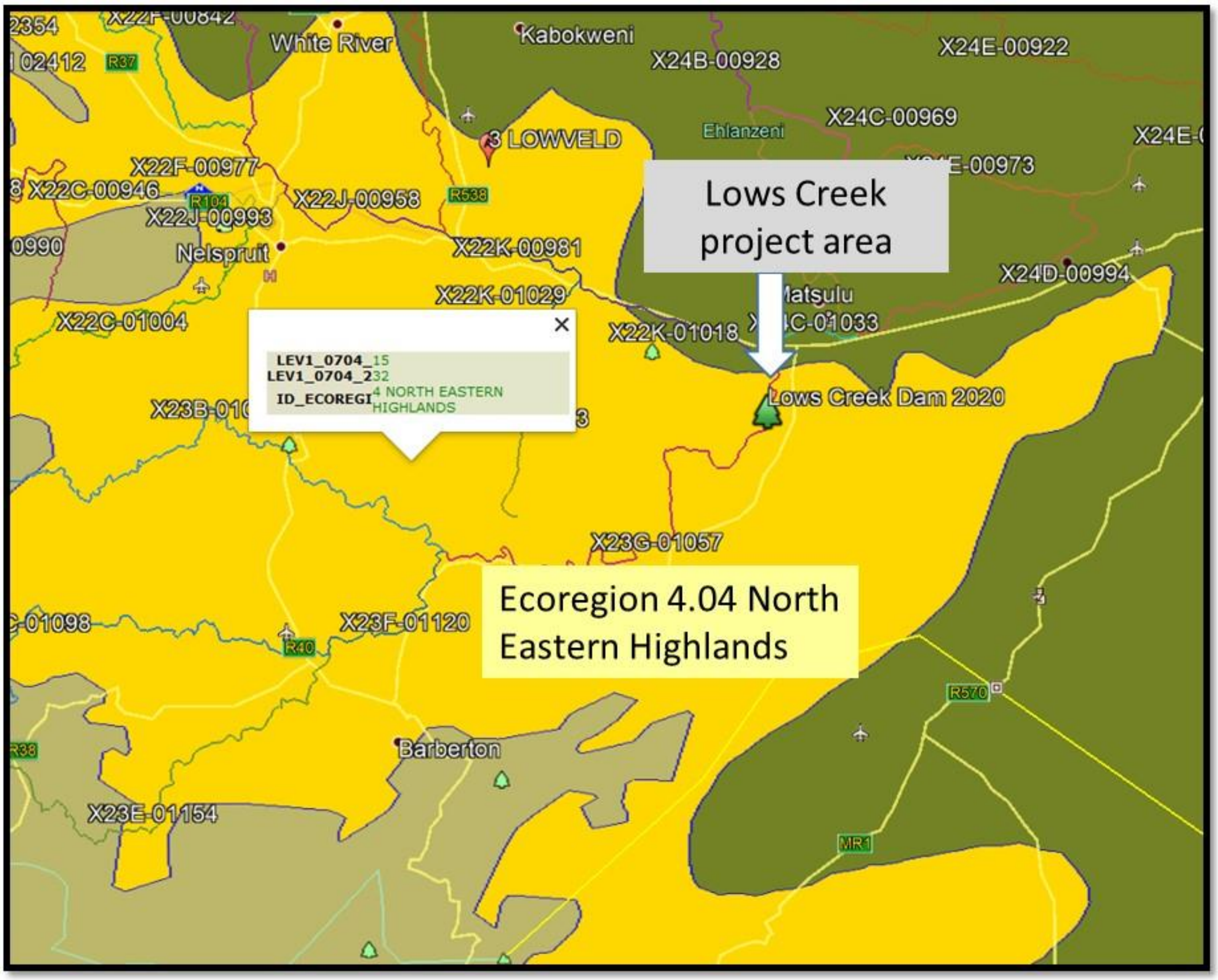


Figure 16: The project site is located in the North Eastern Highlands (4.04) Ecoregion according to the Water Resource Classification System (DWS, 2005).

The mean annual precipitation various between 400mm to 1000mm and is described as moderate to high. The stream frequency varies between low, medium, and medium high with slopes <5%: varying between <20% to 25% – 50% (Kleynhans et al., 2005).

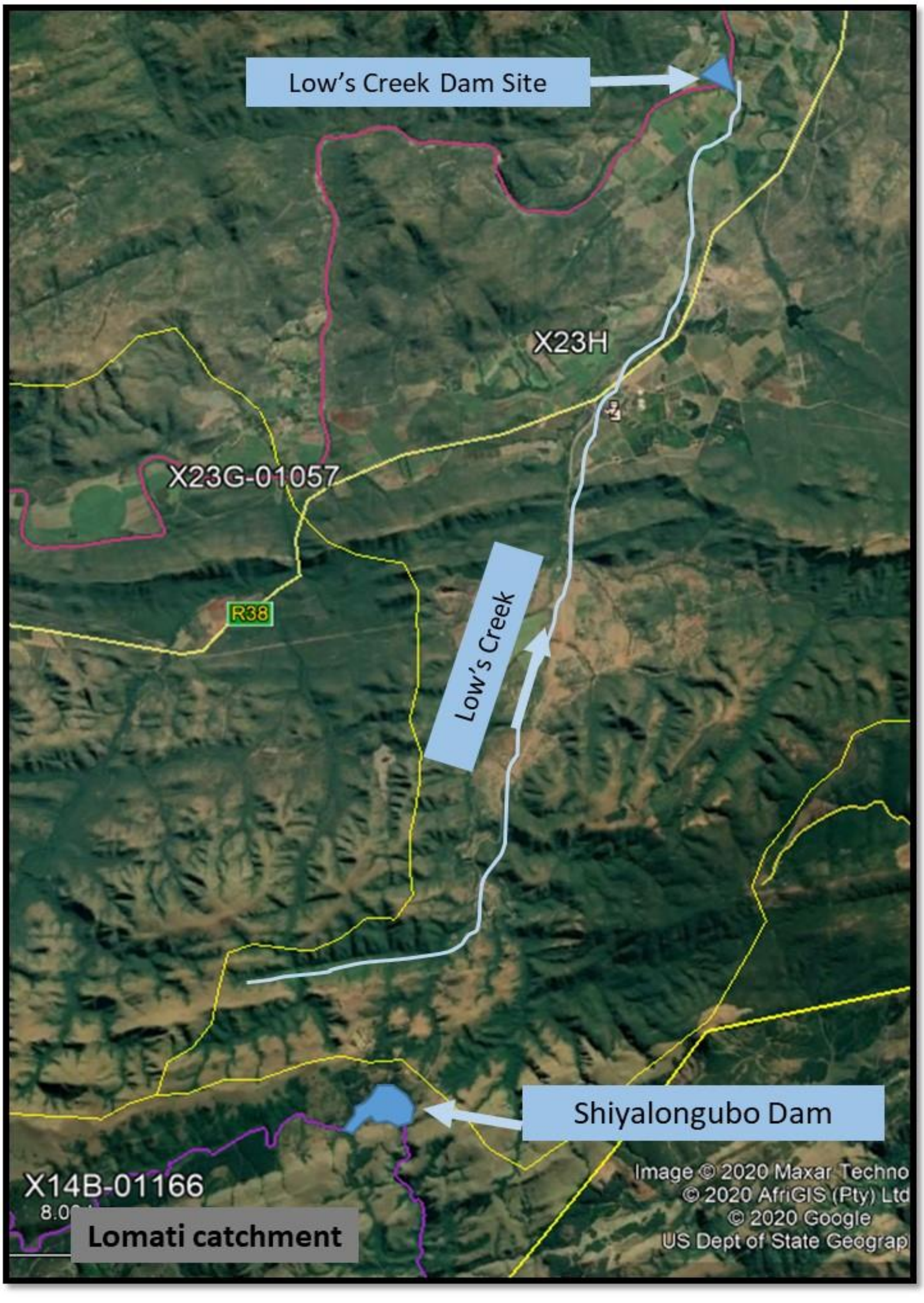
The Noord-Kaap River, Suid-Kaap River and the Queens River are relatively large tributaries of the Kaap sub-catchment. Five smaller tributaries, Hyslop's Creek, Oratava Creek, Figtree Creek, Honeybird Creek and Lows Creek originating from the Barberton Mountainlands, do not fall within a specific reach but are important refugia for this sub-catchment.

Low's Creek originates high up in the Baberton Mountains at an elevation of 985 m a.s.l. It flows northwards to meet the Kaap River at an elevation of 375 masl. Main impacts on this stream are from the small town, Sincobile. Small scale agricultural activities and mining have also had negative impacts on this stream.

Water from the Shiyalongubu Dam is pumped over the watershed to a diverted Low's Creek. Most of the water supplied for the Low's Creek irrigation is supplied from the Shiyalongubu Dam, located on a tributary of the Lomati River. Due to the extensive farming in the Low's Creek valley, water was required. During the drought of the 1930's, the Low's Creek stopped flowing. This led to the first dam in the lowveld being designed and constructed. The site chosen was the confluence of the Shiyalongubo and Ugutugulo Creeks, 9km south of Low's Creek and 20km east of Barberton and the dam capacity of 2.29 million m^3. The dam, the canal and tunnel to the farmlands were completed in 1939.

It is classified as a small scheme and transfers water from the Lomati catchment into the upper Kaap River catchment. The Shiyalongubo Dam on the Shiyalongubo River transfers an estimated 4 million m^3/annum to the Kaap River Catchment and is operated by the Low's Creek Irrigation Board.

The catchment reference numbers were obtained from the DWS PESEIS documents. The Google Earth image in Figure 17 indicates the location of the Low's Creek Project Area in the X23H catchment. The Low's Creek is a tributary of the Kaap River which is in the Sub-Quaternary Reach X23G-01057 (Figure 17). The Low's Creek is not viewed as a significant tributary by DWS and thus this drainage line was not addressed by the Department of Water and Sanitation Desktop PESEIS assessment process.



3H catchment, also showing the Shiyalongubo Dam and the proposed location of the Low's Creek Dam.

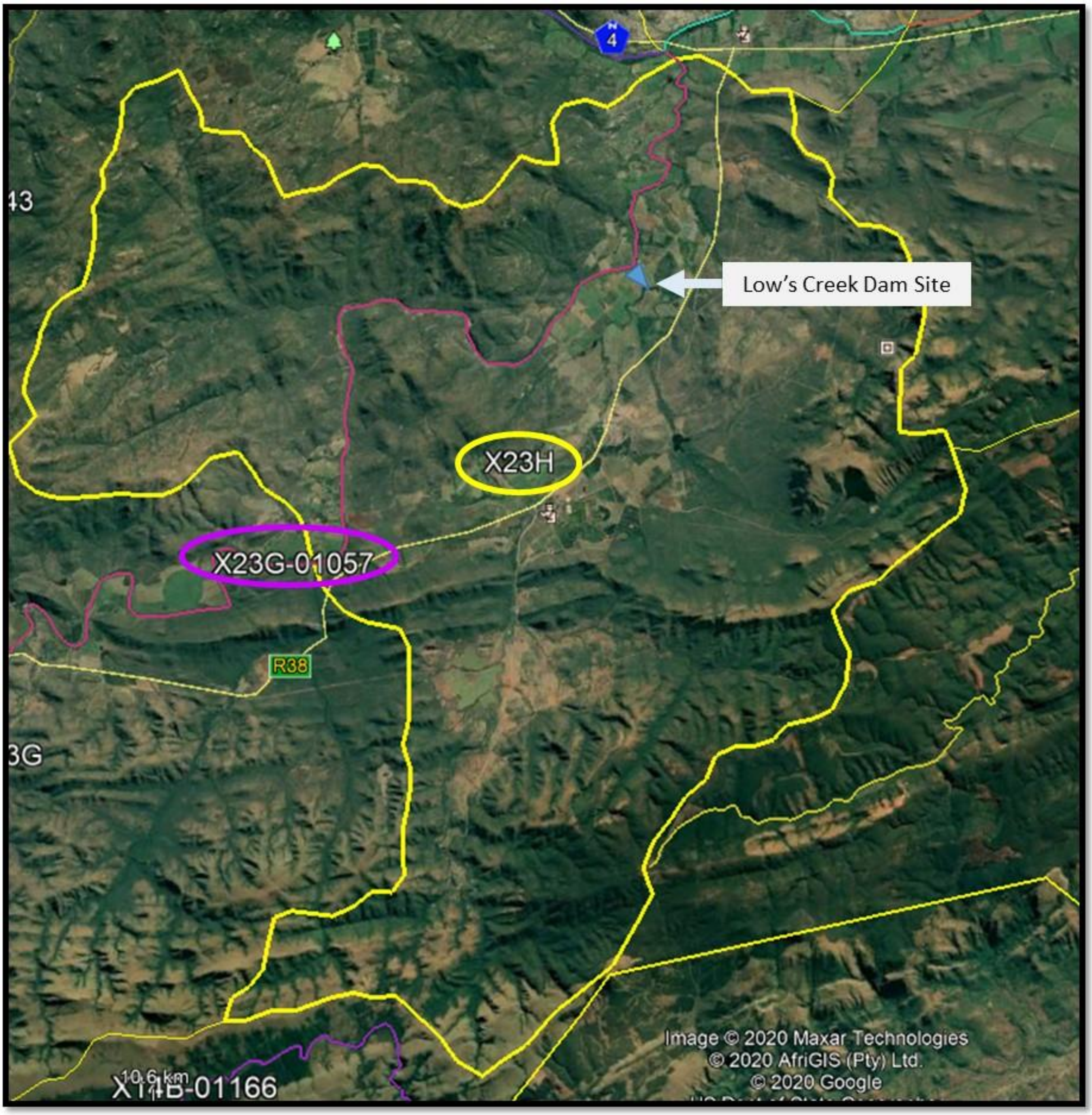


Figure 18: A Google Earth image indicating the location of the proposed Low's Creek Dam position in the X23H catchment and associated catchment reference numbers.

4. Results

4.1 Vegetation units and land cover types within the study area

The most recent vegetation map for South Africa, Lesotho and Swaziland (Mucina & Rutherford, 2007), places the entire study area (Figure 19) within **Granite Lowveld** (**SVI 3).** Vegetation/habitat types are mapped on the basis of available information (aerial photography, soil types, geology) and will consist of structurally distinct vegetation units (wetland, grasslands, woodland) as well as transformed areas (cultivated land, areas of alien vegetation). Vegetation/habitat units will be graded according to biodiversity value and conservation status.

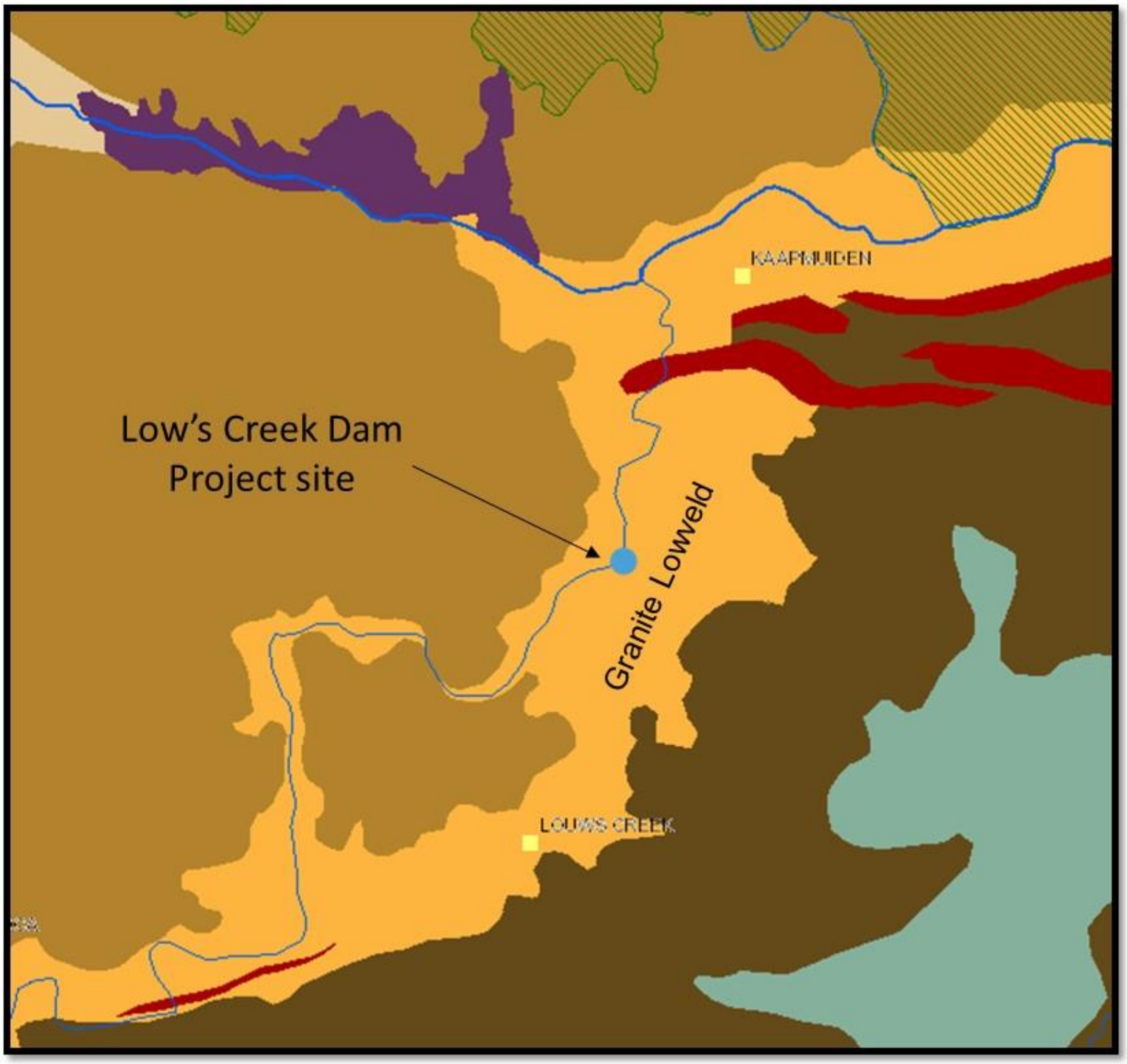


Figure 19: The Low's Creek study area is situated within **Granite Lowveld.**

Figure 20 below illustrates the land cover surrounding the Low's Creek project area. Most of the project area is transformed by cultivation and old lands.

The following broad-scale vegetation units are simply practical units that combine various plant communities which share structural and functional characteristics and have common management requirements.

A total of three units comprising transformed vegetation/habitat and one unit comprising untransformed vegetation/habitat were identified (Figure 20). These four units are listed below, and each unit is later described in more detail.

Vegetation units and land cover type:

Untransformed vegetation/habitat

1. Untransformed Riverine – Riparian and aquatic

Transformed vegetation/habitat

2. Agriculture - Current cultivation
3. Infrastructure
4. Dams

Vegetation and land cover types identified for the ecological surveys

1. Untransformed Riverine – Riparian and Aquatic (39.2 ha)

The untransformed (primary) riverine habitat in the project area is confined to the macro-channel of the Low's Creek streambed (covers 19.2% of the project area). The Low's Creek is a drainage line running through the project area, and it is flanked by its riparian zone which is the interface between the terrestrial and aquatic ecosystems. There are higher areas with rocky outcrops along the drainage system.

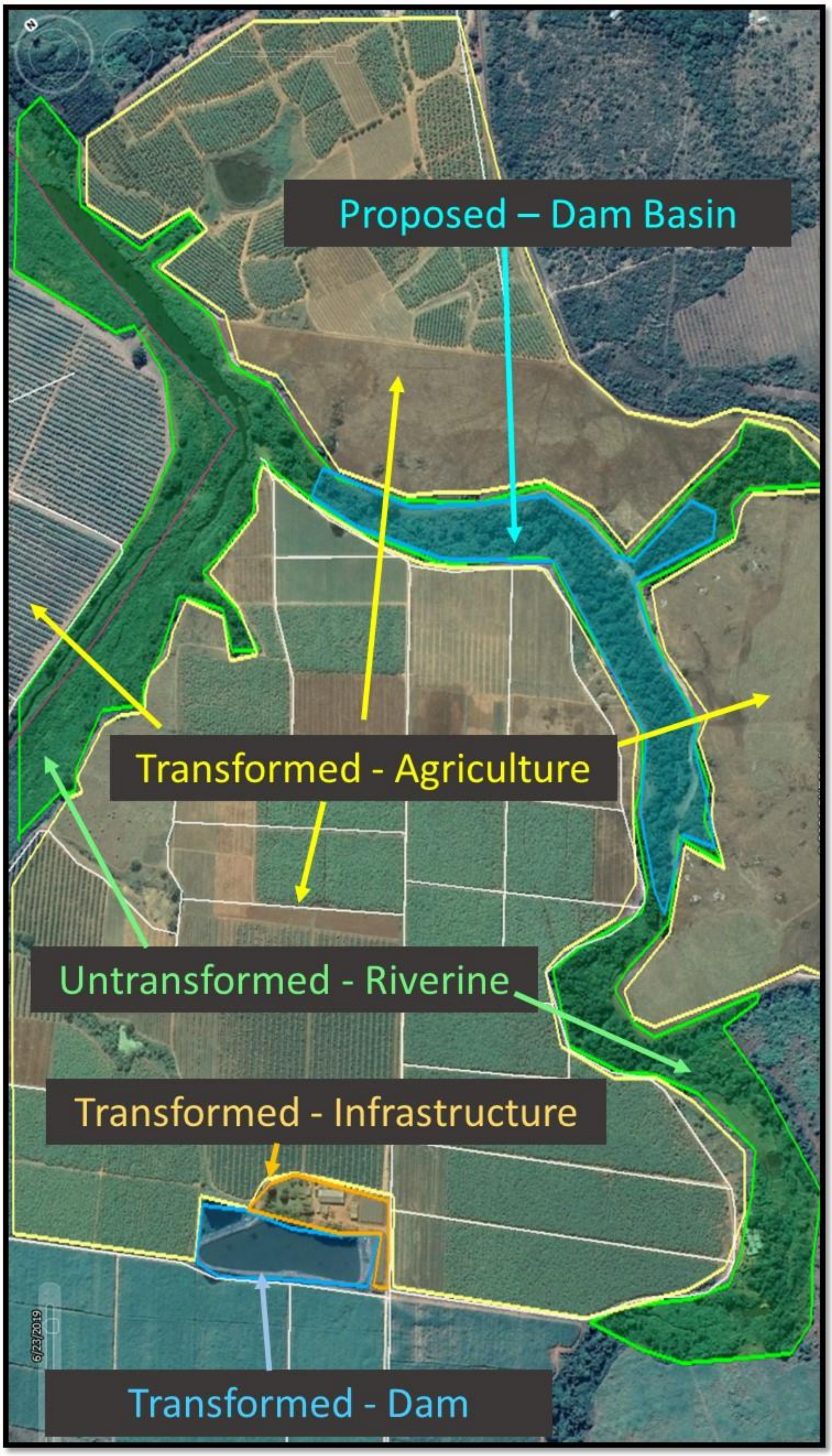


Figure 20: The broad-scale vegetation units or ground cover of the Low's Creek Dam project area.

Figure 21: The riverine habitat types of the Low's Creek project area.
Figure 21a: The river reach downstream of the preferred dam wall site with the Kaap River in the background.
Figure 21b: The riparian zone of the Low's Creek with orchards in the background.
Figure 21c: Alien Spanish reed flourishes along the stream edges.
Figure 21d: Dense riparian vegetation forms a corridor for animal movement.
Figure 21e: A shallow run in the Low's Creek.
Figure 21f: A deeper pool in the project area.

Transformed vegetation/habitat

2. Agriculture - Current cultivation (161.3 ha)

Most of the project area is transformed by agriculture (covers 79.0% of the project area), mostly orchards.

3. Infrastructure (1.48 ha)

There are some buildings and other infrastructure on the farm (covers 0.7% of the project area).

4. Dams (2.51 ha)

The main off-storage dam covers 2.51 ha, while there are other smaller storage facilities on the farming area (covers only 1.2% of the project area).

4.2 Ecological survey transects in the Low's Creek project area.

A major component of this study is the characterisation of habitat types and associated fauna (obtained from regional distribution records) of the available landscape/environment. This information is used as a basis for predicting the potential impacts of the proposed project, and other human-induced activities, on the composition of threatened fauna in the study area. Representative survey sites were selected in all prominent vegetation types of the study area. Extensive transects (400-3000m) were then surveyed for prevailing habitat and all associated fauna. GPS readings provide fixed locations of these transects for future monitoring (Table 8; Figure 22).

Table 8: Description of transects or point counts conducted for habitat, micro-habitat, influences and impacts, birds, mammal signs and herpetofauna (January – August 2020).

Habitat	Coordinates		Length (m)	Total (m)
	Start	End		
Untransformed vegetation/habitat				
1. Untransformed Riverine				
Transect 1	25°35'30.11"S 31°18'34.22"E	25°35'30.77"S 31°18'31.37"E	82	
Transect 2	25°35'33.83"S 31°18'39.53"E	25°35'36.53"S 31°18'37.11"E	107	
Transect 3	25°35'41.80"S 31°18'41.95"E	25°35'41.33"S 31°18'38.07"E	112	
Transect 4	25°35'51.52"S 31°18'36.67"E	25°35'49.39"S 31°18'35.22"E	76	
Transect 5	25°35'56.11"S 31°18'29.82"E	25°35'54.02"S 31°18'29.62"E	64	
			Total	441

GPS coordinates, acquired in the field (Table 8), were added to Google Earth to illustrate and demarcate the study area and survey transects. Five transects were completed to assess resident biota and their associated habitats. Specific habitat features were identified to provide an indication of available habitat for different animals favouring a specific biotope (specifically medium-sized fauna across all vertebrate groups).

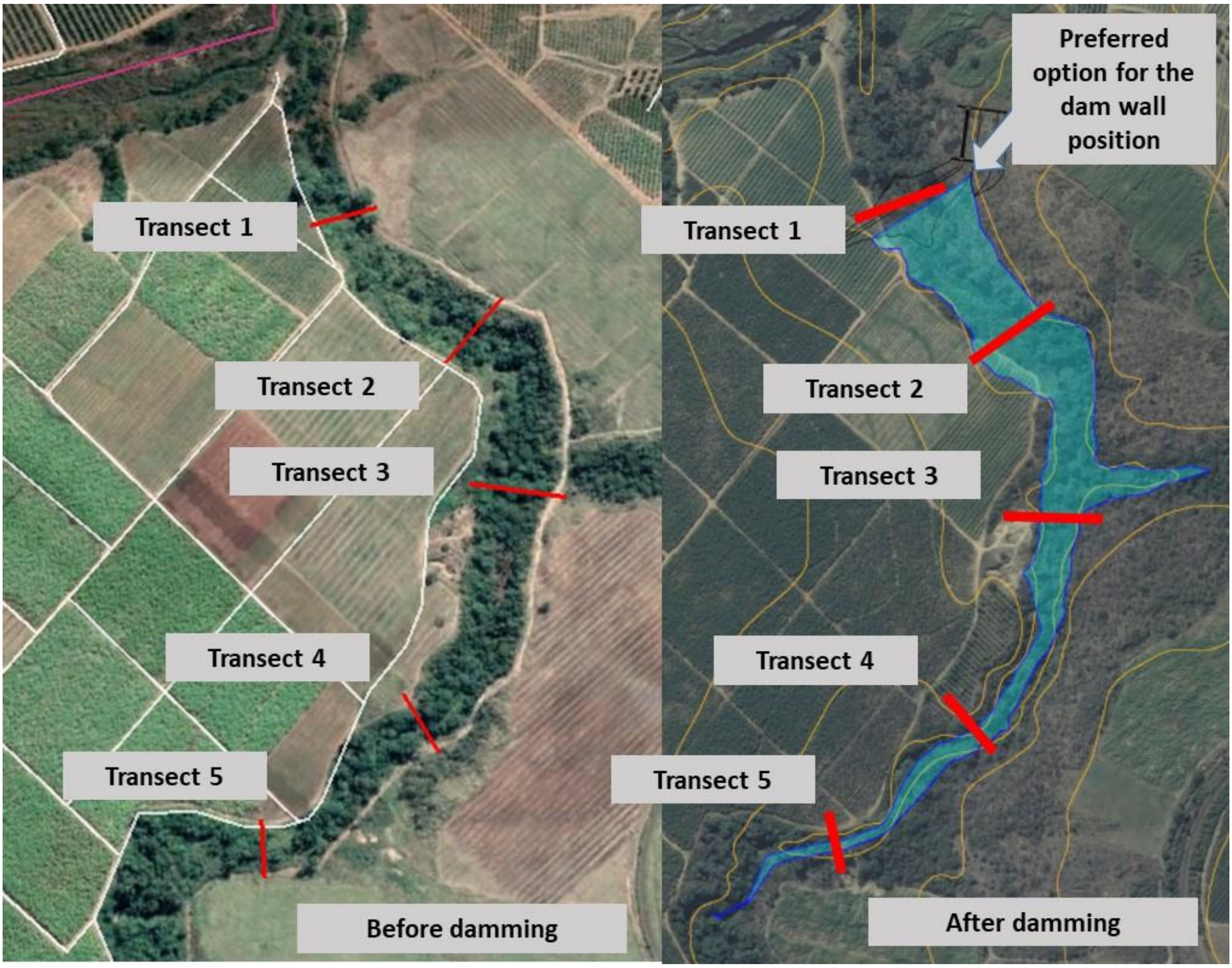


Figure 22: A map which was compiled by using a Google Earth image, indicating the before and after damming positions of the survey transects undertaken through the drainage line.

4.2 Biodiversity assessments

The fieldwork component of this study was conducted in the period January to August 2020. The survey methods described herein make use of a habitat surrogate technique, where habitat type and availability are used as a baseline assessment, with species' presence used to verify habitat integrity. The specialist report includes detailed species lists obtained from an extensive background review and the field monitoring results, with emphasis on the following:

- Probability of occurrence of species with high conservation value and assessment of the availability of their habitat on the property, as well as potential risks or threats to these species.
- Detailed overview on the current biodiversity status of the area in terms of terrestrial and wetland biota.
- Status of habitat, habitat preference and probability of occurrence.

During the biodiversity assessments of the Low's Creek environment, different vegetation and land cover units were identified. By definition, ecosystem status reflects the ecosystem's ability to function naturally, at a landscape scale and in the long-term. Vegetation types provide a good representation of terrestrial biodiversity because most animals, birds, insects and other organisms are associated with specific vegetation types (Table 9).

In order to establish a baseline of faunal occurrence, an assessment was made of the ecosystem template. The ecosystem template is a function of the geomorphology (abiotic) and the vegetation (biotic) structure of the area. By using species occurrence data from the current surveys (2020) and expected occurrence records of known species distributions and preferred habitat type, the baseline integrity of the study is established.

Ecosystem status reflects the ecosystem's ability to function naturally, at a landscape scale and in the long-term. The single biggest cause of biodiversity loss in South Africa is the loss and degradation of natural habitat. Vegetation types provide a good representation of terrestrial biodiversity, as they often reflect specific habitat types and associated animals, birds, insects and other organisms. The vegetation/land cover types were thus classified on the basis of structural and functional characteristics with the following objectives in mind:

- To assess the status of vegetation/land cover types impacted by development: due to either historical and/or present farming practices, residential occupation and/or mining practices;
- To assess the status of faunal assemblages in the study area, with emphasis on Species of Special Concern.

The next step is to establish the likelihood of Species of Special Concern, occurring in the vicinity (include degree of confidence). For this report, the category "Species of Special Concern" is considered to include all threatened taxa listed by South African Red Data lists (Species of Conservation Concern), Threatened or Protected Species (NEMBA) and all South African endemic taxa.

Conservation-important plant species listed for the quarter-degree grid 2531CB in the Mpumalanga Tourism & Parks Agency's (MTPA) threatened species database were used to produce a list of the most likely occurring species, which were searched for during fieldwork. Due to their limited distribution and range in South Africa, endemic species are also included as species of special interest. Traditionally, an endemic species will have a global distribution restricted to >90% of the atlas region.

Species of special concern are those that have particular ecological, economic or cultural importance and include: those that are rare, endemic or threatened; species with unusual distributions; and medicinal and other indigenous species that are exploited commercially or for traditional use. A ‘Species of Special Concern’ is any species or subspecies of biota, native to the province that has entered a long-term state of decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance. These are species that are threatened, or, if not, their population number is a special concern of the following ecological foundations:

- Occur in small, isolated populations or in fragmented habitat, and are threatened by further isolation and population reduction;
- Show marked population declines. Population estimates are unavailable for the vast majority of taxa. Species that show a marked population decline, yet are still abundant, do not meet the Special Concern definition, whereas a marked population decline in uncommon or rare species is an inclusion criterion;
- Depend on a habitat that has shown substantial historical or recent declines in size. This criterion infers the population viability of a species based on trends in the habitat types upon which it specialises;
- Occur only in or adjacent to an area where habitat is being converted to land uses incompatible with the animal's survival;
- Have few records, or which historically occurred here but for which there are no recent records; and
- Occur largely on public lands, but where current management practices are inconsistent with the species persistence.

Threatened faunal species represent a decline in biological diversity because of their numbers decrease and their genetic variability is severely diminished. Rare species, as well as those of special concern carry challenges different to most other large and common species; characteristics of these species are:

- extremely small or localised range
- requiring a large territory
- having low reproductive success
- needing specialised breeding areas
- needing specialised feeding areas
- habitat specificity
- life-histories not captured completely in the area (migrants)

4.3 Biota assemblages of the Low's Creek project areas

4.3.1 Vegetation communities

The vegetation communities of the Low's Creek Dam study area are classified as the **Granite Lowveld.**

Only one untransformed vegetation community was identified within the study area (Figure 20) on the basis of distinctive vegetation structure (grassland, wetland, thicket, etc), floristic composition (dominant and diagnostic species) and position in the landscape (mid-slopes, terrace, crest, etc). The detail of the species found in the riverine community and different morphological levels are listed in Table 9.

Plant surveys

A total of 83 indigenous plant species were recorded during fieldwork (Table 9); as well as 17 exotic species, some declared alien invaders.

Table 9: Vegetation assemblages and relevant plant species in the identified morphological levels in the project footprint. Vegetation types: 1= valley bottom; 2= Mid-slope; 3= Macro-channel bank (Shaded cells indicate presence of the species).

Plant species	1	2	3
Trees			
African olive (*Olea europaea africana*)			
African wattle (*Peltophorum africanum*)			
Apple-leaf (*Philenoptera violacea*)			
Black monkey orange (*Strychnos madagascariensis*)			
Blue sweetberry (*Bridelia cathartica melanthesoides*)			
Broom cluster fig (*Ficus sur*)			
Buffalo-thorn (*Ziziphus mucronata*)			
Bushman's grape (*Rhoicissus tridentata*)			
Bushveld paddle-pod (*Pristimera longipetiolata*)			
Common spike thorn (*Gymnosporia buxifolia*)			
Common tree Euphorbia (*Euphorbia ingens*)			
Common wild currant (*Searsia pyroides*)			
Common wild fig (*Ficus burkei*)			
Common wild pear (*Dombeya rotundifolia*)			
Dead-man's tree (*Euphorbia cupularis*)			
False-horsewood (*Hippobromus pauciflorus*)			
Firethorn corkwood (*Commiphora pyracanthoides*)			
Flame climbing bushwillow (*Combretum microphyllum*)			
Flame thorn (*Acacia ataxacantha*)			
Hedge euphorbia (*Euphorbia tirucalli*)			
Jackal berry (*Diospyros mespiliformis*)			
Jacket plum (*Pappea capensis*)			
Knob thorn (*Vachellia nigrescens*)			
Large-leaved false-thorn (*Albizia versicolor*)			
Large-leaved rock fig (*Ficus abutifolia*)			
Lebombo cluster leaf (*Terminalia phanerophlebia*)			
Lowveld bitter tea (*Gymnanthemum colorata*)			
Magic guarri (*Euclea divinorum*)			
Marula (*Sclerocarya birrea*)			
Matumi (*Breonadia salicina*)			
Moepel (*Mimisops zeyheri*)			

Mountain aloe (*Aloe marlothii*)			
Natal guarri (*Euclea natalensis*)			
Natal mahogany (*Trichelia emetica*)			
Pigeonwood (*Trema orientalis*)			
Potato bush (*Phyllanthus reticulatus*)			
Pride-of-De Kaap (*Bauhinia galpinii*)			
Puzzle bush (*Ehretia rigida*)			
Quinine tree (*Rauvolfia caffra*)			
Red bushwillow (*Combretum apiculatum*)			
Red-leaved fig (*Ficus ingens*)			
River euphorbia (*Euphorbia triangularis*)			
River bushwillow (*Combretum erythrophyllum*)			
River climbing thorn (*Senegalia schweinfurthii*)			
Robust thorn (*Vachellia robusta*)			
Rock tree nettle (*Obetia tenax*)			
Russet bushwillow (*Combretum hereroense*)			
Scented-pod thorn (*Vachellia nilotica*)			
Sickle bush (*Dichrostachys cinerea*)			
Small knobwood (*Zanthoxylum capense*)			
Smooth dombeya (*Dombeya cymosa*)			
Sneezewood (*Ptaeroxylon obliquum*)			
Swazi thorn (*Vachellia swazica*)			
Sycamore fig (*Ficus sycamorus*)			
Thorny karee (*Searsia gueinzii*)			
Transvaal saffron (*Elaeodendron transvaalense*)			
Umbrella thorn (*Vachellia tortilis*)			
Weeping lavender tree (*Heteropyxis natalensis*)			
White-berry bush (*Flueggea virosa*)			
White-leaved raisin (*Grewia bicolor*)			
White stinkwood (*Celtis africana*)			
Wild date palm (*Phoenix reclinata*)			
Wing-leaved wooden-pear (*Schrebera alata*)			
Woolly caper-bush (*Capparis tomentosa*)			
Forbs			
African cucumber (*Momordica balsamina*)			
Leopard orchid (*Ansellia africana*)			
Barberton daisy (*Gerbera jamesonii*)			
Blaasklits (*Priva cordifolia*)			
Bushveld grape (*Cissus rotundifolia*)			
Cape honeysuckle (*Tecomaria capensis*)			
Caustic vine (*Sarcostemma viminale*)			
Common kalanchoe (*Kalanchoe rotundifolia*)			
Droog-my-keel (*Cyphostemma cirrhosum*)			
Dyschoriste rogersii			
Large Ledebouria (*Ledebouria floribunda*)			
Mother-in-law's tongue (*Sansevieria hyacinthoides*)			
Wild foxglove (*Ceratotheca triloba*)			
Wing-seeded sesame (*Sesamum alatum*)			
Grass and sedges			
Common crowfoot (*Dactyloctenium aegyptium*)			
Guinea grass (*Panicum maximum*)			
Herringbone grass (*Pogonarthria squarrosa*)			

Matjiesgoed (*Cyperus sexangularis*)			
Natal red top (*Melenis repens*)			
Spear grass (*Heteropogon contortus*)			
Thatching reed (*Phragmites mauritianus*)			
Alien invading plants			
*Bugweed (*Solanum mauritianum*)			
*Castor oil bush (*Ricinis communis*)			
*Christmas berry (*Lantana camara*)			
*Common bamboo (*Bambusa balcooa*)			
*Demoina shrub (*Parthenium hysterophorus*)			
*Elephant grass (*Pennisetum purpureum*)			
*Guava (*Psidium guajava*)			
*Mexican poppy (*Argemone mexicana*)			
*Mexican sunflower (*Tithonia diversifolia*)			
*Moonflower (*Ipomoea alba*)			
*Peanut senna (*Senna didymobotrya*)			
*Pigweed (*Amaranthus hybridus*)			
*Sisal (*Agave sisalana*)			
*Spanish reed (Arundo donax)			
*Syringa (*Melia azedarach*)			
*Triffid weed (*Chromolaena odorata*)			
*Tropical richardia (*Richardia brasiliensis*)			

The Threatened Species Programme | SANBI Red List of South African Plants website (previously named POSA) provides access to South African plant names (taxa), specimens (herbarium sheets) and observations of plants made in the field (botanical records; Table 9). Data is obtained from the **Botanical Database of Southern Africa (BODATSA)**, which includes records from **the National Herbarium in Pretoria, the Compton Herbarium in Cape Town and the KwaZulu-Natal Herbarium in Durban.**

Table 10: Plant species obtained from the **Botanical Database of Southern Africa are** listed in this table for the area illustrated in Figure 23.

Family	**Species**	**Ecology**
Plumbaginaceae	*Plumbago auriculata*	Indigenous
Solanaceae	*Solanum nigrum*	Not indigenous; Naturalised
Lamiaceae	*Leonotis ocymifolia*	Indigenous
Cucurbitaceae	*Coccinia rehmannii*	Indigenous

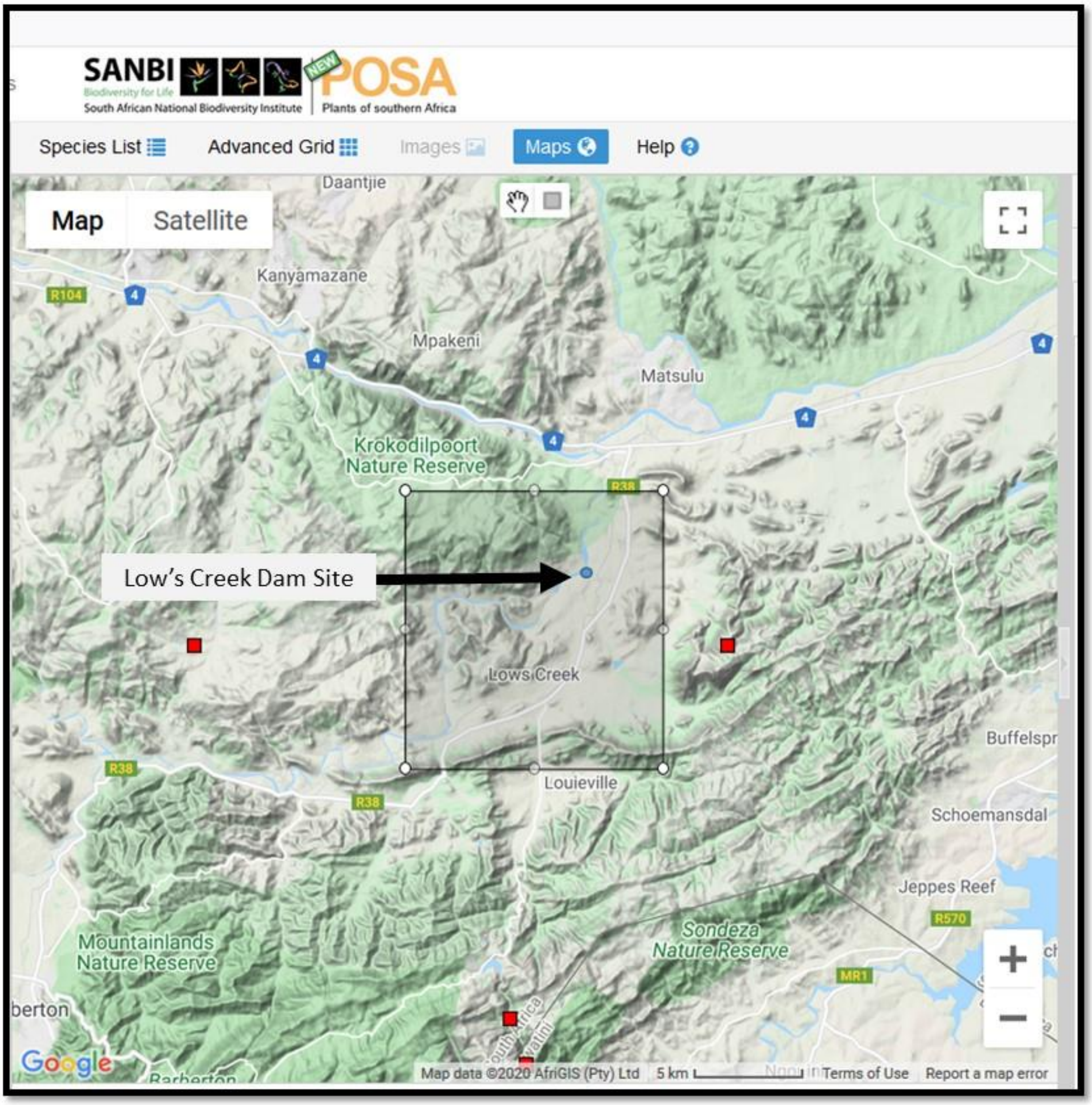


Figure 23: A map of the area searched on the POSA website, indicating the Low's Creek project area and surrounds. The species listed in the MTPA threatened species database (2531CB grid) have been narrowed down to the area demarcated.

Species of Concern: Plants

During the survey, the following protected trees (Government Gazette, 2019; Department of Agriculture, Forestry and Fisheries, 2019) were observed in the project area:

- Matumi (*Breonadia salicina*)
- Transvaal saffron (*Elaeodendron transvaalense*)
- Apple-leaf (*Philenoptera violacea*)
- Marula (*Sclerocarya birrea*)

Protected trees: Notice of the list of protected tree species under the National Forest Act, 1998 (Act No. 48 of 1998). “No person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any manner require or dispose of any protected tree or any forest product derived from a protected tree, except under a licence or exemption granted by the Minister of Agriculture, Forestry and Fisheries to an applicant and subject to such period and conditions as may be stipulated.”

Conservation-important plant species listed for the quarter-degree grid 2531CB in the Mpumalanga Tourism & Parks Agency's (MTPA) threatened species database (obtained from Mr. Mervyn Lötter) were used to produce a list of the most likely occurring species, which were searched for during fieldwork. The extensive list of species (fauna and flora) for the 2531CB grid have been narrowed down to the area demarcated in Figure 23 and listed below.

Low’s Creek 271 JU

Transvaal saffron *(Elaeodendron transvaalense)* (Conservation status for South Africa – Vulnerable; Conservation status for Mpumalanga – Vulnerable); Orange fire lily *(Cyrtanthus eucallus)* (Conservation status for South Africa – Vulnerable; Conservation status for Mpumalanga – Vulnerable; Endemic – South Africa)

Additionally, information which was obtained from the Screening Tool exercise, lists the environmental sensitivity of the project region (Figure 23) and also recorded certain Species of Special Concern (SSC) for the Animal and Plant species themes expected in the footprint. These assemblages will also be evaluated as part of the expected SSC lists.

Table 11: Sensitive and threatened species expected to occur in the project region according to the Environmental Screening Tool results (compare with Figure 23).

Theme	Sensitivity	Feature
Plant Species Theme	Medium	*Streptocarpus fasciatus*

Table 12 summarises the expected SSC plants, the habitat where they would be expected to occur and the threatened status per species.

Table 12: A lists of plants of special concern that have distribution ranges and habitat preferences that overlap with the study area (Grid: 2531CB). The description of the status categories is available in Appendix 4.

Species	Habitat	Status
Transvaal saffron *(Elaeodendron transvaalense)*	Savanna or bushveld, from open woodland to thickets, often on termite mounds.	**Near threatened**
Orange fire lily *(Cyrtanthus eucallus)*	Plants occur in scattered clumps in suitable habitat on large boulders or cliff faces.	**Vulnerable**
Streptocarpus fasciatus	Terrestrial: Scarp and mistbelt forest.	**Vulnerable**

Species of Special Concern - Synopsis

<u>Near-threatened</u>

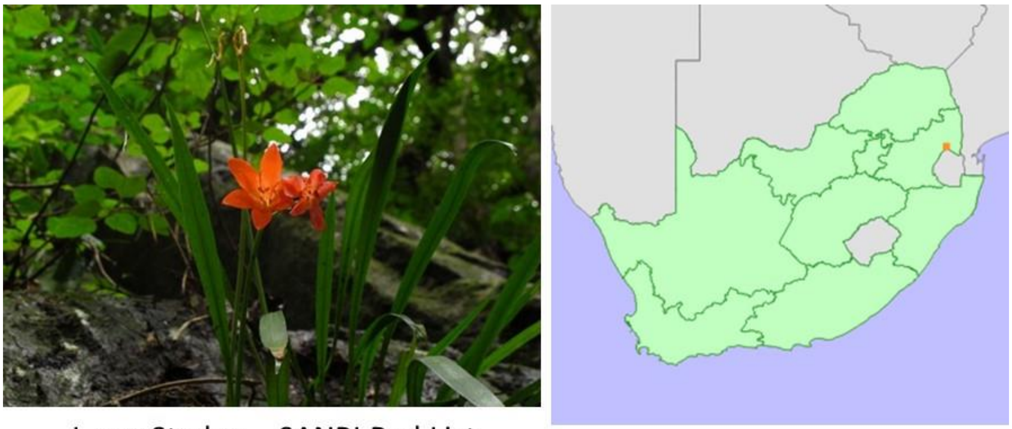
CELASTRACEAE: Transvaal saffron *(Elaeodendron transvaalense)* (Conservation status for South Africa – Vulnerable; Conservation status for Mpumalanga – Vulnerable) (Figure 24).

Figure 24: Transvaal saffron *(Elaeodendron transvaalense)*

A very popular species in the muthi markets and heavy exploitation and sub-population declines have been observed. Over-exploitation is likely to continue, and the species is further threatened by poor wound recovery following bark-stripping. It is likely to experience a 20% decline over a moving window of 180 years (110 years in the past and 70 years into the future) (generation length suspected to be a minimum of 60 years.

<u>Vulnerable</u>

AMARYLLIDACEAE - Orange fire lily *(Cyrtanthus eucallus)* (Conservation status for South Africa – Vulnerable; Conservation status for Mpumalanga – Vulnerable; Endemic – South Africa) (Figure 25).



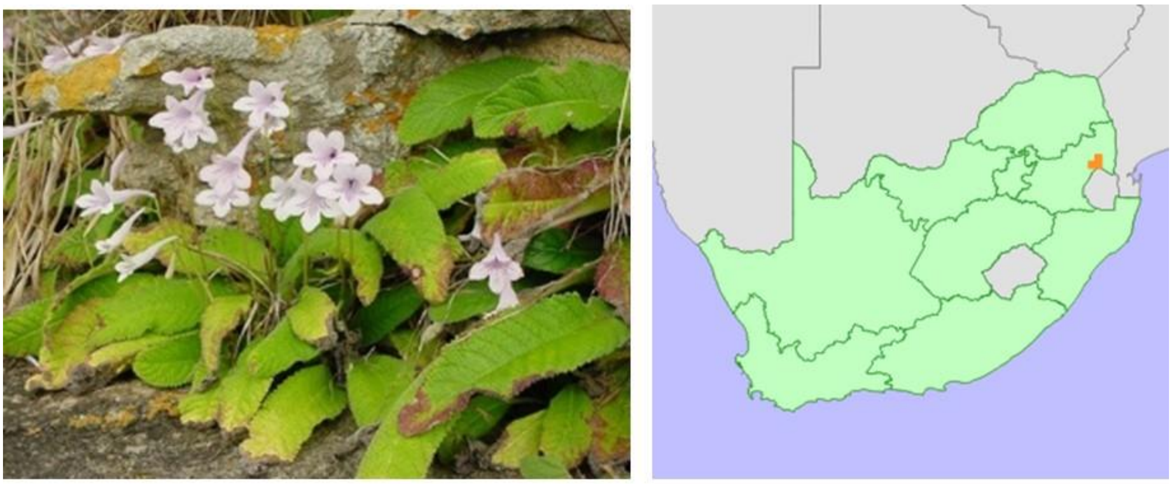
L van Staden – SANBI Red List

Figure 25: Orange fire lily *(Cyrtanthus eucallus)*.

Plants occur in scattered clumps in suitable habitat on large boulders or cliff faces. Only a few plants were seen during a recent survey of the only known locality, however, it is difficult to estimate the population size as the habitat is generally very inaccessible. Alien invasive species is a big problem in the riparian areas near Barberton, and a potential threat to this species (M. Lotter, pers. comm.). Recent observations of plants at the only known locality recorded scattered alien plants in the area, but invasions are unlikely to be causing decline at present.

<u>Vulnerable</u>

Streptocarpus fasciatus (Conservation status for South Africa – Vulnerable; Conservation status for Mpumalanga – Vulnerable; Endemic – South Africa) (Figure 26).



M. Stalmans – SANBI Red List

Figure 26: *Streptocarpus fasciatus.*

One known location is potentially threatened by alien plant invasion and habitat degradation as a result of deforestation for subsistence use: this shade dependent species might be impacted if its woodland habitat is cleared of woody species. Crocodile Gorge Mountain Bushveld, Malelane Mountain Bushveld, Scarp Forest - Shady woodland, among granite boulders.

4.3.2 Riverine Ecology

4.3.2.1 The extent of the riparian habitat

Low's Creek and associated riparian zone

During the survey of the Low's Creek project area, the riverine environment was surveyed by completing five transects in the project area. Figure 22 consists of a map which was compiled using a Google Earth image which indicates the survey transects in the Low's Creek.

Viewing the Google Earth image (Figures 20 and 22), it is clear that in the whole reach of importance, the area is transformed by agriculture right up to the riparian zone. No riparian buffers have been considered during the development of the orchards. The riparian zone is relatively narrow (21 to 39 metres wide) and the stream width between 1.5 and 2.0 metre.

The vegetation in the riverine area, consists of larger trees in the marginal areas, especially matumi and sycamore figs, while the non-marginal areas are covered by semi-wetland and terrestrial species. Reeds, both indigenous (thatching reed) and alien (Spanish reed) line the lower portions of the riparian zone. Numerous species of alien plants have invaded the drainage line, especially via the downstream Kaap River.

Of the 100 tree species on the riverbanks, nine riparian indicator species have been observed, as well as 17 alien species. Four trees, the Matumi (*Breonadia salicina*), Marula (*Sclerocarya birrea*). Transvaal saffron (*Elaeodendron transvaalense*) and Apple-leaf (*Philenoptera violacea*), are considered South African protected species.

The river itself is a small stream (1.5 to 2.0 m wide) with a sandy bed and some cobble riffles in steeper areas. Pools are rare in the project reach.

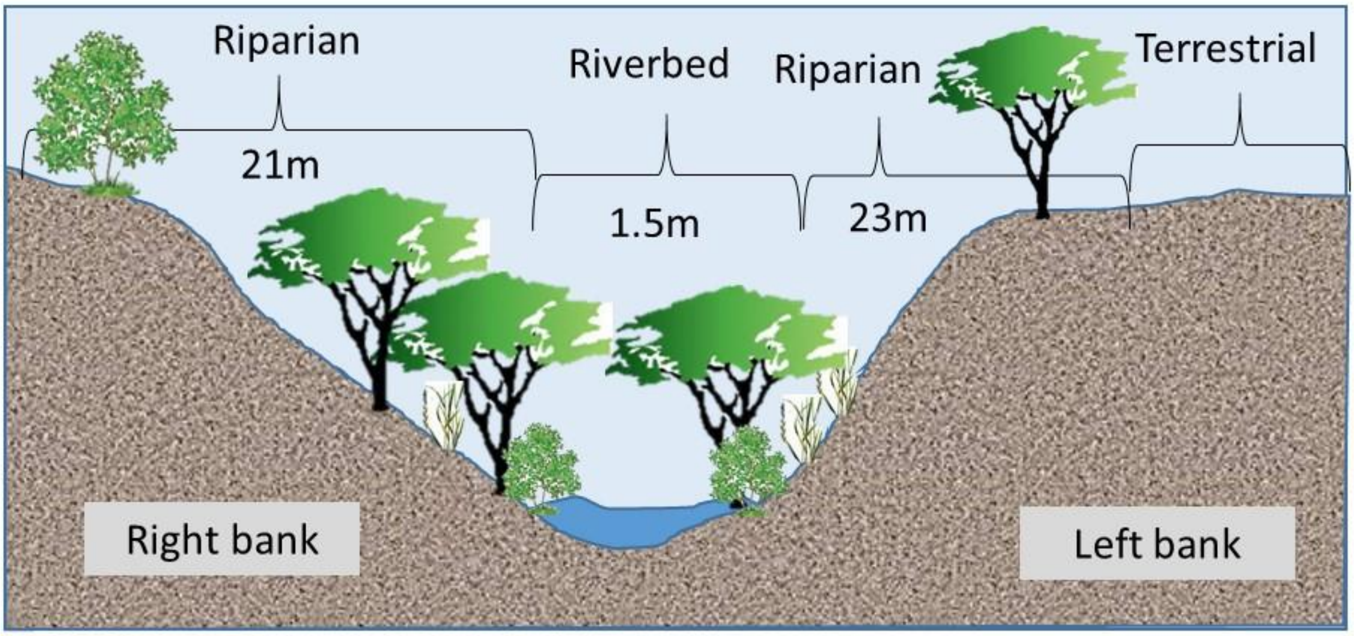
Table 13: Riparian indicator plant species observed in the riparian zone along the Low's Creek reach during the survey.

FAMILY	*TAXON*	HABITAT
RUBIACEAE	Matumi (*Breonadia salicina)*	Along banks of permanent streams and rivers, in riverine fringe forest.
COMBRETACEAE	River bushwillow (*Combretum erythrophyllum)*	Along riverbanks where it can form thick stands, with trunks reclining in- and overhanging the water.
STERCULIACEAE	Smooth dombeya (*Dombeya cymosa*)	In coastal bush or, further inland, along river and stream banks.
MORACEAE	Sycamore fig (*Ficus sycamorus)*	Frequently along riverbanks, forming a distinctive part of the riverine thicket; also in mixed woodland
SAPINDACEAE	False-horsewood (*Hippobromus pauciflorus*)	Riverine thicket, scrub, along stream banks and at margins of evergreen forest.
OLEACEAE	African olive (*Olea europaea africana*)	Variety of habitats, usually near water, on stream banks, in riverine fringes, but also in open woodland, among rocks and in mountain ravines.
EUPHORBIACEAE	Potato bush (*Phyllanthus reticulatus*)	Low altitude riverine vegetation and thicket.
APOCYNACEAE	Quinine tree (*Rauvolfia caffra)*	Nearly always associated with available ground water, along wooded stream banks and at the margins of evergreen forest.
RHAMNACEAE	*Buffalo thorn (Ziziphus mucronata)*	In a wide variety of habitats, in open woodland, often in alluvial soils along rivers, and frequently on termite mounts; it is said to indicate the presence of

		underground water.

During the site visit to the Low's Creek project area, three survey sites were earmarked for assessment. At each of these survey sites, a transect was surveyed: from the edge of the riparian area (left and right bank), and through the streambed to the other side. The site information is summarized in Figures 27 to 29. **Transect 2 has been omitted due to its similarity to Transect 1.**

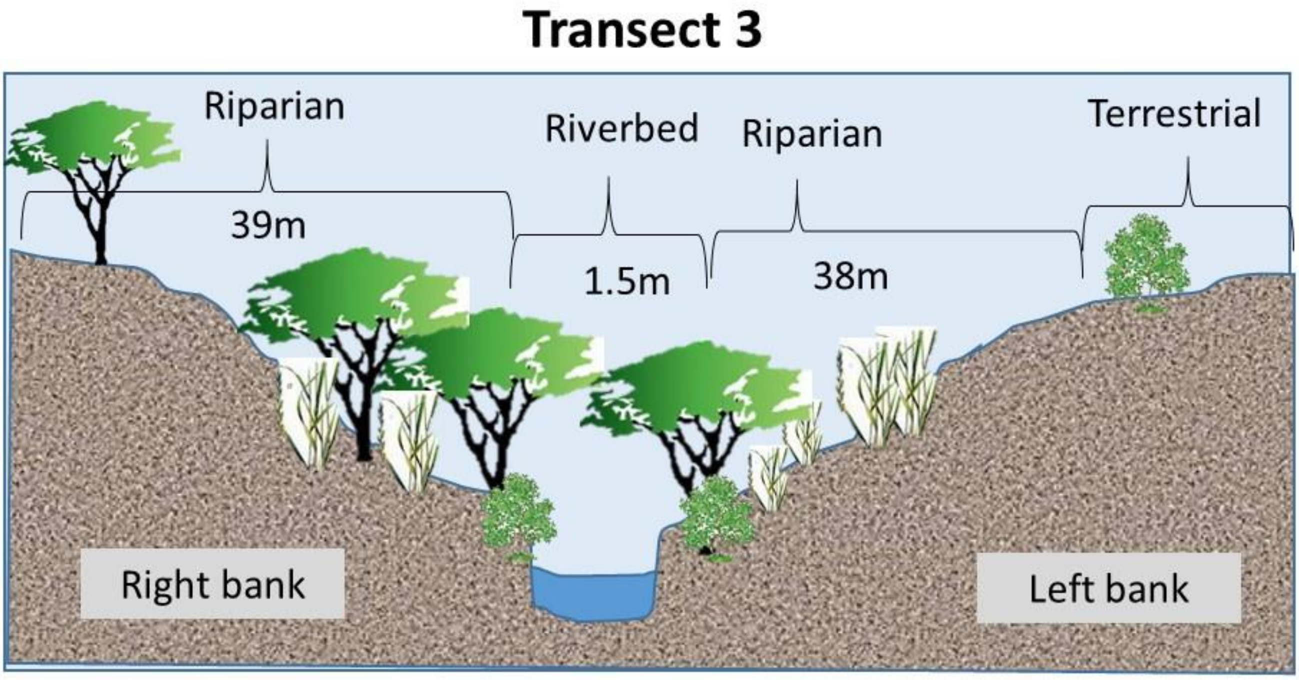
Transect 1



Riparian width		Riverbed		Transect	#1
Left bank	23m	Width	1.5m	Transect length	83.9m
Right bank	21m				
Riparian vegetation - Left bank		Riverbed cover		Riparian vegetation - Right bank	
*Syringa (*Melia azedarach*)		Fine sand bed		Wild date palm (*Phoenix reclinata*)	
Flame climbing bushwillow (*Combretum microphyllum*)		Surface water		Sycamore fig (*Ficus sycamorus*)	
Pigeonwood (*Trema orientalis*)				*Bugweed (*Solanum mauritianum*)	
Flame thorn (*Acacia ataxacantha*)				*Syringa (*Melia azedarach*)	
*Common bamboo (*Bambusa balcooa*)				*Castor oil bush (*Ricinis communis*)	
Terrestrial					
Orchards				Orchards	

*Alien invader plant

Figure 27: Transect 1: Properties of the Low’s Creek upstream section.

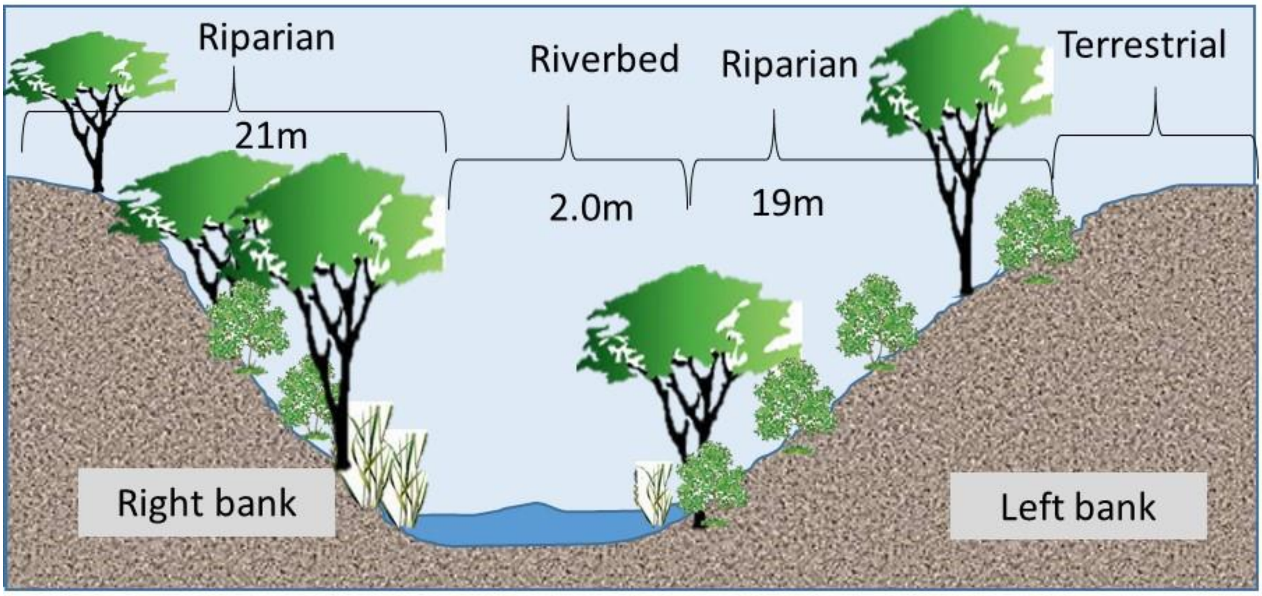


Riparian width		Riverbed		Transect	#3
Left bank	38m	Width	1.5m	Transect length	111m
Right bank	39m				
Riparian vegetation - Left bank		Riverbed cover		Riparian vegetation - Right bank	
Jackal berry (*Diospyros mespiliformis*)		Fine sand and gravel bed		Thatching reed (*Phragmites mauritianus*)	
Flame climbing bushwillow (*Combretum microphyllum*)		Surface water		*Syringa (*Melia azedarach*)	
Natal mahogany (*Trichelia emetica*)				Natal mahogany (*Trichelia emetica*)	
False-horsewood (*Hippobromus pauciflorus*)				Sycamore fig (*Ficus sycamorus*)	
River bushwillow (*Combretum erythrophyllum*)				Apple-leaf (*Philenoptera violacea*)	
Terrestrial					
Orchards				Orchards	

*Alien invader plant

Figure 28: Transect 3: Properties of the Low's Creek dam section.

Transect 4



Riparian width		Riverbed		Transect	#4
Left bank	38m	Width	2.0 m	Transect length	64m
Right bank	39m				
Riparian vegetation - Left bank		Riverbed cover		Riparian vegetation - Right bank	
Blue sweetberry (*Bridelia cathartica melanthesoides*)		Fine sand and gravel bed		*Spanish reed (Arundo donax)	
River climbing thorn (*Senegalia schweinfurthii*)		Surface water		White stinkwood (*Celtis africana*)	
Moepel (*Mimisops zeyheri*)				Matumi (*Breonadia salicina*)	
*Spanish reed (Arundo donax)				Sycamore fig (*Ficus sycamorus*)	
Matumi (*Breonadia salicina*)				Robust thorn (*Vachellia robusta*)	
Terrestrial					
Orchards				Orchards	

*Alien invader plant

Figure 29: Transect 4: Properties of the Low's Creek downstream section.

6.4.2.1 Aquatic habitat assessment

Aquatic surveys and biomonitoring are essential components of the system ecology and aim to measure present biological conditions and trends in the aquatic ecosystem. It attempts to relate the observed variation to changes in available habitat, as dictated by physical system drivers of the system such as water quality, geomorphology, and hydrology (Kleynhans & Louw, 2008).

During the survey, aquatic habitat types surveyed at Transect 1, consisted of a narrow sandy channel flanked by reeds and large riparian trees, and water flowing in the narrow channel. In areas of steeper slopes, small cobble riffles are washed open and in some areas small pools of deeper water are formed.

Figure 30: The Low's Creek consists of a narrow sandy channel flanked by reeds and large riparian trees, and water flowing in the narrow channel.

During the monitoring survey in August 2020 the following parameters were measured - IHAS (Integrated Habitat Assessment System) and HQI (Habitat Quality Index) with the results summarized in Table 14.

Table 14: The combined habitat parameters as measured at the drainage lines sites with surface water.

SITE	IHAS%	CATEGORY	HQI%	CATEGORY
SITE 1	68	Fair	68	Fair

During the August 2020 survey, the IHAS and HQI scores were mostly moderate due to the lack of deep-water habitats and fast flows, thus classified as a "Fair" category at the Transect 1 (Table 14).

Surveys of Aquatic Invertebrates and Fish

Macro-invertebrates and fish are good indicators of river health. By making use of established and accepted survey methods (SASS5 for invertebrates and FRAI-based surveys for fish) and incorporating the habitat aspects, a proper basis for biological diversity can be obtained.

4.3.2.2 Aquatic invertebrate assessment

The macro-invertebrates were sampled according to the SASS5 method at the combined site, and Table 15 lists the macro-invertebrates sampled at the site and reflects the SASS5 scores for the August 2020 survey.

Table 15: SASS5 scores of the different habitat types at the sampling pool site (a complete table of this summarized version can be viewed in Appendix 3).

TAXON	Stones	Vegetation	GSM	Total
Potamonautidae 3	1			1
Atyidae (Shrimp) 8		B		B
Baetidae 2 spp 6	B	B	A	B
Chlorocyphidae 10		A		A
Coenagrionidae 4		A		A
Aeshnidae 8	1			1
Libellulidae 4	1	A		A
Gerridae 5		A	A	A
Nepidae 3		A		A
Dytiscidae 5		A		A
Gyrinidae 5		A	A	A
SASS Score	21	50	16	61
No of families	4	9	3	11
ASPT	5.2	5.5	5.3	5.5

Estimated abundance: 1=1; A=2-10; B=11-100; C=101-1000; D=>1000

Table 16: A summary of the IHAS, HQI and SASS scores in the Low's Creek project area.

SURVEY SITE	Habitat scores		SASS5 Scores		
	IHAS %	HQI %	SASS score	Number of families	ASPT
Lows Creek River	68	68	61	11	5.5

Judging from Table 16, the habitat scores are moderate and is thus categorized as “Fair” (Table 17). The lack of deep-water habitats and fast flows, but presence of shallow riffles and good overhanging vegetation also reflected in the macro-invertebrate scores, resulting in “Good” SASS scores and a relative high number of families (Table 16).

Table 17: Categories used to classify Habitat, SASS and ASPT values:

HABITAT	SASS4	ASPT	CONDITION
>100	>140	>7	Excellent
80-100	100-140	5-7	Good
60-80	60-100	3-5	Fair
40-60	30-60	2-3	Poor
<40	<30	<2	Very poor

4.3.2.2 Fish communities - Fish Response Assessment Index (FRAI)

The purpose of the Fish Response Assessment Index (FRAI) is to provide a habitat-based cause-and-effect interpretation underpinning the deviation of the fish assemblage from the reference condition.

The application of the FRAI is based on the following:

- The FRAI is an assessment index based on the environmental intolerances and preferences of the reference fish assemblage and the response of the constituent species of the assemblage to particular groups of environmental determinants or rivers.
- These intolerance and preference attributes are categorised into metric groups with constituent metrics that relates to the environmental requirements and preferences of individual species.
- Assessment of the response of the species metrics to changing environmental conditions occur either through direct measurement (surveys) or are inferred from changing environmental conditions (habitat). Evaluation of the derived response of species metrics to habitat changes are based on knowledge of species ecological requirements. Usually, the FRAI is based on a combination of fish sample data and fish habitat data.
- Changes in environmental conditions are related to fish stress and form the basis of ecological response interpretation.

Determine reference fish assemblage: species and frequency of occurrence

<u>Frequency of Occurrence (FROC)</u>

The fish reference Frequency of Occurrence (FROC) database (Kleynhans, Louw, & Moolman, 2007), which provides consistent reference frequency of occurrence for more than 700 fish sites in South Africa, was used to establish the baseline data for this report.

Fish are considered to be one of the important indicators of river health and their responses to modified environmental conditions are measured in terms of the Fish Response Assessment Index (FRAI) (Kleynhans 1999; Kleynhans *et al*. 2005). This index is based on a combination of fish species habitat preferences as well as intolerance to habitat changes, and the present frequency of occurrence of species compared to the reference frequency of occurrence (Kleynhans, Louw, & Moolman, 2007).

The list of species is based on species that are expected to be present or to have been present under close to reference habitat conditions. Species that are derived to have been present under relatively recent reference habitat conditions are also identified. The resulting species reference list is a combination of both of the above approaches.

The rating of the FROC refers to the reference fish frequency of occurrence (FROC) in a particular ecologically defined reach of a river. Ratings are scored from 1 to 5.

Rating of the reference fish FROC refers to the reference fish frequency of occurrence in a particular ecologically defined reach of a river. This means that FROC ratings are derived based on conditions at the particular site as well as the available habitat in the reach for species expected under reference conditions. Basic habitat conditions that were considered in terms of the FROC of species are based on intolerance and preference rating as contained in the FRAI (Kleynhans *et al.* 2005). The presence and abundance of habitat features such as velocity-depth classes, cover types (including substrate) and the characteristics of the natural flow regime (especially the degree of perenniality) in a river reach under reference conditions formed the basis for the expert judgement of the FROC (Kleynhans, Louw, & Moolman, 2007).

There is no FROC Data available for the Low's Creek (project reach). On the other hand, fish data for the Kaap River, X23G-01057 is available and will be used as an indication of the species with the potential to migrate up the Low's Creek tributary and inhabit the habitat types available (FROC & PESEIS data base - DWS).

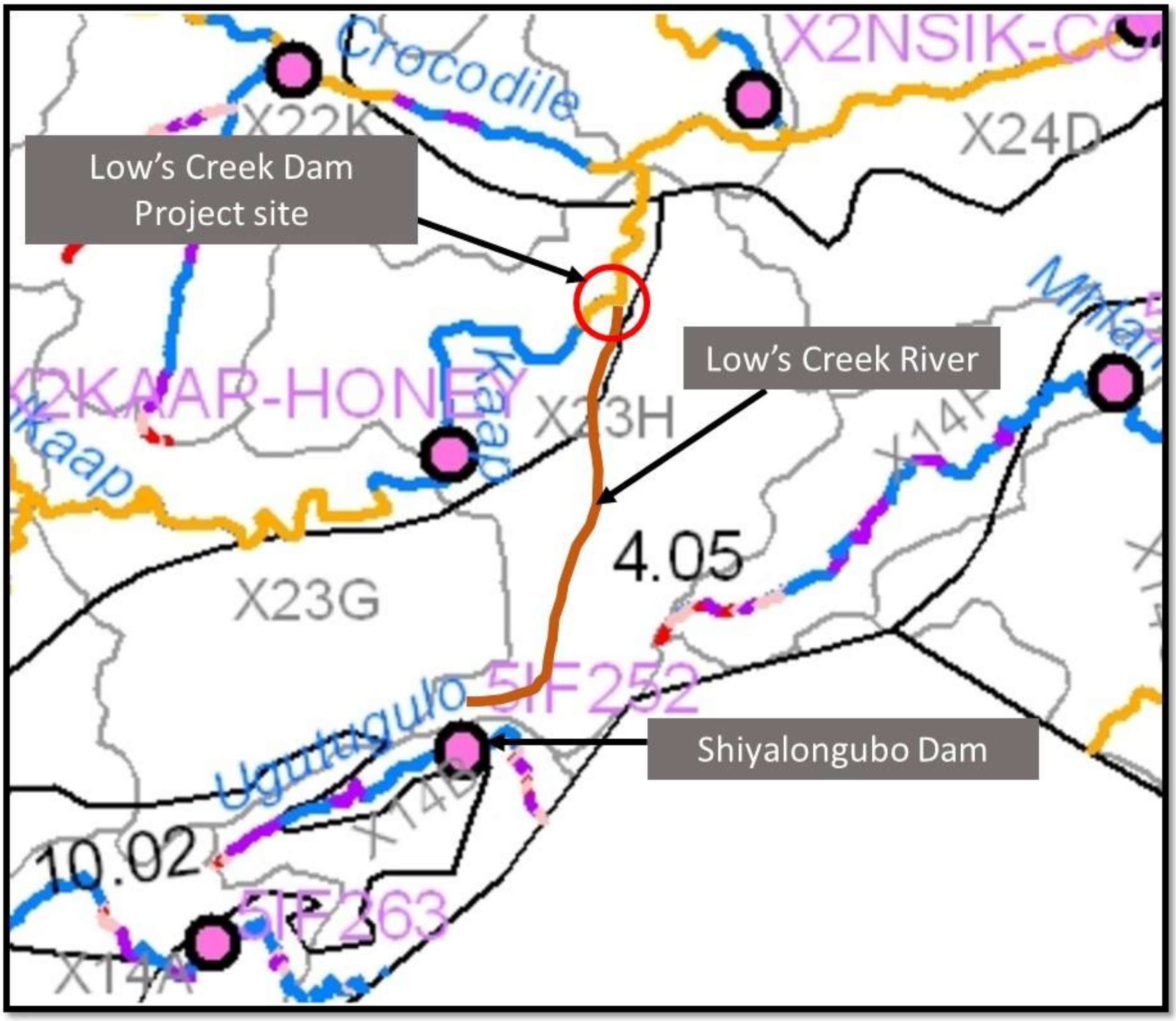


Figure 31: Low's Creek stream is situated in the X32H catchment as recorded in the DWS PESEIS documents (DWS, 2014).

Table 18: The PESEIS fish list (and their potential to migrate) up the Low's Creek stream.

Fish Species	Migration potential
Migration critical (4-5):	
Longfin eel *(Anguilla mossambica)*	5: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Largescale yellowfish *(Labeobarbus marequensis)*	5: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Orangefin barb *(Enteromius eutaenia)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal. Migrate into floodplains & seasonal rivers confirmed).
Longbeard barb *(Enteromius unitaeniatus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal. Migrate into floodplains & seasonal rivers confirmed).
Beira barb *(Enteromius radiatus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal). Swim upstream into seasonal rivers confirmed/shoals of adults.
Three-spot barb *(Enteromius trimaculatus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal). Swim upstream into seasonal rivers confirmed/shoals of adults.
Bowstripe barb *(Enteromius viviparus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Southern barred minnow *(Opsaridium peringueyi)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Red eye labeo *(Labeo cylindricus)*	Juveniles and adults: 4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Leaden labeo *(Labeo molybdinus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal). Strong swimmers, migrate upstream [including seasonal rivers]
Rednose labeo *(Labeo rosae)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Silver robber *(Micralestes acutidens)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Migration moderately important (3):	
Bulldog *(Marcusenius macrolepidotus)*	3: Migration moderately important for survival of species (uncertain)
Migration not important (1-2):	
Sharptooth catfish *(Clarias gariepinus)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).
Sawfin suckermouth (*Chiloglanis paratus)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).

Shortspine suckermouth (*Chiloglanis pretoriae)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).
Lowveld suckermouth (*Chiloglanis swierstrai)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).
Oreochromis mossambicus	2: Migration not important for survival of species (migration mostly undertaken for dispersal). Juvenile: 1: Migration not important for survival of species (migration mostly undertaken for dispersal).
Redbreast tilapia *(Tilapia rendalli)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal). Juvenile: 1: Migration not important for survival of species (migration mostly undertaken for dispersal).
Banded tilapia *(Tilapia sparrmanii)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal). Juvenile: 1: Migration not important for survival of species (migration mostly undertaken for dispersal).
Southern mouthbrooder *(Pseudocrenilabrus philander)*	1: Migration not important for survival of species (migration mostly undertaken for dispersal).

Determine present state for drivers

The purpose is to provide information on the fish response and associated habitat condition and *vice versa* (i.e., fish responses that are possible, given certain habitat conditions). This assessment considers the whole river section to be studied. If information on the drivers is available, these should be used.

In the project area, the Low's Creek seems to be a semi-perennial stream as it also receives water from the Shiyalongubo Dam on the Shiyalongubo River (Lomati catchment).

Sampling site selection

During the survey, aquatic habitat types which were surveyed at Transect 1, consisted of a narrow sandy channel flanked by overhanging reeds and large riparian trees. The water flowing in the narrow channel was shallow with a sandy riverbed. In areas of steeper slopes, small cobble riffles are washed open and in some areas small pools of deeper water have been established.

Figure 32: The narrow run with some cobble and gravel where all of the fish species were collected. Due to the terrain and flows in the river only electro-shocking and cast netting methods were applied.

Table 19: Habitat types sampled and the sampling effort made per survey site.

HABITATS SAMPLED AND EFFORT

SAMPLING EFFORT	SLOW DEEP	SLOW SHALLOW	FAST DEEP	FAST SHALLOW
Electro shocker (min)		20 minutes		20 minutes
Small seine (mesh size, length, depth, efforts)				
Large seine (mesh size, length, depth, efforts)				
Cast net (dimensions, efforts)	10 casts			
Gill nets (mesh size, length, time)				

A number of sharptooth catfish (*Clarias gariepinus*), some Barbs (*Barbus trimaculatus*) and Tilapia (*Oreochromis mossambicus*) were caught with the cast net in the deeper areas and smaller species with the electro-shocker in the shallow areas.

Table 20: Fish sampled during the survey.

SPECIES SAMPLED	SLOW DEEP	SLOW SHALLOW	FAST DEEP	FAST SHALLOW
Largescale yellowfish *(Labeobarbus marequensis)*				3
Orangefin barb *(Enteromius eutaenia)*				4
Longbeard barb *(Enteromius unitaeniatus)*				5
Beira barb *(Enteromius radiatus)*		1		
Three-spot barb *(Enteromius trimaculatus)*	1	3		1
Bowstripe barb *(Enteromius viviparus)*				6
Silver robber *(Micralestes acutidens)*		1		3
Sharptooth catfish (*Clarias gariepinus*)	1	1		
Mozambique tilapia *(Oreochromis mossambicus)*	2	3		
Banded tilapia *(Tilapia sparrmanii)*		1		
Southern mouthbrooder *(Pseudocrenilabrus philander)*		3		

Execute the FRAI model

The FRAI model makes use of the fish intolerance and preference database that was compiled in 2001 (Kleynhans 2003). This information was built into the FRAI. The approach followed included the ranking, weighting and rating of metric groups. A large component of the FRAI is based on an automated calculation of rankings, weights and ratings. Table 21 indicates the weights of the different metric groups for fish at the Low's Creek site.

Table 21: The weight allocated to the different metric groups in the model.

WEIGHT OF METRIC GROUPS	
METRIC GROUP	WEIGHT (%)
VELOCITY-DEPTH	100,00
COVER	94,59
FLOW MODIFICATION	89,19
PHYSICO-CHEMICAL	67,57
MIGRATION	40,54
IMPACT OF INTRODUCED	13,51

According to Table 21, the Velocity-depth metric carries the most weight due to the lower flows in the drainage, followed by Cover parameters as marginal vegetation provides most of the aquatic habitat. Flow modification relates somewhat to the flows transferred from the Shiyalongubo Dam.

The relative FRAI score of 91% at this reach in the Low's Creek was placed within the limits of an ecological state category Class A/B (>87.4 and <92.01%), which means this reach is "No change" or "Unmodified, or approximate natural conditions closely." according to Table 22. The fact that 11 fish species are able to reach the sampling site in the Low's Creek study area (Table 20), means that they currently can migrate up to this point during periods of high flow, and probably can pass through the system higher up in the catchment.

Table 22: Ratings for the fish integrity classes

	FRAI ASSESSMENT CLASSES	
Class rating	Description of generally expected conditions for integrity classes	Relative FRAI score (% of expected)
A	Unmodified, or approximate natural conditions closely.	90 to 100
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.	80 to 89
C	Moderately modified. A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at lower limits of this class.	60 to 79
D	Largely modified. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderate intolerant species. Impairment of health may become more evident at the lower limit of this class.	40 to 59
E	Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately	20 to 39

	intolerant species. Impairment of health may become very evident.	
F	Critically modified. An extremely lowered species richness and an absence of intolerant and moderately intolerant species. Only tolerant species may be present with a loss of species at the lower limit of the class. Impairment of health generally very evident.	0 to 19

Species of Concern: Fish

The only fish species expected to occur in the project river reach is the Southern barred minnow *(Opsaridium peringueyi)* (Conservation status International – Least concern; Conservation status for South Africa – Least concern; Conservation status for Mpumalanga – **Vulnerable**). The Southern barred minnow was not observed or sampled during the current survey.

4.3.3 Terrestrial ecology

4.3.3.1 Invertebrates

Although no in-depth surveys were done for invertebrates, all insects observed were photographed and identified to species level. No invertebrate Species of Special Concern are expected or reported by the MPTA Database or the National Web based Environmental Screening Tool for the study area.

4.3.3.2 Frogs

Frog fauna is a product of the diversity of the region's topography, climate and associated habitat types. Although frogs have adapted to almost every type of environment, many species are highly specialised to suit conditions in a particular locality. This can leave a species vulnerable when a habitat is degraded or irreversibly changed (Du Preez & Carruthers, 2009). Recent work has shown that amphibian species are declining worldwide as a result of global habitat loss.

Their small areas of occupancy make them more susceptible to extinction due to habitat loss and degradation compared to other vertebrates. Suitable environmental conditions, especially breeding sites, are critically important, and species are often very specific to those habitat types. Therefore, habitat conservation should be a priority for amphibian preservation.

The amphibian populations in the Mpumalanga Province are faced with several environmental threats. Major threats include habitat destruction and invasion by alien vegetation resulting in a fragmentation of populations. Agriculture has already resulted in the rapid destruction and fragmentation of habitat types responsible for supporting populations of many species discussed here.

Overgrazing and severe fires in the grassland catchment areas have resulted in extensive silting of streams and wetlands, thereby also threatening the breeding habitat of these frogs. For many reasons, frogs are important and useful indicators of environmental health.
Factors that make frogs particularly sensitive to environmental deterioration include (Du Preez & Carruthers, 2009):

- Absorbent skin surface – absorbs water and any solvents it may contain
- Food contaminants – tadpoles are susceptible to ingesting pollutants
- Fragmented distribution – habitat losses may isolate surviving populations

- Sequestered tissue contaminants – disrupting hormone interference
- Temperature – extreme environmental temperature fluxes affect their biology
- Amphibious lifestyle – frogs are exposed to aquatic as well as terrestrial environment and are thus affected by changes to both
- Trophic level – important prey items to wide array of predators

In addition, water pollution is another major concern, which may arise from different contamination sources of, including:

- Chemical contamination
- Agricultural pesticides and herbicides
- Acid precipitation (atmospheric pollution)
- Heavy metals
- Eutrophication (fertiliser run-off)
- Endocrine-disrupting contaminants

Other factors include out-of-season fires caused by humans, road mortalities, diseases and climate change.

Amphibians are localised in their movement and habitat choices. Although most frogs can live away from water, they need water to lay their eggs and for the larval stage. An absence of standing water will therefore denote an absence of frog species in the area. After good rains when standing water is replenished, frogs believed absent may emerge to feed and breed. The rest of the year they will seek shelter in damp places in order to escape the dry or cold climate.

Their permeable skin gives them the advantage of being amphibious, but it is also this permeable skin that makes them very susceptible to air- and water pollution. Frog surveys, therefore, give a good indication of water quality and overall environmental condition. The frog diversity in areas less affected by mining activities might appear moderately healthy, although the effects of air pollution or disease on these assemblages are unknown.

Wetlands are interlinking systems, as such upstream or wetland-adjacent impacts can adversely affect the ecosystems downstream. Numerous water quality-related problems may exist in a farming area, and these will have further negative impacts on the wetland systems in the area if not contained. In compiling the expected frog lists, detailed frog distribution records (from the old Transvaal compiled by Jacobsen 1989) were used, along with interpolated distribution maps, and data from the frog atlas project (Minter et al 2004). Additional information from the latest comprehensive work of Du Preez and Carruthers (2009) was also consulted.

Frog surveys

According to the 2004 Frog Atlas (Minter, *et al* 2004), the Low's Creek project area is situated in the Bushveld District. The Bushveld District has a relatively high species richness (>30 species per grid cell), decreasing westwards, but is moderate in endemic species (7-10 species) (Minter *et al*, 2004).

The associated frog distribution maps, confirm 28 frog species are expected to be present in the study area. Of these frog species that are expected to occur in the riverine habitats within the study area, we anticipate 19 species will reside here, accommodated by potential habitat in the area. During surveys of the frog species (January to August 2020), 9 of the 19 expected species were encountered in the Low's Creek project area (See Appendix 5 for detail):

- African common toad (*Sclerophrys gutturalis*)
- African split-skin toad (*Schismaderma carens)*
- Painted reed frog (*Hyperolius marmoratus taeniatus*)
- Tinker Reed Frog (*Hyperolius tuberilinguis)*
- Bubbling kassina (*Kassina senegalensis*)
- Dwarf puddle frog (*Phrynobatrachus mababiensis*)
- Anchieta's ridged frog (*Ptychadena anchietae*)
- Delalande's river frog (*Amietia delalandii*)
- Natal sand frog (*Tomopterna natalensis*)

Most of the expected species will be present in the riverine habitats of the Low's Creek drainage system since the rest of the surrounding area is transformed by agriculture.

Species of Special Concern: Frogs

Species of special concern consists of threatened, endemic and rare species.
According to the South African Frog Atlas map (Minter, *et al.* 2004) the study area potentially contains 7-10 endemic species. Using distribution maps and habitat quality, no endemic species are expected to occur in the Low's Creek project area. Currently no threatened frog species is expected to occur in the area.

4.3.3.3 Reptiles

Current knowledge of reptiles within the study area is derived from the Reptile Atlas Project (Bates, *et al.* 2014). In compiling the expected reptile lists, the detailed distribution records by Jacobsen (1989) of the herpetofauna of the old Transvaal were used together with the distribution maps. The Animal Demographic Unit's reptile atlas project data (ADU, 2010), collated in the Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland, was also referenced (Bates, et al. 2014).

We conclude that the following factors played a role in lower numbers of reptile species being recorded across all project sites:

- Subterranean lifestyle of many species
- Nocturnal lifestyle of many species
- Secretive and retiring lifestyle of many species
- Small size of most of the species
- Well-camouflaged species

Surveys in primary habitats

The savanna is the most extensive ecoregion in the subregion, occurring over much of the northern parts of southern Africa. Savanna has a well-developed, grassy layer and a medium density of scattered trees. Rains occur during summer, and fire is an important regulator of the balance between densities of grass- and woody vegetation. Reptile species richness and endemism is extremely high, but this is partially a result of the large extent of the ecoregion. Few savanna reptiles are classified as threatened, and many have extensive ranges (Alexander & Marais, 2007).

According to the distribution of reptiles in South Africa, 74 species have distribution ranges extending into the region. Of the 74 species, 62 species are expected to occur in the riverine habitats of the Low's Creek project area (Jacobsen, 1989; Animal Demographic Unit, 2010) as adequate habitat is available. During the surveys of reptile species (2020), 10 of the 62 expected species were recorded in the riverine habitat of the project area (See Appendix 6 for detail). Additional species observed by the local inhabitants were also added to the list:

- Common dwarf gecko *(Lygodactylus capensis capensis)*
- Common tropical house gecko (*Hemidactylus mabouia*)
- Incognito thread snake (*Leptotyphlops incognitus*)
- Western yellow-bellied sand snake (*Psammophis subtaeniatus*)
- Spotted bush snake (*Philothamnus semivariegatus*)
- Rainbow rock skink (*Trachylepis margaritifer*)
- Striped skink (*Trachylepis striata*)
- Variable skink (*Trachylepis varia*)
- Yellow-throated plated lizard (*Gerrhosaurus flavigularis*)
- Water monitor *(Varanus niloticus niloticus)*

Species of Special Concern: Reptiles

Species of special concern comprises threatened, endemic and rare species.
Threatened reptile species are rated by standards established by the *International Union for Conservation of Nature (IUCN) 2014,* National Environmental Management: Biodiversity Act (NEMBA) of 2004, and the SA Red List (Bates, et al. 2014). There are more endemic reptiles in southern Africa than any other vertebrates, and new species are being discovered regularly in this country.

Due to their limited distribution and range in South Africa, endemic species are included as species of special interest below. An endemic species has a global distribution restricted to >90% of the atlas region. According to the South African Reptile Atlas (ADU, 2010), there are 3 endemic reptile species that have distribution ranges overlapping the study area and expected in the riverine habitats (SA endemic - Including Lesotho & Swaziland):

- Barberton girdled lizard *(Smaug warreni barbertonensis*)
- Wilhelm's flat lizard (*Platysaurus intermedius wilhelmi*)
- Distant's ground agama *(Agama aculeata distanti)*

There is one threatened reptile species, and one South African Threatened or Protected Species (TOPS) expected to be present in the region:

- Southern African python (*Python natalensis*). NEMBA TOPS (2015): Protected,
- Nile crocodile (*Crocodylus niloticus*) - Regional: Vulnerable (2014). NEMBA TOPS (2015): Protected, suggested Vulnerable; SARCA (2014): Vulnerable.

4.3.3.4 Birds

Birds are important species in many ecosystems, fortunately they are also relatively easy to observe and count. Bird count data has been shown to accurately detect environmental change. A decline in species richness and diversity, as determined by routine monitoring, may serve as an early warning of environmental degradation. The presence or absence of bird species with specific habitat requirements can be indicative of the state of the environment.

The Bird Atlas (Harrison et al. 1997, Volumes 1 & 2) formed the basis of the distribution data used in this report, as it is currently the most updated printed information sources on South African birds available. Roberts Birds of southern Africa (Hockey, et al. 2005) was also consulted for habitat- and bird data.

Of the bird species expected to be found in the study area, certain birds were resident and thus remain in the area throughout the year. Nomadic species periodically move to other areas further away from the study area for feeding- or breeding purposes. Of the expected migratory bird species, some North African visitors will only appear during the warmer seasons where they will feed and likely breed. The Palaearctic migrants spend our winters in Eurasia and are summer visitors to the warm south during the cold winters up north, however very few breed in southern Africa.

Surveys in untransformed habitats

During the period January to August 2020, the untransformed riverine habitat of Low’s Creek was surveyed for bird species. A total of 332 bird species were observed in this region during the Bird Atlas project (Harrison *et al.* 1997) (Appendix 7). If bird distribution and local habitat are evaluated, it is clear that a total of 203 species of birds are likely to utilise the riverine biotope of the Low’s Creek study area.

During the January to August 2020 surveys, only the Low’s Creek riverine habitat types were surveyed, as these were the only untransformed vegetation types with viable habitat for bird species. A total of 52 bird species across all the riverine transects were observed in the Low’s Creek project area (See **Appendix 7** for detail):

1. Reed cormorant (*Microcarbo africanus*)
2. Western Cattle egret (*Bubulcus ibis*)
3. Hadeda Ibis (*Bostrychia hagedash*)
4. Egyptian goose (*Alopochen aegyptiaca*)
5. Natal spurfowl (*Francolinus natalensis*)
6. African Wattled plover (*Vanellus senegallus*)
7. Water Thick-knee (*Burhinus vermiculatus*)
8. Laughing dove (*Spilopelia senegalensis*)
9. Red-eyed Dove (*Streptopelia semitorquata*)
10. Emerald-spotted Wood Dove (*Turtur chalcospilos*)
11. Tambourine Dove (*Turtur tympanistria*)
12. African Green-Pigeon (*Treron calva*)
13. Purple-crested Turaco (*Tauraco porphyreolophus*)
14. Burchell's Coucal (*Centropus burchellii*)
15. Diederik Cuckoo (*Chrysococcyx caprius*)
16. Speckled mousebird (*Colius striatus*)
17. Brown-hooded Kingfisher (*Halcyon albiventris*)
18. Pied kingfisher (*Ceryle rudis*)
19. White-fronted bee-eater (*Merops bullockoides*)
20. European Bee-eater (*Merops apiaster*)
21. Golden-tailed Woodpecker (*Campethera abingoni*)
22. Brown-throated Martin (*Riparia paludicola*)

23. Fork-tailed Drongo (*Dicrurus adsimilis*)
24. Black-headed Oriole (*Oriolus larvatus*)
25. Dark-capped Bulbul (*Pycnonotus tricolor*)
26. Sombre Greenbul (*Andropadus importunus*)
27. Kurrichane Thrush (*Turdus libonyana*)
28. White-browed robin-chat (*Cossypha heuglini*)
29. Little rush warbler (*Bradypterus baboecala*)
30. Great reed warbler (*Acrocephalus arundinaceus*)
31. Yellow-breasted Apalis (*Apalis flavida*)
32. Green-backed Camaroptera (*Camaroptera brachyura*)
33. Red-faced Cisticola (*Cisticola erythrops*)
34. Tawny-flanked prinia (*Prinia subflava*)
35. African Paradise Flycatcher (*Terpsiphone viridis*)
36. Southern Black Flycatcher (*Melaenornis pammelaina*)
37. Ashy flycatcher (*Muscicapa caerulescens*)
38. Yellow-throated Longclaw (*Macronyx croceus*)
39. Black-backed puffback (*Dryoscopus cubla*)
40. Western Olive Sunbird (*Cyanomitra [o.] obscura*)
41. Scarlet-chested Sunbird (*Chalcomitra senegalensis*)
42. Collared Sunbird (*Hedydipna collaris*)
43. Cape white-eye (*Zosterops capensis*)
44. Spectacled Weaver (*Ploceus ocularis*)
45. Holub's Golden Weaver (*Ploceus xanthops*)
46. Southern Masked weaver (*Ploceus velatus*)
47. Red-billed Quelea (*Quelea quelea*)
48. Bronze Mannikin (*Lonchura cucullata*)
49. Red-billed Firefinch (*Lagonosticta senegala*)
50. African Firefinch (*Lagonosticta rubricata*)
51. Common Waxbill (*Estrilda astrild*)
52. Yellow-fronted Canary (*Crithagra mozambicus*)

Species of Special Concern: Birds

In this document, the category “Species of Special Concern” is considered to include all threatened taxa listed by South African Red Data lists, and all South African endemic taxa. Through comparisons with expected bird lists, a total of 11 bird species expected to be found in the area are listed as “Species of Special Concern”. If bird distribution and local habitat are evaluated, all the Species of Special Concern birds are likely to utilise the different biotopes of the study area.

Currently three endemic bird species are expected to occur in the area:

- Knysna Turaco *(Tauraco corythaix)*
- Chorister Robin-Chat *(Cossypha dichroa)*
- Greater Double-collared Sunbird *(Cinnyris afer)*

A sub-section of the 2531CB quarter-degree grid square was demarcated and used to present a more realistic component of the species of special concern (SSC) assemblage in the project area vicinity (MTPA threatened species database). No birds relating to SSC were recorded for the area.

The following threatened bird species (IUCN, 2014; NEMBA, 2014; Red Data Book, 2015) can make use the Low's Creek riverine habitat for feeding, perching or nesting:

- Yellow-billed stork (*Mycteria ibis*) - SA Red Data (Taylor 2015): Endangered. IUCN 2016 Status: Least concern.
- African Openbill *(Anastomus lamelligerus)* - SA Red Data (Barnes 2000): Near-threatened.
- Black stork (*Ciconia nigra*) - SA Red Data (Taylor 2015): Vulnerable, TOPS (2007): Vulnerable. IUCN 2016 Status: Least concern. Mpumalanga: Vulnerable.
- Wooly-necked stork (*Ciconia episcopus*) **-** SA Red Data (Barnes 2000): Near-threatened.
- Marabou Stork *(Leptoptilos crumeniferus)* - SA Red Data (Taylor 2015): Near threatened. IUCN 2014 Status: Least concern.
- African Finfoot *(Podica senegalensis)* - SA Red Data (Taylor 2015): Vulnerable. Mpumalanga: Vulnerable. IUCN 2015: Least concern.
- African White-backed Vulture *(Gyps africanus)* - IUCN 2015: Critically Endangered; SA Red Data (Taylor 2015): Critically Endangered. NEMBA TOPS (2015 - Endangered
- Tawny Eagle *(Aquila rapax)* - SA Red Data (Taylor 2015): Endangered; NEMBA TOPS (2015): Endangered species; IUCN 2015 Status: Least concern.
- Martial Eagle *(Polemaetus bellicosus)* - IUCN 2015 Status: Near-threatened; SA Red Data (Taylor 2015): Endangered; NEMBA TOPS (2015): Endangered species.
- African Crowned Eagle *(Stephanoaetus coronatus)* - IUCN 2015 Status: Near-threatened. SA Red Data (Taylor 2015): Vulnerable. NEMBA (TOPS 2007): Vulnerable species. Mpumalanga: Vulnerable.
- Half-collared Kingfisher *(Alcedo semitorquata)* - SA Red Data (Taylor 2015): Near-threatened. Mpumalanga: Near-threatened. IUCN 2015 Status: Least concern.

Species of Special Concern habitat requirements

Viability and estimated population size: Birds

Comparing the habitat requirements of Species of Concern with habitat availability in the biotopes, the following units have habitat assemblages that correspond with the optimal requirements of these birds, which will have a direct influence on their viability and estimated population size. The reporting rates supplied by the ADU Atlas report provide an indication of the population sizes of these birds in the area:

Comparing the habitat requirements of Species of Concern with habitat availability in the Low's Creek riverine habitats, the following habitat assemblages correspond with the optimal requirements of these birds.

<u>The potential of the area to supply habitat – “Optimal” for the following species.</u>

Evergreen and riverine forest

Knysna Turaco (*Tauraco corythaix*)
Chorister Robin-Chat (*Cossypha dichroa*)

Clear water and well-wooded banks

Half-collared Kingfisher *(Alcedo semitorquata)*

<u>The potential of the area to supply habitat – “Good” for the following species.</u>

Densely wooded and riverine gallery forest

Martial Eagle (*Polemaetus bellicosus*)
Crowned Eagle (*Stephanoaetus coronatus*)

<u>The potential of the area to supply habitat – “Medium” for the following species.</u>

Quiet wooded streams and rivers flanked by thick riparian vegetation

African Finfoot *(Podica senegalensis)*

<u>The potential of the area to supply habitat – “Low” for the following species.</u>

Tall trees for roosting and nesting

African White-backed Vulture *(Gyps africanus)*
Tawny Eagle *(Aquila rapax)*

<u>The potential of the area to supply habitat – “Poor” for the following species.</u>

Large river systems

Yellow-billed stork (*Mycteria ibis*)
Black stork (*Ciconia nigra*)

Floodplains

African Openbill *(Anastomus lamelligerus)*
Wooly-necked stork (*Ciconia episcopus*)
Marabou Stork *(Leptoptilos crumeniferus)*

A final synopsis of habitat present in the project area and the preferred habitat available for expected SSC bird species, lists the species most likely to be present in the project area, or occasionally visit the area. Bird species with “Medium” to “Optimal” ratings to potentially utilise available habitats in the Low’s Creek riverine project area, are listed below.

- Knysna Turaco (*Tauraco corythaix*)
- Chorister Robin-Chat (*Cossypha dichroa*)
- Half-collared Kingfisher *(Alcedo semitorquata)*
- African Finfoot *(Podica senegalensis)*

4.3.3.5 Mammals

Of all the mammal species that have distribution ranges in the region, 128 coincide with the Low’s Creek project area (Friedman & Daly, 2004).

Under natural conditions the area had the potential to accommodate larger mammal species. However, due to persecution by humans and habitat loss, some of the expected larger game species are most likely lost to the area:

- Leopard (*Panthera pardus*)
- Nyala (*Tragelaphus angasii*)
- Waterbuck (*Kobus ellipsiprymnus*)

If available habitat types in the Low’s Creek riverine area are evaluated, only 51 mammal species are likely to occur in the project area (excluding the three large species).

During the 2020 surveys, signs and/or sightings of 8 mammal species were recorded (See Appendix 8 for detail) or reported by the staff on the farm:

- Wahlberg’s epauletted fruit bat (*Epomophorus wahlbergi*)
- Thick-tailed bush baby (*Otolemur crassicaudatus*)
- Vervet monkey (*Cercopithecus aethiops*)
- Water mongoose (*Atilax paludinosus*)
- Hippopotamus (*Hippopotamus amphibius*)
- Bushpig (*Potamochoerus larvatus)*
- Red duiker (*Cephalophus natalensis)*
- Bushbuck (T*ragelaphus scriptus*)
- Greater Cane-rat *(Thryonomys swinderianus)*

Species of Concern: Mammals

Of the 51 expected mammal species in the study area, not all of them will remain resident as many are nomadic and will visit the area when conditions are favourable. The larger more mobile species will not be resident, but many of the smaller species will settle in the area and use the habitat available.

Seven (7) of the species which have distribution ranges overlapping with the project area, and suitable habitat available, are listed as Species of Special Concern, most of which are considered threatened:

- Swamp musk shrew (*Crocidura mariquensis)* - SA Red Data (2016): Near-threatened. IUCN 2016: Least concern.
- Leopard (*Panthera pardus*) - IUCN (2016): Vulnerable. SA Red Data (Child 2016) Vulnerable. NEMBA (TOPS 2015): Protected species.
- Serval *(Leptailurus serval*) - SA Red Data (Child 2016): Near threatened; NEMBA (TOPS 2015): Protected species. IUCN (2016) Least concern.
- Cape clawless otter (*Aonyx capensis*) - IUCN (2016): NT Near-threatened; SA Red Data (Child 2016): Near-threatened; NEMBA (TOPS 2007): Protected species.
- Spotted-necked otter (*Hydrictis maculicollis*) - IUCN (2016): NT Near-threatened; SA Red Data (Child 2016): Vulnerable; NEMBA (TOPS 2007): Protected species.
- Hippopotamus (*Hippopotamus amphibius*) - IUCN (2014): VU Vulnerable.
- Water Rat *(Dasymys incomtus)* - SA Red Data (Child 2016): Near threatened; IUCN (2016): Least concern.

Two of the potential SSC species, the Hippopotamus (*Hippopotamus amphibius*) and the Spotted-necked otter (*Hydrictis maculicollis*), lack suitable habitat in the project area as the system is too seasonal and lacking the volumes of water required by these two species. On the other hand, hippo are present in the adjacent Kaap River section, but the Low's Creek reach has no deep pools available as habitat. Hippo tracks were however observed in the riverine area.

Viability of habitat for SSC Mammals at Low's Creek

Comparing the habitat requirements of Species of Concern with habitat availability in the Low's Creek riverine habitats, the following habitat assemblages correspond with the optimal requirements of these mammal species.

<u>The potential of the area to supply habitat – "Optimal" for the following species.</u>

Thick grass and reed beds along riverbanks

Swamp musk shrew (*Crocidura mariquensis*)
Serval (*Leptailurus serval*)
Water Rat (*Dasymys incomtus*)

<u>The potential of the area to supply habitat – "Low" for the following species.</u>

Deeper pooled in-stream areas

Cape clawless otter (*Aonyx capensis*)

<u>The potential of the area to supply habitat – "Poor" for the following species.</u>

Large river systems - Deep in-stream water

Spotted-necked otter (*Hydrictis maculicollis*)
Hippopotamus (*Hippopotamus amphibius*)

A final synopsis of habitat present in the project area and the preferred habitat available for expected SSC mammal species, lists the species most likely to be present in the project area, or occasionally visit the area.

Mammal species with “Optimal” habitat ratings, have the potential to occur in the Low’s Creek riverine biotopes. These species are listed below:

- Swamp musk shrew (*Crocidura mariquensis*)
- Serval (*Leptailurus serval*)
- Water Rat (*Dasymys incomtus*)

4.3.3.6 Summary of all vertebrate fauna

After analysing the fauna distribution data and habitat availability, 19 frog species, 62 reptile species, 203 bird species and 51 mammal species are expected to occur in the project area, a total of 335 animal species. The presence of these different faunal groups is however dependent on availability of potential habitat types in each distinct riverine biotope.

Assessing the conservation status of species has become a critical aspect of monitoring trends in biodiversity conservation at both a national- and global level, but identifying threatened species using internationally accepted criteria and through a standardised process is also a useful tool for the conservation of priority species.

Proposed developments that will involve a change of land use may cause loss of natural habitat or alteration of such habitat. Habitat destruction and habitat change are the greatest threats to fauna in South Africa. In terms of some of the principles of the National Environmental Management Act (Act 107 of 1998) (NEMA, 1998), sustainable development requires the consideration of disturbance and loss of biodiversity, which should be avoided or, if that is not possible, should be minimised and mitigated.

According to the project brief, the Red Data listed and endemic species requires a monitoring programme to assess their numbers and status in the project area. Twelve Species of Special Concern that have a high probability of occurring in the region, are expected to frequent the Low’s Creek project area.

In the event that any threatened or near-threatened animal species are recorded within the study area in future, appropriate conservation measures should be developed in consultation with the relevant conservation authorities.

5. Impact Assessment

5.1 Present Ecological State of the Project Area

Screening Report

The National Web based Environmental Screening Tool is a geographically based web-enabled application which allows a proponent intending to submit an application for environmental authorisation in terms of the Environmental Impact Assessment (EIA) Regulations 2014, as amended to screen their proposed site for any environmental sensitivity. It also provides site specific EIA process and review information and allows for the generation of a Screening Report referred to in Regulation 16(1)(v) of the Environmental Impact Assessment Regulations 2014, as amended.

Following is an abstract from the original Screening Tool application:

Cadastral details of the proposed site

Table 23: Property details:

No	Farm Name	Farm/ Erf No	Portion	Latitude	Longitude	Property Type
1	BRUSNENGO	220	0	25°35'5.98S	31°19'26.79E	Farm
2	CARACETO	223	0	25°35'9.11S	31°17'45.71E	Farm
3	ESPERADO	253	0	25°36'39.27S	31°18'51.79E	Farm
4	ESPERADO ANNEX	222	0	25°36'59.14S	31°17'29.3E	Farm
5	ESPERADO ANNEX	222	3	25°36'2.72S	31°17'53.43E	Farm Portion
6	BRUSNENGO	220	3	25°35'14.4S	31°18'43.27E	Farm Portion
7	ESPERADO	253	0	25°36'23.48S	31°19'6.07E	Farm Portion
8	ESPERADO ANNEX	222	1	25°35'39.98S	31°18'22.44E	Farm Portion
9	ESPERADO	253	11	25°36'18.36S	31°18'30.53E	Farm Portion
10	CARACETO	223	0	25°34'59.28S	31°17'51.47E	Farm Portion
11	ESPERADO	253	8	25°36'27.31S	31°18'12.56E	Farm Portion
12	ESPERADO ANNEX	222	2	25°35'53.57S	31°18'8.09E	Farm Portion
13	ESPERADO	253	1	25°36'50.13S	31°18'46.93E	Farm Portion
14	EUREKA STATION	285	0	25°37'35.89S	31°14'32.75E	Farm Portion

Table 24: Property details: Nearby developments and Environmental Management Frameworks (EMF) areas.

Wind and Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area	No nearby wind or solar developments found.
Environmental Management Frameworks relevant to the application	No intersections with EMF areas found.

Environmental screening results and assessment outcomes

The following sections contain a summary of any development incentives, restrictions, exclusions or prohibitions that apply to the proposed development footprint as well as the most environmental sensitive features on the footprint based on the footprint sensitivity screening results for the application classification that was selected.

Table 25: A summary of any development incentives, restrictions, exclusions or prohibitions.

Application classification	Agriculture - Forestry – Fisheries | Crop Production | Fisheries - Crop Production
Relevant development incentives, restrictions, exclusions or prohibitions	No intersection with any development zones found.

Proposed Development Area Environmental Sensitivity

The following summary of the development footprint environmental sensitivities is identified. Only the highest environmental sensitivity is indicated. The footprint environmental sensitivities for the proposed development footprint as identified, are indicative only and must be verified on site by a suitably qualified person before the specialist assessments identified below can be confirmed.

Table 26: The development footprint environmental sensitivities (Figure 33).

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme	**X**			
Animal species			**X**	
Aquatic Biodiversity Theme	**X**			
Archaeological and Cultural Heritage Theme		**X**		
Civil Aviation Theme			**X**	
Plant Species Theme				**X**
Defence Theme			**X**	
Terrestrial Biodiversity Theme				**X**

The following section with maps represents the results of the screening for environmental sensitivity of the proposed site for selected environmental themes associated with the project classification.

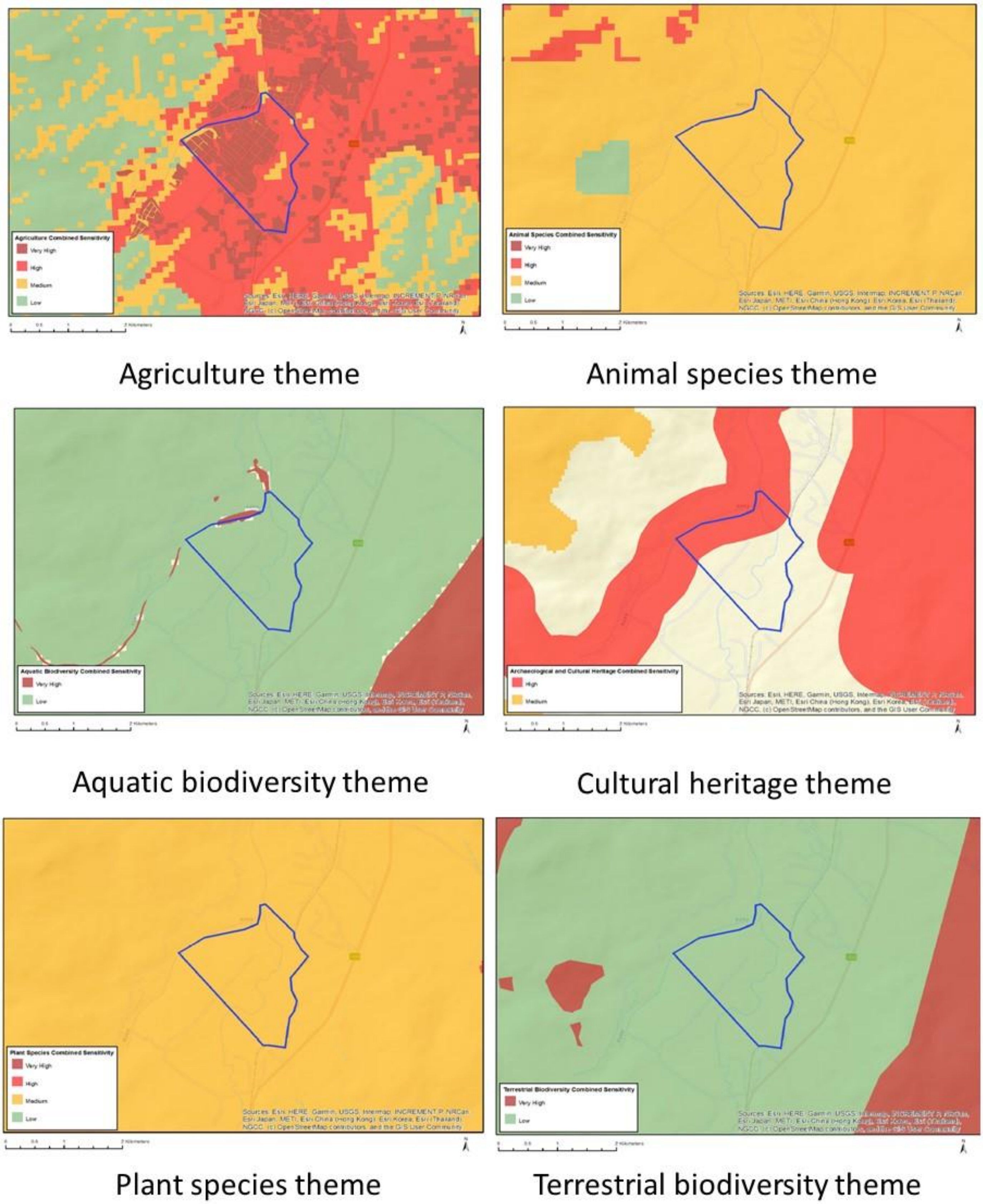


Figure 33: Maps of relative theme sensitivity for important for selected themes (Table 26).

Table 27: Sensitivity features of the project area.

Theme	Sensitivity	Feature
Agriculture Theme	Very High	Land capability; 12 & 13. High-Very high
Animal species theme	Medium	Mammalia - *Lycaon pictus* Mammalia - *Chrysospalax villosus*
Aquatic biodiversity	Low	Low's Creek River
Archaeological and Cultural Heritage Theme	High	Within 500 m of an important river
Plant Species Theme	Medium	Sensitive species 275
Terrestrial Biodiversity Theme	Low	Low sensitivity

5.2 Sensitivity mapping

Sensitivity assessments identify those sections of the study area that have high conservation value or that may be sensitive to disturbance. Sensitivities could be determined based on:

- areas containing untransformed natural vegetation and associated faunal habitat;
- irreplaceability of the vegetation type and associated faunal habitat;
- ecological importance of vegetation and faunal habitat;
- high diversity or complexity of faunal habitat;
- observations of the abundance and diversity of floral and faunal species present at the time of the assessment;
- occurrence of Species of Conservation Concern (SCC);
- systems vital to sustaining ecological functions;
- presence or absence of CBAs and ESAs;
- degree of disturbance encountered as a result of historical activities.

In contrast, any transformed area that has no importance for the functioning of ecosystems is considered to have a low sensitivity.

An ecological sensitivity map of the project area was produced by integrating the information collected on-site with the available ecological- and biodiversity information available in the literature and various relevant reports. This includes delineating the different vegetation and habitat units identified in the field and assigning sensitivity values to the units based on their ecological properties. Additionally, values and potential presence of vegetation and fauna species diversity, as well as species of conservation concern, were evaluated.

Five, broad-scale botanical biodiversity 'sensitivity' categories were identified and were developed for practical mapping purposes. They are intended as a summary of the perceived botanical biodiversity value and sensitivity, of mapped broad-scale vegetation and land-cover type units. Based on the assessment, the sensitivity of the project footprint can be divided into five categories of sensitivity: Very high, High, Moderate, Low and Negligible. These categories are listed as biodiversity sensitivity categories in Table 28.

Table 28: Important parameters relating to faunal diversity and landscape sensitivity listed in the different vegetation and land cover types in order to establish the biodiversity sensitivity and value of the project area.

Vegetation/ Land cover type unit	**Status and sensitivity of vegetation type**	**CBA Category**	**Biota:** Species of special concern (**SSC**)	**Biodiversity value and sensitivity**	**Overall ecological value and sensitivity**
1. Low's Creek riverine habitats	**Granite Lowveld** - Vulnerable	ESA: Protected area buffer	**SSC:** 5 reptiles; 3 birds; 3 mammals	Moderate	**Moderate**

The Low's Creek drainage line is part of a landscape changed completely by agricultural activities. These drainage lines fulfil an important function in maintaining the narrow riparian zones which acts as migration corridors and to buffer these riparian habitats.

The drainage lines also provide connectivity with the larger Kaap River system, which includes the important Crocodile River system. The project area is situated in a Protected Area Buffer of the 2200 ha Boondocks bushveld reserve, which connects the area with the Protected Area Buffer of the Kruger National Park.

Despite the fact that most of the project area consists of cultivated area and old lands (Figure 20), the drainage line and its associated riparian line renders this vegetation unit to have a **Moderate** sensitivity and value in terms of biodiversity conservation.

5.3 Land-use planning and Decision-making

The use of CBA maps in Environmental Impact Assessments

Ideally, all land-users and people who make decisions about land and the use of natural resources should be aware of spatial biodiversity priorities and should know how to take these into consideration in their planning and decision-making processes. This is so that they can proactively identify the ecological opportunities and constraints within a landscape and use these to locate different land-uses appropriately (Cadman *et al.*, 2010).

Systematic biodiversity planning provides a powerful set of tools (maps and land-use guidelines) that facilitate this in a wide range of sectors, at both the policy-making and operational decision-making levels. The Mpumalanga Biodiversity Sector Plan represents the biodiversity sector's input to a wide range of planning and decision-making processes, frameworks and assessments in multiple land-use sectors (MBSP Handbook, Lötter *et al.* 2014).

Mpumalanga Biodiversity Sector Plan (MBSP) and Threatened Ecosystems

The Mpumalanga Biodiversity Sector Plan (MBSP) (Mpumalanga Tourism & Parks Agency, Mbombela (Nelspruit). provides maps of Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) for the entire province, which is referred to as the CBA Map in the MBSP.

Critical Biodiversity Area (CBA) maps and their associated land-use guidelines are used to determine the biodiversity context of a proposed land-use site, ahead of making the first site visit. Although the CBA maps supply crucial guidelines for the assessment, additional background information is required to develop a broader understanding of the study area. A number of resources and tools are therefore used to establish how important the proposed development site is for meeting biodiversity targets. Specifically, the Land-Use Decision

Support Tool (LUDS) and the Mpumalanga Biodiversity Sector Plan (MBSP) are extensively used to compile reports (BGIS, 2015). LUDS was developed to facilitate and support biodiversity planning and land-use decision-making at a national and provincial level.

The conservation status of the SVl3 Granite Lowveld is "Vulnerable" with a target of 19%. It has been greatly transformed (20%), mainly by cultivation and by settlement development. (Mucina & Rutherford 2006).

The Low's Creek Project Area falls within the planning domain of the Mpumalanga Biodiversity Sector Plan, developed by the Mpumalanga Tourism and Parks Agency (MTPA). The potential impact of the development on Critical Biodiversity Areas should be considered in detail as these areas have been identified through systematic conservation planning exercises and represent biodiversity priority areas which should be maintained in a natural to near natural state in order to safeguard biodiversity patterns and ecological processes.

This report made use of the Mpumalanga Biodiversity Sector Plan (MBSP), which was founded on an extensive biodiversity database compiled over the years by the Province's conservation biologists. These detailed records, together with the latest mapping and remote sensing data on vegetation, land use and water resources, have been combined and subjected to sophisticated analyses. For the finer components of a conservation plan, the MBSP maps were consulted and the detail added to the sensitivity assessment of the study area.

The CBA maps indicate the most efficient selection and classification of land portions requiring safeguarding in order to meet national biodiversity objectives. Critical Biodiversity Areas (CBAs) are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. If these areas are not maintained in a natural or near-natural state, then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.

Its primary objective is to serve as a guide for biodiversity planning but should not replace specialist ecological assessments. To maintain an area in a 'natural' state, a variety of biodiversity-compatible land uses and resource uses should be followed.

The MBSP maps the distribution of the province's known biodiversity into seven categories. These are ranked according to ecological- and biodiversity importance and their contribution to meeting the quantitative targets set for each biodiversity feature. The categories are:

- Protected areas - already protected and managed for conservation;
- Irreplaceable areas - no other options available to meet targets—protection crucial;
- Highly significant areas - protection needed, very limited choice for meeting targets;
- Important and necessary areas - protection needed, greater choice in meeting targets;
- Ecological corridors – mixed natural and transformed areas, identified for long term connectivity and biological movement;
- Areas of Least Concern – natural areas with most choices, including for development; and,
- Areas with No Natural Habitat Remaining – transformed areas that make no contribution to meeting targets.

It must first be established how important the site is for meeting biodiversity targets. To do this, it is necessary to answer the following three simple but fundamentally important questions:

- How important is the site for meeting biodiversity objectives (e.g., is it in a CBA or Ecological Support Area (ESA)?
- Is the proposed land-use consistent with these objectives or not (to be checked against the land-use guidelines)?
- Does the sensitivity of this area trigger the MTPA requirements for assessing and mitigating environmental impacts of developments, or in terms of the listed activities in the EIA regulations?

Table 29: The key results of the LUDS Report as extracted for the Low's Creek project area from national datasets available from BGIS.

National Data Set	Aspect	Present
National terrestrial information: Portions of Remaining Extent of Esperado 253 JU and Portions 1 and 2 of Esperado Annex 222JU Kaapmuiden area, Mpumalanga.		
South African District	Ehlanzeni	
South African municipal boundaries	Municipality name: Umjindi	MP323
Quarter-degree grid square		2531CB
Terrestrial CBAs		
Bioregion	**National vegetation map**	**Status**
Savanna Biome (Lowveld)	SVl3 Granite Lowveld	**Threatened ecosystem status:** Vulnerable
Ecological Support Areas	Protected area buffer	2200 ha Boondocks Bushveld Reserve
Aquatic Critical Biodiversity Areas		
Water Management Area (WMA)	Inkomati WMA	
Sub Water Management Area	Crocodile Catchment	
Ecoregion 1	North-Eastern Highlands	4.04

Critical Biodiversity Areas

Overlaying the BGIS Critical Biodiversity Areas map onto the Low's Creek Project Area, resulted in the compilation of Figures 34 to 36 and Table 29. According to these maps and LUDS Report (Table 29) the project area falls into the following sensitive areas:

- Terrestrial:
  - Ecological Support Area: Protected area buffer
  - Vulnerable Ecosystem Status: Granite Lowveld

With these landscape properties, it is paramount to approach the construction- and operation phases of the entire project with caution.

Ecological Support Areas: Those areas that play a significant role in supporting ecological functioning of Critical Biodiversity Areas and/or delivering ecosystem services, as determined in a systematic biodiversity plan. A Critical Biodiversity Area map is a map of Critical Biodiversity Areas and Ecological Support Areas based on a systematic biodiversity plan. Critical Biodiversity Areas and Ecological Support Areas are areas that require safeguarding to ensure the continued existence of biodiversity, ecological processes and ecosystem services. A Critical Biodiversity Area map, often developed at provincial level, provides the basis for a biodiversity sector plan.

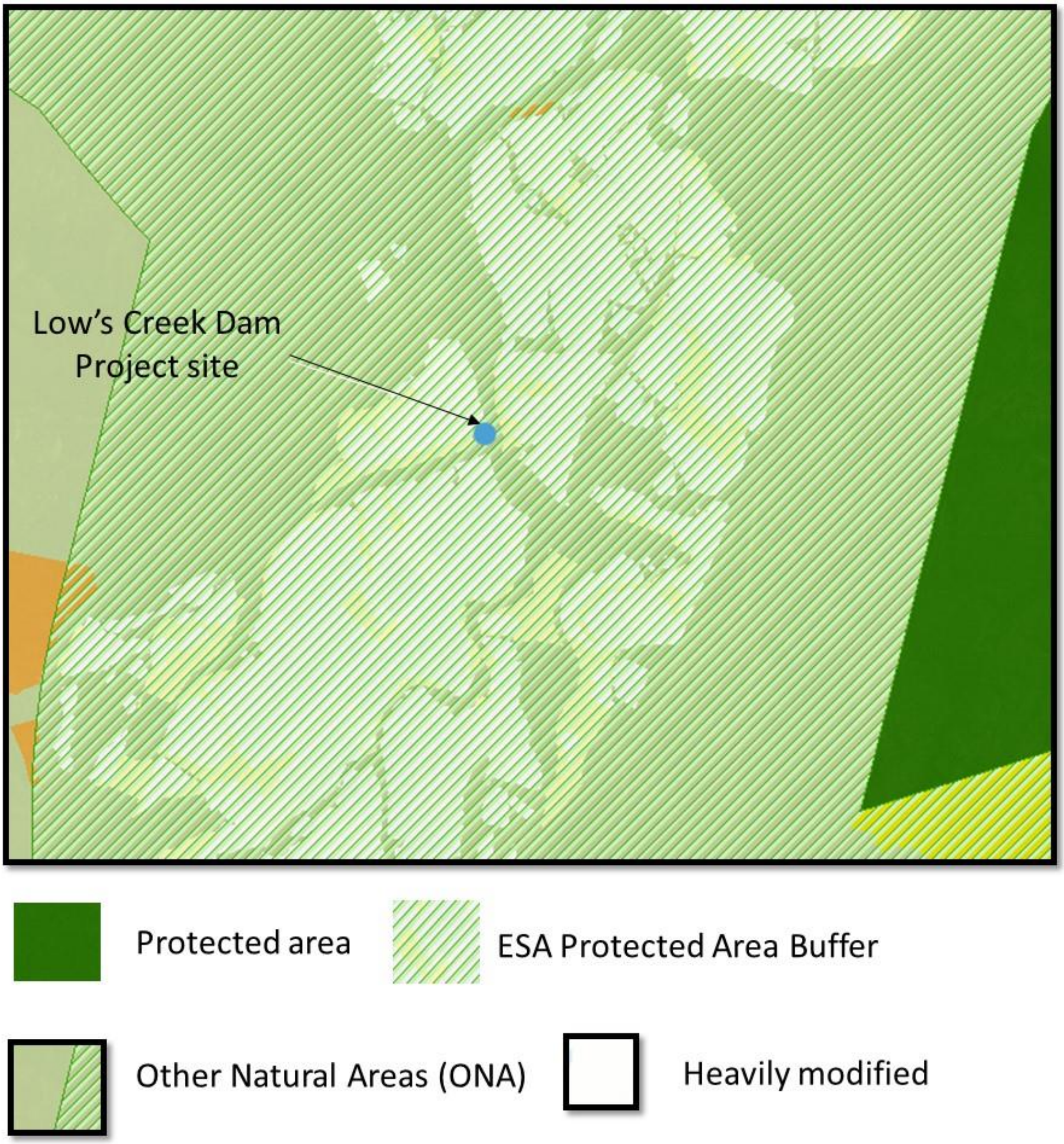
A CBA map of the study area was compiled by using the Biodiversity Geographic Information System (BGIS) maps as illustrated in Figure 34. Every attempt should be made during all phases of the project development not to have an impact on these areas. While determining the area and distribution of a core habitat is important, it is equally important that appropriate management measures be defined to ensure the core habitat continues to function effectively.

The goal is to maximise connectivity in CBAs and ESAs, the retention of intact natural habitat and avoid fragmentation: Design project layouts and select locations that minimise loss and fragmentation of remaining natural habitat and maintain spatial components of ecological processes, especially in ecological corridors, buffers around wetlands, CBAs and ESAs.

Activities that are proposed for CBAs must be consistent with the desired management objectives for these features and should not result in fragmentation.

Figure 20 illustrates the Present Ecological State of the project area as illustrated by the LUDS programme (BGIS, 2015) for Mpumalanga. It indicates the current and historically cultivated areas including the position of the proposed dam.

Figure 34: The Critical Biodiversity areas for the Low's Creek Project Area as illustrated by the LUDS programme (BGIS, 2015) for Mpumalanga.



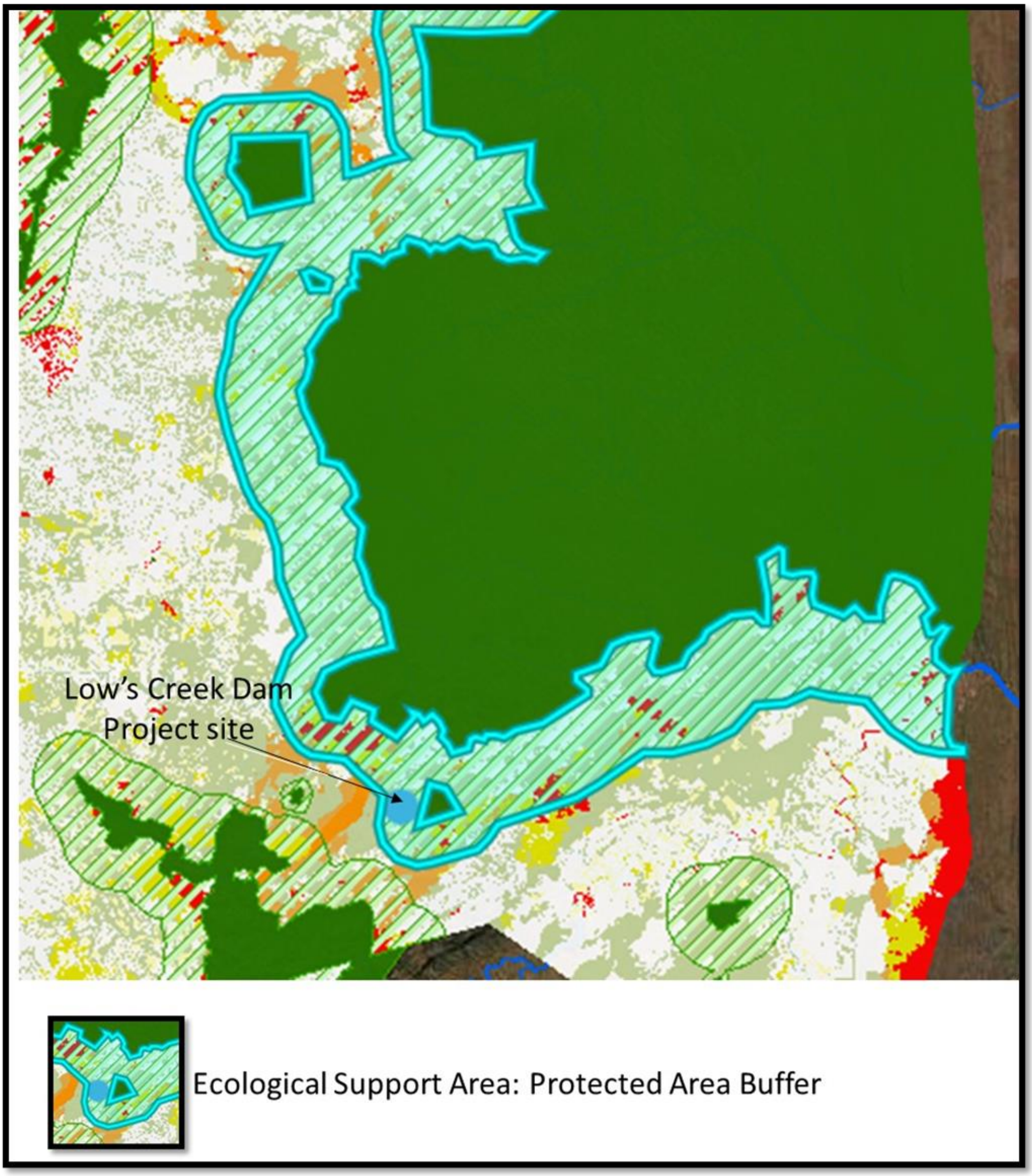


Figure 35: The Terrestrial Critical Biodiversity areas for the Low's Creek Project Area, illustrating the ESA Protected Area Buffer around the 2200 ha Boondocks Bushveld Reserve illustrated by the LUDS programme (BGIS, 2015) for Mpumalanga.

Figures 34 and 35 illustrate the Critical Biodiversity areas for the Low's Creek Project Area as compiled from the LUDS programme (BGIS, 2015) for Mpumalanga. Most of the area has been totally transformed by agriculture ("Heavily Modified"), with only small patches of Other Natural Areas in between. However, the entire farm is situated in an ESA: Protected Area Buffer.

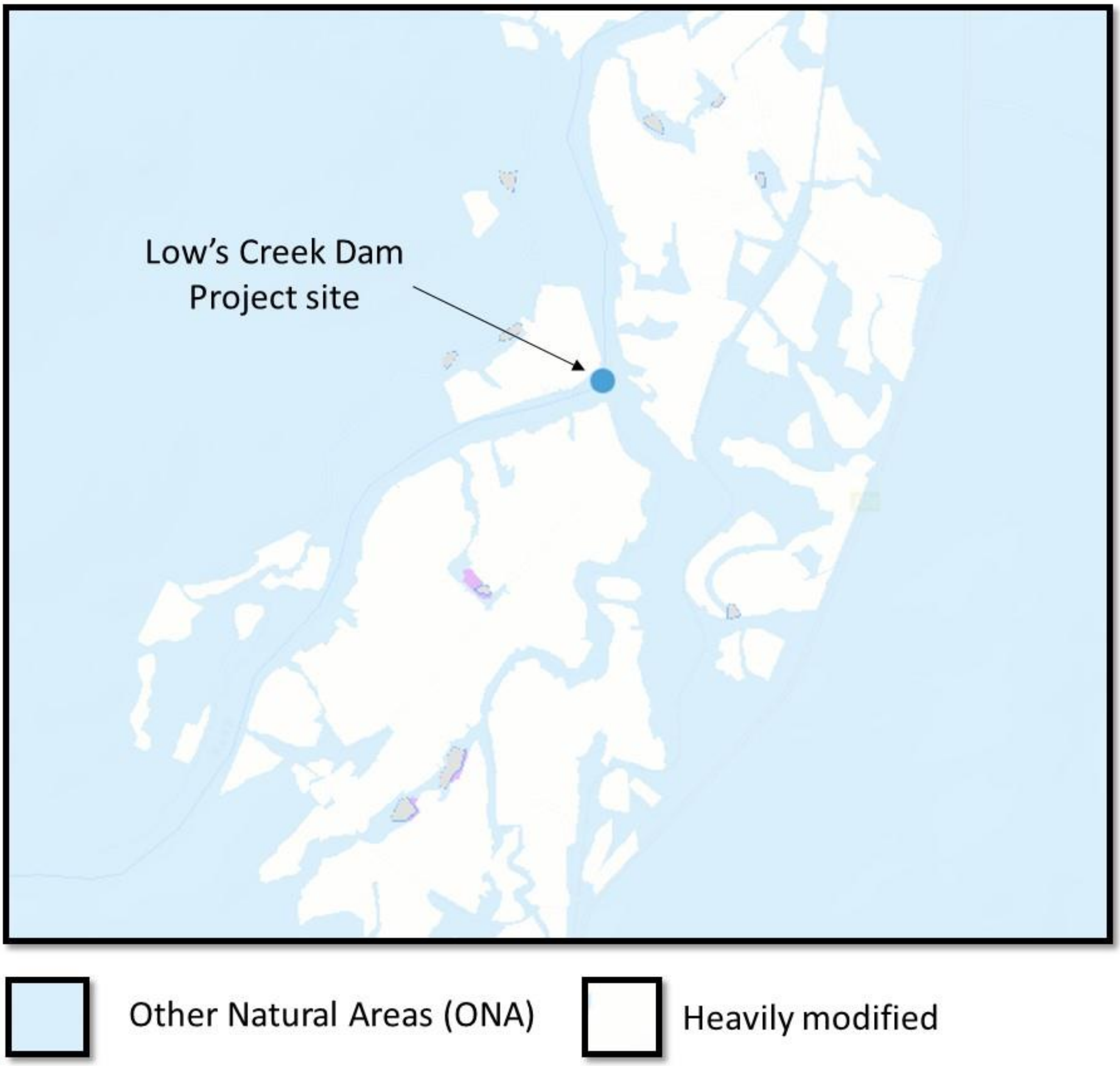


Figure 36: A map obtained by the 2014 Mpumalanga Biodiversity Sector Plan to indicate the Freshwater CBAs and ESAs in the project area, (blue dot). Light blue = Other Natural Areas; White = Heavily Modified Areas (Mpumalanga Biodiversity Sector Plan, 2014).

Freshwater Ecosystem Priority Areas (FEPAs) are identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries. There were no FEPAs identified for the project area (Figure 36).

As the Low's Creek is situated in an Ecological Support Area (ESA Protected Area Buffer), the Desired Management Objectives are to minimise habitat and species loss through judicious planning and maintain basic ecosystem functionality and ecological condition within the surrounding landscape (sub-catchment).

5.3.1 Corridors for Connectivity

The guidelines for land-use practices or activities that impact on water quantity in freshwater CBAs includes: Generic buffers should be established around streams within these catchments. These buffers can be refined based on a site visit and applying the DWS's wetland delineation tool.

Due to their positioning adjacent to water bodies, buffer zones associated with streams and rivers will typically incorporate riparian habitat. Riparian habitat, as defined by the NWA, includes the physical structure and associated vegetation of the areas associated with a watercourse (Macfarlane et al, 2015). However, the riparian zone is not the only habitat type that is present in the buffer as the zone may also incorporate stream banks and terrestrial habitat, depending on the width of the aquatic impact buffer zone applied. Therefore, the riparian zone must be delineated before the buffer zone is established.

5.3.2 Riparian delineation

During the process of riparian delineation, five transects were surveyed. A transect runs from the outer edge of one riparian zone (left bank), through the drainage line to the outer edge of the other riparian zone (right bank). The results of the surveys are illustrated in Figures 27 and 29 in the previous section.

Riparian delineation and habitat evaluation was undertaken according to the DWAF Guidelines (2005) and DWAF updated manual (2008) (see Methods Section 2.1 Vegetation). Figure 37 illustrates the Low's Creek with the riparian zone delineated. The delineation shapefiles are available as Appendices 9 and 10.

It is clear in Figure 37 that the riparian zone is already defined by the agricultural activities of the farms adjacent to the river and thus the fence delineates the current extent of the zone. Cleared lands, orchards and roads border the remaining riparian zone, and the farming activities has advanced right onto the edge of the riparian zone. The figure also shows the dam levels should the dam be filled, and although some of the riparian zone will be drowned, a band of riparian vegetation will remain intact around the dam basin, especially higher up into the flooded area.

5.3.3 Buffer zones

Landscape connectivity may be achieved through several main types of habitat configurations that function as linkages for species, communities or ecological processes. Linkages are used as pathways by animals undertaking a range of movements, including daily or regular movements, seasonal and migratory movements, dispersal movements and range expansion. Linkages also contribute to other ecological functions in the landscape and in particular, have an important role to play in providing habitat for plants and animals in human-dominated environments (Bennett, 2003).

Buffer zones have been used in land-use planning to protect natural resources and limit the impact of one land-use on another. Buffer zones will serve as a mitigating measure for impacts created by the construction- and operational phases of the Project.

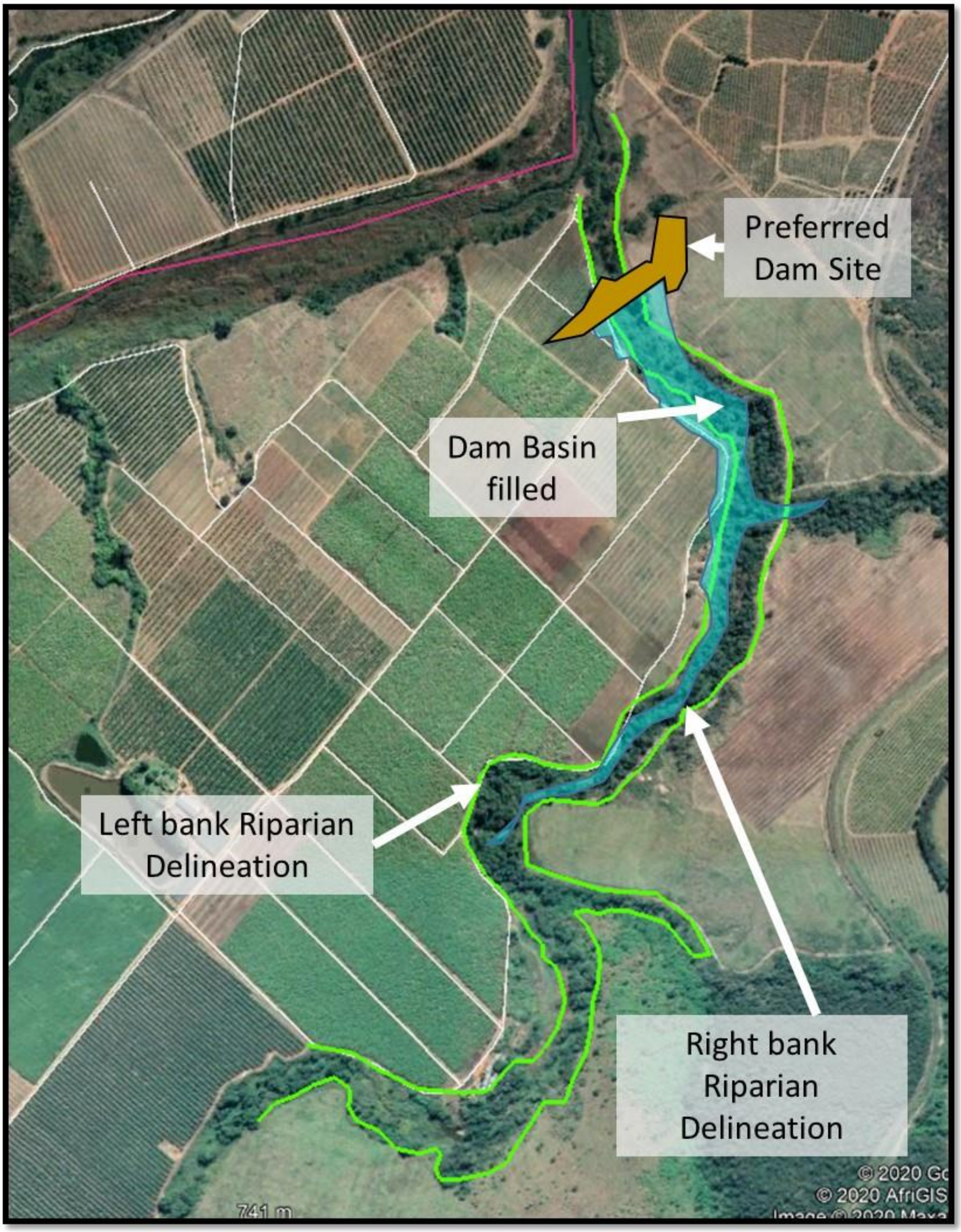


Figure 37: The Low's Creek proposed dam, showing the filled basin and the expected correlation to the riparian delineation of the stream (See Appendices 9 and 10)

Buffer zones associated with water resources have been shown to perform a wide range of functions and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity. These functions include:

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic- and semi-aquatic species;
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

To establish a buffer zone for the proposed Low's Creek Dam project will be a futile excersise as the site is already transformed by farming practises up to the outer edge of the riparian delineation. The riparian delineated area should thus be viewed in the same light as a buffer area. The **entire riparian corridor**, as well as the core areas in the riverine zone, should have explicit and very strict biodiversity conservation management measures and the operating teams should be made aware of this.

Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality. The protected riparian zone will serve as a mitigating measure for impacts created by the construction- and operational phases of the proposed project.

The only corridors present in the project area, are represented by the drainage lines running through the area. The proposed dam and inundation of the dam basin will compromise the link in the corridor as a damwall will pose a fish migration obstruction, and the inundation of riparian areas will also compromise the corridor for species movement (birds and small mammals).

5.3.4 Land-use guidelines

The following section outlines land-use activity descriptions and it includes a summary of the circumstances under which any of these land-use activities can be regarded as biodiversity compatible and outlines additional biodiversity-related management practices and controls. Maintaining biodiversity patterns and ecological processes and the ecosystem services derived from these, requires integrated management over large areas of land.

Although a system of well-managed, strategically located protected areas is the most secure long-term strategy for conserving biodiversity, it is generally acknowledged that protected areas alone will never be adequate to conserve a representative sample of biodiversity and maintain ecosystem functioning – it is both impractical and undesirable to secure all biodiversity priority sites through formal protection, protected areas can be expensive to establish and manage and carry high opportunity costs. It is also difficult to conserve ecological processes in isolated protected areas alone.

There remains a need to safeguard biodiversity beyond the boundaries of protected areas to maintain the integrity of ecosystems across broader landscapes and for all who live and work in these landscapes to play a part in managing them sustainably. This is the essence of the 'landscape approach' to conservation, in which protected areas are embedded in a matrix of land-uses that strives for biodiversity compatibility and in which biodiversity management objectives are integrated into the plans, decisions and practices of a wide range of land users. These land-use guidelines are designed to help achieve this.

Different categories of CBA have specific management objectives, according to their biodiversity priority (Table 30). In broad terms, the biodiversity priority areas need to be maintained in a healthy and functioning condition, whilst those that are less important for biodiversity can be used for a variety of other land-use types (Lötter et al, 2014).

Table 30: The different categories on the CBA maps have specific management objectives, according to their biodiversity priority (MBSP Handbook 2014).

Map Category	Definition	Desired management objectives
Critical Biodiversity Areas (CBAs)	Areas that are required to meet biodiversity targets, for species, ecosystems or ecological processes.	Must be kept in a natural state, with no further loss of habitat. Only low-impact, biodiversity-sensitive land-uses are appropriate.
Ecological Support Areas (ESAs)	Areas that are not essential from meeting biodiversity targets, but that play an important role in supporting the functioning of protected areas or CBAs and for delivering ecosystem services.	Maintain in a functional, near-natural state, but some habitat loss is acceptable. A greater range of land-uses over wider areas is appropriate, subject to an authorisation process that ensures the underlying biodiversity objectives are not compromised.
ESA: Protected Area Buffer	A buffer distance of either 10 km for National Parks; 5 km for all other PAs; and 1 km for Protected Environments.	Maintain or improve ecological and tourism functionality of a PA, ensuring none of the PA objectives are compromised by activities or land-use changes in the buffer zone.
Other Natural Areas (ONAs)	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been prioritised for biodiversity, they are still an important part of the natural ecosystem.	An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some authorisation may still be required for high-impact land-uses.
Heavily or Moderately Modified Areas	Areas that have been modified by human activity to the extent that they are no longer natural and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructural functions, even if they are never prioritised for conservation action.	Such areas offer the most flexibility regarding potential land-uses, but these should be managed in a biodiversity-sensitive manner, aiming to maximise ecological functionality and authorisation is still required for high-impact land-uses. Moderately modified areas (old lands) should be stabilised and restored where possible, especially for soil carbon and water-related functionality.

5.3.5 Desired management Objective

The following section outlines land-use activity descriptions and it includes a summary of the circumstances under which any of these land-use activities can be regarded as biodiversity compatible and outlines additional biodiversity-related management practices and controls.

Tables 31 summarises the final permissible land-uses that are proposed for the identified landforms on the Low's Creek Dam project area and the demarcated map illustrated is in Figures 34 to 36. The area is listed and rated as follows:

Critical Biodiversity Areas (CBAs): Entire Low's Creek Project Area: ESA Protected Area buffer (Boondocks Bushveld Reserve)

ESA: Protected Area Buffers are areas around protected areas where changes in land-use may affect the ecological functioning or tourism potential of the adjacent protected area. The purpose of buffer zones is to reduce the impacts of undesirable land-uses on the environment, and to provide opportunities for tourism.

Modification of the natural habitat within the buffer zones may have negative impacts on the zonation and management plan of the adjacent protected area. Only low-impact, biodiversity-sensitive land-uses are appropriate.

Table 31: Permissible land-uses that are set for the identified landforms on the Low's Creek Dam project area.

Permissible land-uses that are unlikely to compromise the biodiversity objective.	Land-uses that may compromise the biodiversity objective and that are only permissible under certain conditions.	Land-uses that will compromise the biodiversity objective and are not permissible.
Livestock & Game Ranching	Arable Lands	Residential
Conservation / Stewardship	Agricultural Infrastructure	Urban Influence
Open Space	Forestry	Low Impact & General Industry
Low Impact Tourism	Municipal Commonage	High Impact Industry
Eco-estates	High Impact Tourism	Quarrying / Opencast Mining
	Rural Residential	
	Roads & Rail	
	Water Works, Sewerage Works, Catchment Transfers	
	Prospecting / Underground Mining	
	Transport Services	
	Linear Structures: Pipelines, Canals, Power lines	
	Other Utilities	

CBAs and listed activities in terms of the EIA Regulations.

Depending on specific activities, CBAs (and ESAs) trigger the need for basic assessments in terms of the EIA regulations, and should inform the development of Terms of Reference for the biodiversity specialists appointed in the EIA process.

The specific activities requiring an environmental authorisation are listed in three notices, reflected in Government Notice R 544, R 545 and R546, as follows:

- *Listing Notice 1*: This states that a Basic Assessment (BA) is required for those activities with known impacts that can be avoided or reduced.
- *Listing Notice 2*: This refers to activities with unknown impacts that require specialist studies to be worked out. Such activities require a comprehensive scoping/environmental impact assessment.
- *Listing Notice 3*: This applies to activities in sensitive geographic areas, requiring a basic assessment and environmental authorisation before commencement of any land-use activity.
- In Mpumalanga these sensitive geographic areas are CBAs and ESAs as defined in the MBSP.

The activities covered by all three of these listing notices are in conflict with the desired management objective for CBAs.

Protected area buffers

When assessing the impacts of proposed land uses in protected area buffers, consideration needs to be given to both direct (e.g., plantation forestry blocking view-sheds and reducing water flows into a Protected Area) and indirect impacts (e.g., light and noise pollution).

Buffer distances vary according to the nature of the Protected Area, as follows:

National Parks: 10 km buffer as indicated in Listing Notice 3.
Nature Reserves: 5 km buffer as indicated in Listing Notice 3.
Protected Environments: 1 km buffer as these may include production landscapes.

Land-use change applications within the buffer zone may be referred to the protected area manager or ecologist for evaluation. A viewshed analysis of the potential visual impact of the proposed land-use on adjacent protected areas should be undertaken where necessary.

5.4 Assessment of impacts

The potential impact of the project on the biodiversity of the study area are assessed under one broad impact, namely:

- Impeding or diverting the flow of water in a watercourse: The construction of a dam covering 6.5 ha with a storage capacity of 193 000 cubic metres in the channel of the Low's Creek river.

The potential impacts of the project on the biodiversity of the study area are assessed under the following broad categories, namely:

- **Activity 1.** The dam basin – clearing vegetation, manipulating soil layers, construction of coffer walls, operating and rehabilitation, construction of the dam wall.
- **Activity 2.** Riparian corridor and adjacent land – influencing riparian habitats and associated biodiversity, as well as areas adjacent to the riparian zone.
- **Activity 3.** River flow – downstream flows.
- **Activity 4.** River flow – water quality.
- **Activity 5.** Erosion and siltation.
- **Activity 6**. Impacts of dam wall.
- **Activity 7.** Alien invasive vegetation.

The impact assessment of all the perceived impacts provided below, describes each broad impact, determines the significance of the impact and lists summarised mitigation- and monitoring measures for each impact.

<u>Impact 1:</u> The dam basin – clearing vegetation, manipulating soil layers, construction of coffer dam walls (operating and rehabilitation) and the dam wall.

Applicable Phase: Clearing and construction phase.
Applicable activity: Clearing the dam basin, manipulate soil and constructing dam walls (including coffer dam walls).

Nature of impact: This impact refers to the loss of untransformed habitat attributes and cleared areas, furthering the risks for erosion and siltation.
During clearing of riverine vegetation in the dam basin and obtaining soil for the dam wall construction, the original riparian corridor of the Low's Creek River will be affected permanently. Disturbing the soil layers during construction of the coffer dam wall and final dam wall will create extensive areas of bare, loose soil, which will pose a serious erosion and siltation threat.

Mitigation of Impact 1:

<u>Mitigation Description</u>: Levelling and landscaping of the site should follow natural drainage patterns as far as possible i.e., drainage towards the river and it must ensure that surface water flow velocities are reduced before draining into any of the rivers and drainage areas.
Clearing for the dam site should take place during the dry period, i.e., winter. However, as high rainfall can occur in any month of the year, all measures should be taken to prevent exposed soils from being washed into the downstream tributary and main stream, which will affect in-stream and marginal habitats.

The remaining peripheral riparian woodland in the dam basin should be left intact in order to maintain the denser riparian corridor utilized by the riparian animals.

Table 32: Impact Rating of Activity 1: The dam basin – clearing vegetation, manipulating soil layers, construction of coffer dam walls (operating and rehabilitation) and the dam wall.

ISSUE:	Clearing of vegetation, manipulating soil layers and construction in dam basin.
Project Phase	**Clearing and Construction**
Nature	Negative
Extent	Local (2)
Intensity	High (3)
Duration	Long term (3)
Consequence	Very high (8)
Probability	Definite
Degree to which impact cannot be reversed	High
Degree to which Impact may cause irreplaceable loss of resources	High
Confidence level	High
Significance Pre- Mitigation	**Very High (-ve)**
Significance Post Mitigation	**High (-ve)**
Degree of Mitigation	Low

Impact 2: Removing or inundating the riparian zone in the dam basin and affecting the link in the up- and down-stream riparian corridor.

Applicable Phase: Clearing and dam filling phase.
Applicable activity: Removing or inundating the riparian zone in the dam basin and affecting the link in the up- and down-stream riparian corridor.

Nature of impact: This impact refers to the permanent loss of untransformed habitat, especially the interruption of the riparian corridor and the influence extending into the adjacent terrestrial land.
During clearing of the dam basin, the riverine vegetation will be removed and the entire area drowned during the filling phase of the dam. Downstream riparian zones will be influenced by the change in flows due to the dam releases and the upstream riparian zone will be vulnerable to further agricultural development.

Mitigation of Impact 2:

Mitigation Description: Very little mitigation will be available in drowning riparian zone in the dam basin during dam filling. Create a buffer zone around the full-water mark and replant some of the key riparian tree species from the basin onto the dam margin border.

Currently there are intact riparian zones upstream and downstream of the proposed dam basin along the riverbanks of the Low's Creek. Usually, a riparian buffer would have been proposed for these riparian vegetation zones, but as the land has historically been developed right up to the edge of the riparian zone (up to the fence around the riparian area), no additional natural buffer will be feasible. Therefore, current riparian zones upstream and downstream of the dam basin should be protected and excluded from any further development in order to maintain the integrity of the intact riparian corridor.

In order to re-establish the link between the riparian corridors upstream and downstream of the dam basin, a riparian buffer should be established along the new marginal zone around the dam. Since the new marginal zone will either be covered with current orchards, or the original terrestrial vegetation, it is proposed that a buffer of 25m wide around the high-level mark of the dam should be established as a buffer for the aquatic environment. The proposed 25 m width is representative of the current average width of the intact riparian zone upstream of the proposed dam position.

The areas adjacent to the high-level mark of the dam should thus be left intact and if possible, the new wetted perimeter should rehabilitated with vegetation removed from the dam basin.

Any remaining peripheral woodland in the dam basin should be left intact in order to represent the new wetted perimeter and create some kind of new riparian zone. This buffer will hopefully represent a denser band of vegetation in time due to the increased availability of water and consequently create a denser vegetation corridor utilized by riparian faunal species.

Table 33: Impact Rating of Activity 2: Removing or inundating the riparian zone in the dam basin and affecting the link in the up- and down-stream riparian corridor.

ISSUE:	Affecting the riparian corridor link.
Project Phase	Clearing and Construction
Nature	Negative
Extent	Local (1)
Intensity	High (3)
Duration	Short term (1)
Consequence	Low (5)
Probability	Definite
Degree to which impact cannot be reversed	High
Degree to which Impact may cause irreplaceable loss of resources	High
Confidence level	High
Significance Pre- Mitigation	**High (-ve)**
Significance Post Mitigation	**Medium (-ve)**
Degree of Mitigation	Low

<u>Impact 3. River flow – downstream flows.</u>

Applicable Phase: Operational phase.
Applicable activity: By storing or diverting water with dams or weirs, the natural distribution and timing of the downstream stream flow will be altered.

Nature of impact: Changes in temporal and spatial characteristics of flow can have an impact on downstream habitat attributes such as an increase in duration of low flow season (or none-flow events), resulting in low availability of certain habitat types or availability of water at the start of the breeding, flowering or growing season of the riverine biota (aquatic and riparian).

Mitigation of Impact 3:

<u>Mitigation Description</u>: An Ecological Water Requirements (EWR) must be implemented and managed by releasing water from the dam to mimic natural flow as closely as possible. An EWR report for the Low's Creek project was prepared by IWR Water Resources (2020) and it is attached as an Appendix to the EIR.

The Ecological Water Requirements (EWR) of the Kaap River have been determined (DWA, 2010) and published in the Government Gazette. Whilst there is no specific EWR for the Low’s Creek, it can be estimated using the Hughes Desktop model (Hughes and Hannart, 2002).

By incorporating the ecological parameters from the PES report (Deacon 2021), the EWR of the Low’s Creek was estimated for a category B river. The rule curve for this EWR is attached in Appendix 9 which was obtained from IWR Water Resources Report (2020). The rule curve expresses the EWR as a function of the natural flow from which a time series EWR can be determined.

While there is a significant amount of irrigation water available within the Low’s Creek catchment, the water for this irrigation is supplied from the Shiyalongubu Dam, located on a tributary of the Lomati River. The yield of the Low’s Creek Dam was assessed over a range of full supply capacities. At the preferred full supply capacity of 195 000 m^3, the yield is 3.2 million m^3/annum at 70% assurance (IWR Water Resources, 2020).

However, the low flow downstream of the dam will decrease significantly due to this development. An analysis of the irrigation water requirements versus supply shows that the irrigation requirements are largely met during the summer, but shortages occur in winter. The Low’s Creek Dam will reduce the assurance of supply of downstream users by about 5 percentage points (from 63% to 58%).

Therefore, in order to compensate downstream irrigators, a release of a B category EWR as well as an additional 1.0 million m^3/annum is recommended. This mitigation measure will result in water being released from the Low’s Creek Dam in the months of May through to the end of October. This measure will decrease the yield of the dam to 2.2 million m^3/annum (IWR Water Resources, 2020).

Table 34: Summary of the EWR (the detailed Ecological Water Requirements table is supplied in Appendix 9).

Natural flow (million m^3 /annum)	**EWR Category**	**EWR**	
17.1	B	**(million m^3 /annum)**	**% of the MAR**
		5.34	31%

The construction of the dam wall should take place and be completed during the low flow period. There are times when the river naturally ceases to flow. When flow in the river resumes, measures must be taken to manage the weir or outlet structures to mimic natural variations in physical habitat upstream.

Table 35: Impact Rating of Activity 3: By storing or diverting water with dams or weirs, the natural distribution and timing of stream flow will be altered.

ISSUE:	Storing or diverting water with dams or weirs
Project Phase	**Operational**
Nature	Negative
Extent	Local (2)
Intensity	High (3)
Duration	Long term (3)
Consequence	Very high (8)
Probability	Definite
Degree to which impact cannot be reversed	Medium
Degree to which Impact may cause irreplaceable loss of resources	High
Confidence level	High
Significance Pre- Mitigation	**Very High (-ve)**
Significance Post Mitigation	**Medium (-ve)**
Degree of Mitigation	Medium

Impact 4. River flow – water quality.

Applicable Phase: Construction and Operational phase.
Applicable activity: Damming changes the physical and chemical attributes of the water in the dam.

Nature of impact: Damming changes the physical-chemical aspects of the dammed water (in the coffer walls and dam basin) and therefore, the water released from the dam could have adverse impacts on the downstream reaches as listed below:

- damming alters water temperature and chemistry;
- alters nutrient regimes due to a nutrient input;
- eutrophication occurs due to the enrichment of water with nutrients (nitrates and phosphates);
- increases TDS (salinity is the quantity of total dissolved inorganic solids, or salts, present in water) due to evaporation losses from dams;
- suspended solids due to siltation;
- hazardous substances associated with construction activities.

Mitigation of Impact 4:

Mitigation Description: Due to the size of the dam and the through flow of water, the chemistry of the water will not pose a significant threat. Nutrients and TDS will not reach levels that will affect the overall water quality and resultant eutrophication.

Hazardous substances associated with construction activities will be mitigated by adhering to the best practice guidelines for these substances.

Design the dams in accordance with the requirements of the Ecological Reserve / EWR of the river. In particular, a mechanism for delivery of continual maintenance flows to the downstream system is critical. Multiple sluices will be able to release water from different levels in the thermocline and therefore mixing the water being released. This action will prevent that only cold, anoxic bottom water be released from the lowest valve, thus mixing the layers to a more acceptable water quality, especially during higher flows when water is topping the dam wall and the fish ladder. The issue relating to suspended solids will be addressed by the section on “erosion and siltation”.

Table 36: Impact Rating of Activity 4: Damming changes the physical and chemical attributes of the water in the dam.

ISSUE:	Physical and chemical attributes of the water in the dam
Project Phase	**Operational**
Nature	Negative
Extent	Local (2)
Intensity	Medium (2)
Duration	Long term (3)
Consequence	High (7)
Probability	Possible
Degree to which impact cannot be reversed	Medium
Degree to which Impact may cause irreplaceable loss of resources	Medium
Confidence level	Medium
Significance Pre- Mitigation	**High (-ve)**
Significance Post Mitigation	**Medium (-ve)**
Degree of Mitigation	Medium

Impact 5. Erosion and siltation.

Applicable Phase: Construction and Operational phase.
Applicable activity: Clearing of vegetation or disturbing the soil layers in the project area.

Nature of impact: Any clearing of vegetation or disturbing the soil layers will subject these areas to erosion and sedimentation impacts due to the lack of cover.

Mitigation of Impact 5:

Mitigation Description: It is important that all work within a water resource should be completed during the dry season, when flows are at their lowest. This significance of the impact can be reduced to low when construction takes place during the dry season and/or when sedimentation ponds are used to settle out the suspended solids.

During vegetation **clearing** of the dam basin, bank protection (e.g., planting) will also be required to reduce sediment input. This will stabilise the problem area and maintain the present condition of the riparian wetland or secondly, attempt to reclaim the riparian wetland area that has been lost.

Use a variety of methods, such as planting herbaceous or woody plants, place hay bales, clay, gabions filled with rock, or if lined with a geo-textile, cover with soil, or even just pack loose rock against head-cut faces. Draft and implement a maintenance plan which optimises macrophyte / riparian plant species development.

Where the dam is **constructed**, adequate erosion and sedimentation control measures must be put in place to prevent downstream impacts during both the construction- and operational phases. A stormwater management and erosion-control plan must be put in place for both the construction- and operational phases. No new roads are envisaged.

During construction, the process may include maintaining a vegetated buffer area until just prior to establishing the dam embankment (this buffer will reduce erosion and sedimentation), and/or constructing a retention swale prior to any clearing 'upstream', or any other method deemed appropriate by the Dam Designer.

Complete rehabilitation of all work areas will be required to return the site to its former condition. All areas that were cleared or disturbed during construction activities must be rehabilitated to an appropriately vegetated state. Care must be taken to ensure that these rehabilitated areas blend in with the immediate environment.

During the **operational** phase a buffer zone (e.g., riparian vegetation) should be established to prevent entry of additional sediment into the water course/impoundment. This will stabilise the problem areas and maintain the present condition of existing riparian woodland or attempt to reclaim the riparian area that has been lost.

The release of bottom water with high silt loads will be detrimental to downstream fish and must be avoided. Whenever possible, there should be a mix of released water from the sluice and dam overflow and/or flow through the fish ladder when the bottom sluice is in operation. This will mix the bottom water with top layer flows and thus dilute and improve the poor quality water.

These measures will prevent the long-term degradation of the downstream river and riparian zone and ensure compliance with the Ecological Reserve, associated water use allocation, and all other Water Use License conditions.

Table 37: Impact Rating of Activity 5: Any clearing within the project area will be subject to erosion and sedimentation impacts due to the lack of vegetation cover.

ISSUE:	Erosion and sedimentation
Project Phase	**Clearing, Construction and Operational**
Nature	Negative
Extent	Local (2)
Intensity	Medium (2)
Duration	Short term (2)
Consequence	Medium (6)
Probability	Possible
Degree to which impact cannot be reversed	Low
Degree to which Impact may cause irreplaceable loss of resources	Medium
Confidence level	High
Significance Pre- Mitigation	**High (-ve)**
Significance Post Mitigation	**Medium (-ve)**
Degree of Mitigation	High

Impact 6. Impacts of dam wall.

Applicable Phase: Operational phase.
Applicable activity: Dams prevent the free passage of aquatic animals and fish and thus disrupt riverine migration routes.

Nature of impact: The disruption of migratory routes affects the lifecycle of migratory aquatic species as dam barriers prevent brood stock from reaching their spawning grounds during the breeding season, resulting in a failure of recruitment and eventual extinction of the stock above the dam.

Mitigation of Impact 6:

Mitigation Description: Low's Creek is a semi-permanent stream that would provide valuable breeding and refuge habitat for fish species found within the river reach. In order to mitigate for the disruption of migratory routes (aquatic environment) caused by the building of the dam, it is recommended that a fish way or fish ladder be incorporated into the dam wall.

The implementation of natural bypass or rock-ramp types of fish passes are usually the preferred design over formal fishway structures.

Broadly described, a rock ramp fish pass is a series of rocks and boulders of various sizes that is embedded into a stable foundation material (concrete) in such a way that the turbulence created by the natural flow path through the boulders creates pooled areas of various sizes, depths and hydraulic conditions. The actual watercourse is broadly an open parabolic-shaped channel. Figure 38 a and b presents a rock-ramp fishway that has been implemented.

Figure 38 a and b: The aim of a rock ramp type fishway is to simulate a natural rapid-type habitat unit that would allow fish to overcome an otherwise hydraulically difficult area.

The design report of EnviRoss CC (2021) is attached as an Appendix to the EIR.

In the case of the Low's Creek Dam site, a fishway channel that simulates a natural bypass channel and rock-ramp type of fishway has been proposed for the site (EnviRoss CC, 2021). The site conditions and the nature of the development tends to suit this style. Two alternative alignments were explored, and both of them are considered viable from an ecological perspective (Figure 39). The preferred alignment will therefore largely be based on site conditions and engineering aspects.

A slope of 1:15-1:25 (or higher) is recommended, where the channel will be more likely to have lower water velocities and therefore, lower turbulence levels. The water will also tend to pool more readily, which will reduce the incidences of supercritical flow conditions.

Given that the design criteria and the alignment route are taken into consideration, it is believed that the proposed fishway channel will adequately cater for the migratory requirements of the target fish species.

It is recommended that once the basic channel has been excavated, that the channel be surveyed and the profile modelled in order to offer an optimal design with modifications presented in areas that are shown to not function adequately.

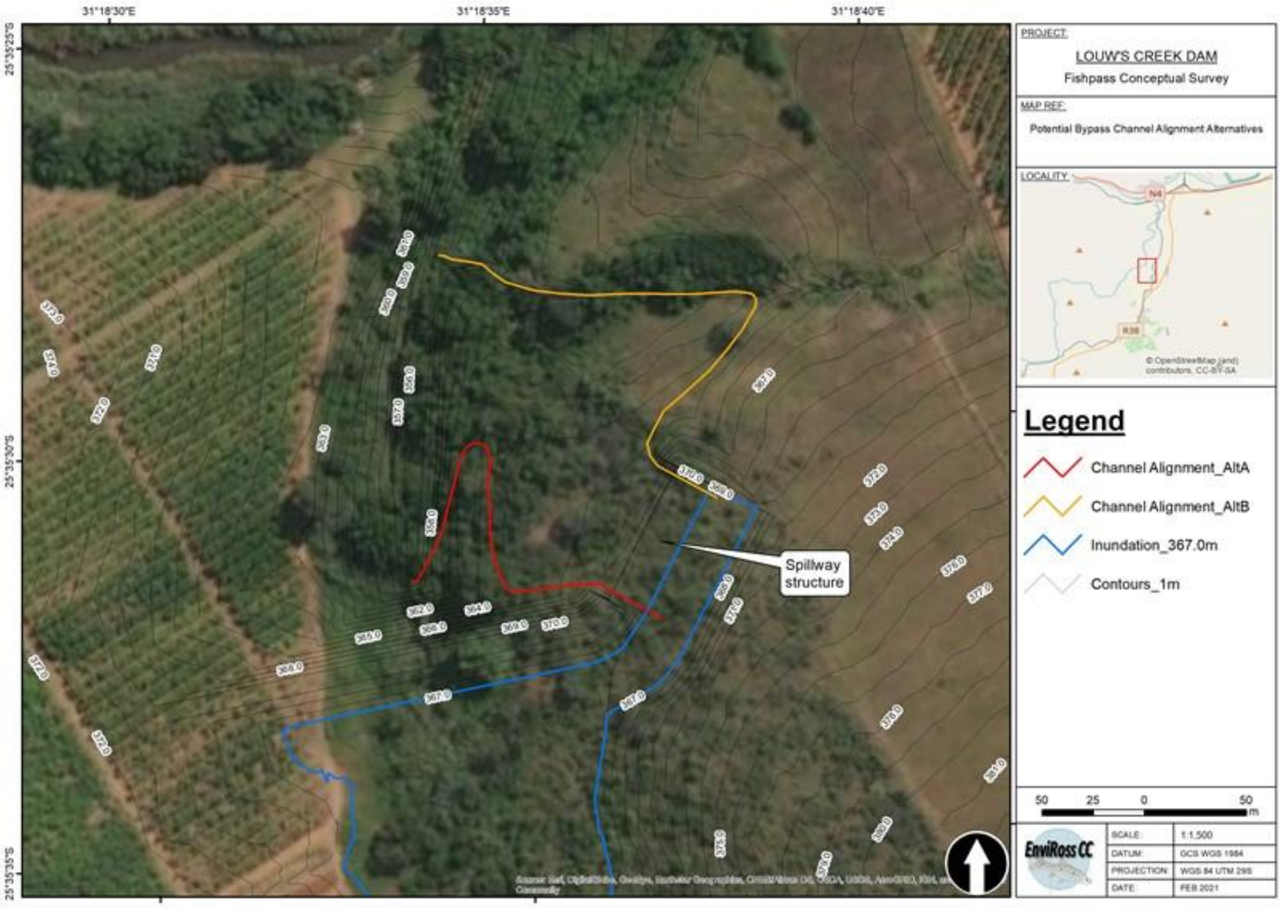


Figure 39: The two identified potential channel alignment alternatives. Both alignments are considered feasible from an ecological perspective (EnviRoss CC, 2021).

The overflow from the dam into the river should be close to the edge of the embankment and sculptured in such a way that most of the fish can continue to find their way up the embankment to find the fish way entrance.

Table 38: Impact Rating of Activity 6: Dams prevent the free passage of aquatic animals and fish, and thus disrupt riverine migration routes.

ISSUE:	The disruption of migratory routes
Project Phase	**Operational**
Nature	Negative
Extent	Regional (3)
Intensity	Medium (2)
Duration	Long term (3)
Consequence	Very high (8)
Probability	Probable
Degree to which impact cannot be reversed	Low
Degree to which Impact may cause irreplaceable loss of resources	Medium
Confidence level	Medium
Significance Pre- Mitigation	**High (-ve)**
Significance Post Mitigation	**Low (-ve)**
Degree of Mitigation	High

Impact 7. The introduction and spread of alien vegetation.

Applicable Phase: Operational phase.
Applicable activity: Invasive, non-native plants often establish in vacant niches, such as cleared or eroded areas and subsequently compete with indigenous plant species for space and thus further transform the natural habitat.

Nature of impact: One of the main threats to the biodiversity is considered to be the introduction and spread of alien vegetation.

Mitigation of Impact 7:

Mitigation Description: The control methods of alien invasive plants can be broadly classified into three categories: mechanical, chemical or biological.

- mechanical control methods involve the physical destruction or total removal of plants (e.g., felling, strip-barking; ringbarking, hand-pulling and mowing).
- chemical control of invasive alien plants includes the foliar spraying of herbicides to kill targeted plants and
- biological control or bio-control methods involves the release of natural enemies that will reduce plant health and reduce population vigour to a level comparable to that of the natural vegetation.

It is often necessary to use a combination of at least two of these methods to control or remove invasive alien plants. With repeated follow-up, mechanical and chemical control methods tend to be short-term activities suitable for smaller plant invasions that can result in the complete removal of the target species. After the implementation of the methods, it is important to evaluate the effectiveness of the methods and to monitor the cleared areas on a regular basis to identify emergent seedlings and to remove those immediately.

Table 39: Impact Rating of Activity 7: The introduction and spread of alien vegetation.

ISSUE:	Alien invasive vegetation.
Project Phase	**Operational**
Nature	Negative
Extent	Site (1)
Intensity	Low (1)
Duration	Short term (1)
Consequence	Very low (3)
Probability	Probable
Degree to which impact cannot be reversed	Low
Degree to which Impact may cause irreplaceable loss of resources	Medium
Confidence level	High
Significance Pre- Mitigation	**Medium (-ve)**
Significance Post Mitigation	**Low (-ve)**
Degree of Mitigation	High

Impact Assessment Summary

Table 40: A summary of the impact assessment post mitigation.

Impact No	Issue and aspect	Phases	Significance without mitigation	Significance with mitigation
1	Clearing of vegetation, manipulating soil layers and construction in dam basin.	Clearing and Construction	**Very High (-ve)**	**High (-ve)**
2	Clearing the dam basin and adjacent riparian zones, as well as impacting on downstream and upstream riparian corridors and adjacent land.	Clearing and Construction	**High (-ve)**	**Medium (-ve)**
3	By storing or diverting water with dams or weirs, the natural distribution and timing of stream flow will be altered.	Operational	**Very High (-ve**	**Medium (-ve)**
4	Damming changes the physical and chemical attributes of the water in the dam.	Operational	**High (-ve**	**Medium (-ve)**
5	Clearing of vegetation or disturbing the soil layers in the project area.	Construction and Operational	**High (-ve**	**Medium (-ve)**
6	Dams prevent the free passage of aquatic animals and fish and thus disrupt riverine migration routes.	Operational	**High (-ve**	**Low (-ve)**
7	The introduction and spread of alien vegetation.	Operational	**Medium (-ve)**	**Low (-ve)**

5.5 Conditions for inclusion in the environmental authorisation

These conditions are based on the identification of mitigation measures and solutions that minimise impacts on biodiversity and conflicts in land-use by making use of CBA maps in the Environmental Impact Assessment (see Table 29). The steps used in this section correspond with the steps which are obtained from the Mpumalanga Biodiversity Sector Plan (2014). Step 2.3 listed in the Land-use planning and Decision-making table (Table 40), lists compromises and solutions that minimise impacts on biodiversity and conflicts in land-use, which are supported by the following five steps:

Step 2.3.1 Retain **natural habitat and connectivity** in CBAs and ESAs: The avoidance of environmentally sensitive areas identified during the Sensitivity Mapping exercise is regarded as the single most effective possible mitigation measure for mitigating impacts on the ecology of the project area.

- The riparian corridor will be inundated by the dam water and the riparian link will thus be affected. The increased moisture from the higher water levels in the dam will enhance plant growth and probably create a secondary riparian zone which will link the original upstream and downstream riparian corridors.
- The project should protect this riparian corridor by incorporating a rehabilitated buffer around the periphery of the dam high level mark.
- By establishing a 25m buffer around the dam high level mark, the new perimeter could be rehabilitated with vegetation removed and replanted from the dam basin.
- This measure of mitigation is consistent with the desired management objectives for riparian corridors and could prevent fragmentation.
- A fish-way over the dam wall will allow passage for fish and create a link between the downstream and upstream reaches.
- In order to maintain the aquatic link, an EWR must be implemented and managed by releasing water from the dam to mimic natural flow as closely as possible. Multiple sluices (in conjunction with the fish way) must release water from different levels in the thermocline therefore mixing the water being released.

Step 2.3.2: Apply the mitigation hierarchy: The mitigation hierarchy for dealing with negative impacts on biodiversity, consists of four activities (Figure 12):

- **Avoid and prevent:** Consider options in land-use location, siting, scale, layout, technology and phasing to avoid impacts on biodiversity, ecosystem services and people. This is the best option but not always possible.
  - Identify the best practicable environmental options by avoiding loss of biodiversity and disturbance to ecosystems, especially in CBAs.
  - Four options for dam placing were proposed, but all four were in the same river reach and none of them having a lower predicted impact on the system.
- **Minimise:** Consider alternatives in land-use location, siting, scale, layout, technology and phasing to minimise impacts on biodiversity, ecosystem services and people.
  - The surrounding area is completely transformed by agriculture; thus the dam location will be restricted to the riverine system with very little opportunity to scale down or move the footprint.
  - Minimise unavoidable impacts: Manage and mitigate impacts where possible, such as clearing of vegetation, erosion of soil, siltation of the river, release of flows, creating fish passage and control alien vegetation.
- **Rehabilitate:** If impacts have been unavoidable, take measures to return impacted areas to a condition similar to the pre-impact or natural state — although this is important and necessary, rehabilitation can never replicate the diversity and complexity of an un-impacted natural site.

   - Due to the fact that the dam is constructed in established orchards, rehabilitation will be straightforward and could be completed in a short period after construction. Replanting the new riparian zone will form part of this process.
- **Offset:** As a last resort, compensate for remaining unavoidable negative impacts on biodiversity. When every other effort has been made to minimise or rehabilitate impacts to a degree of ‘no net loss’ of biodiversity against biodiversity targets, offsets can compensate for unavoidable negative impacts.
   - Unfortunately, due to the level of development on the farming property, there is no untransformed land left to set aside as an offset area.

Step 2.3.3 Secure priority biodiversity in CBAs and ESAs through biodiversity stewardship:

Set aside land of high biodiversity importance for conservation through biodiversity stewardship options. Where biodiversity losses are unavoidable, set aside another piece of land of equivalent or greater biodiversity importance for conservation:

- Unfortunately, due to the level of development on the farming property, there is no untransformed land left to set aside land of high biodiversity importance for conservation. The remaining riverine and riparian corridors should be left intact and protected from further development. Should the riparian zone around the dam re-establish and the corridor regained, this zone should be managed and protected in order to link the downstream Kaap River environment with the catchment upstream of the Low’s Creek Dam.

Step 2.3.4 Remedy degradation and fragmentation through rehabilitation:

Design project layouts and select locations that minimise loss and fragmentation of remaining natural habitat and maintain spatial components of ecological processes, especially in ecological corridors, buffers around rivers and wetlands, CBAs and ESAs. Activities that are proposed for CBAs must be consistent with the desired management objectives for these features and should not result in fragmentation.

- The project should re-establish the riparian corridor between the upstream and downstream riparian zones by establishing a rehabilitated buffer of 25 m around the periphery of the dam high level mark. This measure of mitigation is consistent with the desired management objectives for riparian corridors and should not result in fragmentation.

Step 2.3.5 Promote long-term persistence of taxa of special concern

- Environmental Water Requirement releases and a fish-way in the dam wall will improve the chances of survival for the Southern barred minnow *(Opsaridium peringueyi)* (Conservation status for Mpumalanga – Vulnerable).
- The Nile crocodile (*Crocodylus niloticus*) (Regional: Vulnerable, 2014) and Hippopotamus (*Hippopotamus amphibius*) (IUCN Vulnerable) will be able to settle in the dam.
- Four bird species of special concern will utilize the riparian corridor once it is rehabilitated, and five species will be able to utilize inundated and dead trees in the dam as perching and nesting sites.

Table 41: The use of CBA maps in Environmental Impact Assessment and the reference to relevant sections present in the report.

Land-use planning and Decision-making	**Reference**
Step 1: Prepare for the site visit: Purpose: To determine the biodiversity context of the proposed land-use sites (using CBA maps, land-use guidelines and underlying GIS layers)	
Step 1.1 Establish how important the site is for meeting biodiversity targets? (Is it in a CBA or ESA?)	Critical Biodiversity Areas (under 5.3)
○ Step 1.1.1 Proposed land use	Project description (under section 1.1)
○ Step 1.1.2 Environmental Impact Assessments (EIA) and Freshwater Ecosystem Priority Areas (FEPA)	Mpumalanga Biodiversity Sector Plan (MBSP) and Threatened Ecosystems (under 5.3)
○ Step 1.1.3 Description of the biophysical environment	3.2 Physiography of the study area
○ Step 1.1.4 Present Ecological State of the New Project	3. Description of the study area
○ Step 1.1.5 Critical Biodiversity Areas	Critical Biodiversity Areas (under 5.3)
• Step 1.2 Assess if the proposed land-use is consistent with the desired management objectives for the site (Use the land-use guidelines)	5.3.4 Land-use guidelines
○ Step 1.2.1 Critical Biodiversity Area in the Project area	Figures 34 and 35 (under 5.3)
• Step 1.3 Find out if threatened or other red data-listed species or ecosystems are present ○ Vegetation ○ Fish ○ Frogs ○ Reptiles ○ Birds ○ Mammals	4.3 Biota assemblages of the Low's Creek project areas
Step 2: Conduct the site visit: Purpose: To Ground truth the CBA maps and conduct additional biodiversity assessments in the study area	**4.2 Biodiversity assessments**
Step 2.1 Compare mapped land cover with observed land cover at the site	**Figure 20:** The broad-scale vegetation units or ground cover of the Low's Creek Dam project area.
○ Step 2.1.1 Record observed features in site assessment report ▪ Ecological surveys - methods ▪ Aquatic habitat assessments ▪ Vegetation ▪ Aquatic biota	2. Methodology 4.3 Biota assemblages of the Low's Creek project areas Appendices 5 to 8

▪ Aquatic invertebrate assessment ▪ Fish communities ▪ Terrestrial fauna studies ▪ Amphibian surveys ▪ Reptile surveys ▪ Bird surveys ▪ Mammal surveys	
○ Step 2.1.2 Results of Ecological Surveys	4. Results
Vegetation	4.1 Vegetation units and land cover types within the study area
▪ Observed vegetation	4.3.1 Vegetation communities
▪ Riparian delineation	5.3.2 Riparian delineation
○ Fauna surveys	4.2 Biodiversity assessments
▪ Aquatic habitats and fauna	4.3.2 Riverine Ecology
▪ Aquatic habitat assessment	4.3.2 Riverine Ecology
▪ Aquatic invertebrate assessment	4.3.2.2 Aquatic invertebrate assessment
▪ Fish Response Assessment Index	4.3.2.3 Fish communities
▪ Terrestrial fauna	4.3.3 Terrestrial ecology
○ Frogs	4.3.3.2 Frogs
○ Reptiles	4.3.3.3 Reptiles
○ Birds	4.3.3.4 Birds
○ Mammals	4.3.3.5 Mammals
○ Step 2.1.3 Further planning to proceed using ground-truthed land cover	5.3 Land-use planning and Decision-making
Step 2.2 Compare mapped CBA or ESA features with ground-truthed ones	Vegetation and land cover types identified for the ecological surveys (under 4.1) – Figure 20: The broad-scale vegetation units or ground cover of the Low's Creek Dam project area.
Step 2.3 Identify compromises and solutions that minimise impacts on biodiversity and conflicts in land-use	5.4 Assessment of impacts
○ Step 2.3.1 Retain natural habitat and connectivity in CBAs and ESAs	5.5 Conditions for inclusion in the environmental authorisation.
○ Step 2.3.2 Apply the mitigation hierarchy	Step 2.3.2: Apply the mitigation hierarchy
○ Step 2.3.3 Secure priority biodiversity in CBAs and ESAs through biodiversity stewardship	Step 2.3.3: Secure priority biodiversity in CBAs and ESAs through biodiversity

	stewardship
○ Step 2.3.4 Remedy degradation and fragmentation through rehabilitation	Step 2.3.4: Remedy degradation and fragmentation through rehabilitation
○ Step 2.3.5 Promote long-term persistence of taxa of special concern	Step 2.3.5: Promote long-term persistence of taxa of special concern
Step 3: Assess impact on biodiversity: Purpose: To make recommendations regarding the impacts of the proposed land-use development on biodiversity	5.4 Assessment of impacts
Step 3.1 When impacts are likely to be insignificant	5.4 Assessment of impacts
○ Step 3.2 When significant impacts are unavoidable	5.7.2 Reasoned opinion
○ Step 3.2.1 CBAs and ESAs	5.7.2 Reasoned opinion
○ Step 3.2.2 ONAs	5.7.2 Reasoned opinion
Step 4: Identify opportunities to conserve biodiversity: Purpose: Maximise conservation gains by proactive identification of opportunities to conserve biodiversity	Critical Biodiversity Areas (under 5.3)
○ Step 4.1 Set aside land of high biodiversity importance for conservation through biodiversity stewardship options	Critical Biodiversity Areas (under 5.3)
○ Step 4.2 Where biodiversity losses are unavoidable, set aside another piece of land of equivalent or greater biodiversity importance for conservation	Critical Biodiversity Areas (under 5.3)
○ Step 4.3 Clear invasive alien vegetation and rehabilitate existing degraded habitats	5.4 Assessment of impacts
Step 5: Incorporate biodiversity priorities in EIA report: Purpose: Show explicitly how CBA maps and land-use guidelines have informed project location, design and implementation	Critical Biodiversity Areas (under 5.3)
○ Step 5.1 Determine the least damaging location and design	Critical Biodiversity Areas (under 5.3)
○ Step 5.1.1 Avoiding CBAs	Critical Biodiversity Areas (under 5.3)
○ Step 5.1.2 Reducing pressure on natural habitat and ecological processes.	5.4 Assessment of impacts
○ Step 5.1.3 Concentrating disturbance footprints in heavily modified or degraded areas that are not earmarked for rehabilitation	5.4 Assessment of impacts
○ Step 5.1.4 Integrating *in situ* biodiversity-sensitive management into the overall design and operation of the proposed land-use development	5.4 Assessment of impacts

5.6 Monitoring requirements

Environmental performance monitoring should be designed to ensure that mitigation measures are implemented. The monitoring programme should clearly indicate the linkages between impacts, indicators to be measured, measurement methods and definition of thresholds that will signal the need for corrective actions.

The applicant must appoint an independent ECO that will have the responsibility of monitoring and reporting on compliance with the conditions of the Environmental Authorisation (EA), as well as monitoring and reporting on the implementation of the approved EMPr.

A monitoring programme for the biodiversity associated with the project, would ideally be to record the reaction of the biota to changes in the environment due to the impacts of the project.

Aspect 1: Dam buffer and riparian corridor: It is vital to monitor the effectiveness of the maintenance plan which optimises the riparian plant species development and riparian habitat restoration (ensure integrity of wildlife corridor is retained and links between habitats enhanced). The restoration of the dam buffer area should be monitored throughout the duration of construction activities to ensure that the effectiveness of the final buffer zone areas is maintained, and that management measures are implemented appropriately. Regular inspections during the operational phase should also be undertaken to ensure that functions are not undermined by inappropriate activities.

Aspect 2: Vegetation clearing or disturbing soil: Establish an effective record keeping system for each area where soil is disturbed for whatever purposes. The monitoring will evaluate whether the erosion and sedimentation control techniques that are employed throughout the site preparation activities are effective in minimising erosion of exposed areas and sedimentation of site surface water.

Aspect 3: Water quality: It is recommended that the SASS5 method be implemented as part of the Biomonitoring Programme, specifically for the reaction of the sensitive species to water quality above and below the dam. During the initial survey of the water courses, five sites were surveyed. Monitoring surveys (per year) are suggested as follows:

- One wet season survey at the established sites.
- One dry season survey when the impacts of reduced surface water and water quality issues become evident.

Aspect 4: The dam wall as a physical barrier for fish distribution: Fishway monitoring should be designed to provide data not only on the effectiveness of the fishway in terms of the internal hydraulics at various flows, but also data on the migratory behaviour and swimming ability of the aquatic biota for which it was designed. (Note: In this context the word “fish” is used for all migratory aquatic biota, including crustaceans (prawns and crabs) and eels). It is important to establish what species and size range are present downstream of the barrier weir that could potentially use the fishway. It is recommended that the FRAI methodology be implemented at sites upstream and downstream of the dam as part of the Biomonitoring Programme.

Aspect 5: Environmental water requirements for the Low’s Creek and Kaap River: The low flow downstream of the dam will decrease significantly due to this development. In order to compensate downstream irrigators a release of a B category EWR as well as an additional 1.0 million m^3/annum is recommended. The release should take place over the months May to the end of October. Reserve flows have been established and these flows should be implemented and monitored by a responsible body to maintain the B category EWR for the river.

It is recommended that flow-gauges (incorporating data loggers, gauge plates) be installed in the river. Audit reporting and record keeping (i.e., water abstracted from the river and water released from the dam on a daily basis) by the Orchard Manager in consultation with the Irrigation Board (or their successor) is necessary. This is to ensure proper operation and maintenance.

Aspect 6: Existing riparian vegetation: The intact riparian vegetation, upstream and downstream of the dam, should be monitored to establish the impact of the dam and EWR releases on the system, as well as impacts stemming from the agricultural activities associated with the dam operation. It is suggested that a VEGRAI monitoring programme should be implemented.

Aspect 7: Exotic and alien invasive plants: To anticipate and evaluate imminent or potential risks to the project area regarding exotic- and alien invasive plants, as well as pathways of invasion, a monitoring programme should be developed in order to create effective mechanisms to manage or mitigate these. Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge. It is important to evaluate the effectiveness of control methods and to monitor the cleared areas on a regular basis to identify emergent seedlings and to remove those immediately.

5.7 Recommendations

5.7.1 Summary of mitigation measures

The potential impacts of the project on biodiversity of the study area are assessed under 7 broad impacts (Section 5.4). The following list provides a summary of the impact assessment, indicating the changes from pre-mitigation to post mitigation.

Impact 1: Clearing of vegetation, manipulating soil layers and construction of coffer and dam walls in the dam basin.

Clearing and Construction Phases – Very High significance improves to High significance.

Mitigation: Clearing for the dam site should take place during an (on average) dry period, i.e., winter. Levelling and landscaping of the site should follow natural drainage patterns as far as possible i.e., drainage towards the river. The remaining peripheral riparian woodland in the dam basin should be left intact in order to still create the denser riparian corridor utilized by the riparian animals.

Impact 2: Removing or inundating the riparian zone in the dam basin and affecting the link in the up- and down-stream riparian corridor.

Clearing and Construction Phases – High significance improves to Medium significance.

Mitigation: Any remaining peripheral woodland in the dam basin should be left intact in order to represent the new wet perimeter and create some kind of new riparian zone. In order to re-establish the link between the riparian corridors upstream and downstream of the dam basin, a riparian buffer should be established along the new marginal zone around the dam. It is proposed that a buffer of 25m wide around the high-level mark of the dam, should be established as a buffer for the aquatic environment.

Impact 3: By storing or diverting water with dams or weirs, the natural distribution and timing of downstream stream flow will be altered.

Operational Phase – Very high significance improves to Medium significance.

Mitigation: An EWR must be implemented and managed by releasing water from the dam to mimic natural flow as closely as possible. In order to maintain the downstream ecology, a release of a B category EWR, as well as an additional 1.0 million m^3/annum is recommended. The latter release should take place over the months May to the end of October. Manage the weir or outlet structures to mimic natural variations in the physical habitat upstream.

Impact 4: Damming changes the physical and chemical attributes of the water in the dam.

Construction and Operational Phase – High significance improves to Medium significance.

Mitigation: Design the dam in accordance with the requirements of the Ecological Reserve/EWR of the river. In particular, a mechanism for delivery of continual maintenance flows to the downstream system is critical. Multiple sluices must release water from different levels in the thermocline and therefore mix the water being released. Hazardous substances associated with construction activities will be mitigated by adhering to the best practice guidelines for these substances. Refer to the EMPr.

Impact 5: Any clearing of vegetation or disturbance of the soil layers will subject these areas to erosion and sedimentation impacts due to the lack of cover.

Construction and Operational phase– High significance remains Medium significance.

Mitigation: It is important that all work within a water resource should be completed during the dry season, when flows are at their lowest.

During vegetation **clearing** of the dam basin, bank protection (e.g., planting) will also be required to reduce sediment input.

Where the dam is **constructed**, adequate erosion and sedimentation control measures must be put in place to prevent downstream impacts during both construction and operation.

During the **operational** phase a buffer zone (e.g., riparian vegetation) should be established to prevent entry of additional sediment into the water course / impoundment.

Impact 6: Dams prevent the free passage of aquatic animals and fish, and thus disrupt riverine migration routes.

Operational Phase – High significance improves to Low significance.

Mitigation: It is recommended that a fishway or fish ladder be incorporated into the dam wall. The overflow from the dam should be on the side of the barrier and sculptured in such a way that most of the fish can still find their way up the embankment and into the fishway.

Impact 7: The introduction and spread of alien vegetation.

Operational Phases – Medium significance improves to Low significance.

With repeated follow-up, mechanical and chemical control methods tend to be short-term activities suitable for smaller plant invasions that can result in the complete removal of the target species. After the implementation of the methods, it is important to evaluate the effectiveness of the methods and to monitor the cleared areas on a regular basis to identify emergent seedlings and to remove those immediately.

5.7.2 Reasoned opinion

According to the General Requirements in terms of Appendix 6 (not an appendix to this report) of the EIA Regulations, 2014, a "Reasoned opinion" should include the rational as to whether:

- the proposed activity, activities or portions thereof should be authorised;
- regarding the acceptability of the proposed activity or activities;
- and if the opinion is that the proposed activity, activities 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.

The construction of an in-stream dam will always be viewed as a contentious issue due to the following aspects:

- the completed dam wall interferes with the flow in the river;
- the wall acts as a migration barrier to aquatic animals;
- when the dam basin fills with water, the water inundates a relative large area of natural riverine habitat and terrestrial landscape;
- the large, unnatural body of water (very little flow present in the dam) undergoes physical-chemical changes in time, and when released, the quality and quantity of downstream flows will have an impact on the receiving environment.

The entire project area is situated in a Terrestrial CBA: Ecological Support Area - Protected Area Buffer (Figure 34), and the purpose of buffer zones is to reduce the impacts of undesirable land-uses on the environment, and to provide opportunities for tourism. The dam will be built amidst an area mostly covered with orchards (Figure 29) and other agricultural features (% transformed), features that also do not conform to the tourism scenario.

In order to mitigate for the anticipated impacts of the proposed dam on the environment, the listed adverse influences should be managed to such a degree that the overall ecology in the project area will still be functional.

As indicated in Section 5.4, "Assessment of impacts" (Table 39), most of the impacts can be mitigated to a certain degree. However, clearing the dam basin and filling the dam are impacts that cannot be mitigated satisfactory as a relatively large surface area is inundated and eliminated from the ecosystem footprint, therefore the significance of this action is still listed in a "High" category.

A very important impact to mitigate will be flow in the area downstream of the dam. Should the EWR releases from the dam be implemented successfully and maintained according to the flows set for a B category river, the downstream ecology is expected to function effectively. It must be added that the dam wall will be built in the Low's Creek drainage line only about 300m upstream of the confluence of the Low's Creek with the Kaap River. Thus, the releases from the dam will add flow to the Kaap River system and improve environmental flows in this river.

The change of water quality and sediment regimes in the dam could pose a threat to the downstream environment, however, due to the rather small basin, water will not remain in the dam long enough to deteriorate to a level that it will impact adversely on the Kaap River, especially if flows in the Kaap River are maintained. Additionally, multiple sluices in the dam wall will be able to release water from different levels in the thermocline and therefore mix the water. Temperatures in the water should thus remain stable.

A fish-way (fish ladder) has been designed for the dam overflow and this will allow migrating fish swimming up the Low's Creek, to negotiate over the dam wall during their migration and disperse further upstream into the Low's Creek catchment.

By re-establishing a 25m buffer around the periphery of the dam high level mark will hopefully establish a secondary riparian zone around the banks of the dam, which will link up with the original upstream and downstream riparian corridors of the dam.

By implementing all the mitigation measures and managing the system as prescribed on a continuous basis, all the impacts will be alleviated to a satisfactory level. Therefore, it is proposed that the dam construction and operation of the project should be authorised with the provision that the mitigation measures prescribed in this document are included in the EMPr.

5.7.3 Consultation process

The input from the following parties:

- Mr. Walter Giuricich regarding the extensive background of the study;
- Mr Stephen Mallory - EWR reports and flow rates;
- Mr Barend Marx - information relating to the dam wall and operation of releases;
- Dr Mathew Ross and Dr Tahla Ross - information relating to the fish-way;
- Dr. Mervyn Lotter regarding the Mpumalanga Threatened Species Database is appreciated.

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Appendices

Appendix 1: Declaration of interest

The specialist appointed in terms of the Regulations_

10.4 The Specialist

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

I …Dr Andrew Richard Deacon…, 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):

X	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
Name of company: Andrew Deacon Environmental Consultant
Date: 01 March 2021

Appendix 2: Curriculum Vitae

CURRICULUM VITAE: DR ANDREW RICHARD DEACON

Born in Klerksdorp, South Africa in 1951. Matriculated at the Goudveld High School in 1969. South African citizen. Married and with one child.

FORMAL EDUCATION
Ph.D., Zoology (RAU 1987) Thesis: "The nutritional ecology and physiology of *Tilapia rendalli* and *Oreochromis mossambicus* in a warm, sewage-enriched habitat".
M.Sc., Zoology (RAU 1983) Thesis: "The occurrence and feeding habits of *Anguilla*-species in selected rivers of the Transkei".
B.Sc., Hons. in Zoology (RAU 1980)
B.Sc., majors Zoology and Botany (PU for CHE 1974)

PROFESSIONAL EXPERIENCE

2012-ongoing Environmental consultant
1989-2012 Scientific Services, Kruger National Park, SANParks
2000-2012 Programme Manager: Small vertebrates
1989-2000 Senior Scientist: Freshwater Ecologist.
1988 Consulting - Technikon of RSA; Berghoek Nature Reserve; Klaserie Nature Reserve.
1985-1987 Lecturer (Part-time) - Witwatersrand Technikon. Biology for the Food Technologists.
1984-1986 Lecturer - Department of Zoology at RAU. Biology and Taxonomy.
1983 Lecturer - Goudstad College of Education. Zoology.
1979-1982 Research assistant - Department of Zoology at RAU.
1978 Research technician - Onderstepoort Veterinary Institute. Helminthology - Taxonomy and physiology of South African helminths.
1975 – 1977 Teacher - Biology and Science

National Biomonitoring Programme - Project leader for River Health Programme (1998 - 2010)
Olifants River Forum - Vice Chairman (1994)
Research Unit for Terrestrial and Aquatic Ecology (RAU) (1991-1996)
Water Research Commission Steering Committee (30 projects) (1990 - 2011)
Lowveld Pollution Incident Committee – collaborator (1991-1998)
Mpumalanga River Health Programme - Project leader (1999 - 2005)

CONSULTING PROJECTS (112 projects)

Specialist fields for environmental studies (surveys and monitoring):

Specialist studies for:
Environmental Impact Assessments – Specialist studies (10 studies)
Reserve Determination – Environmental Water Requirements (13 projects)

Aquatic ecosystem
Hydro-electrical projects (5 projects)
Fish, macro-invertebrates and riparian (37 project)
Fish-ways (3 projects)
Wetland delineation (3 projects)

Terrestrial ecosystems (Mammals, birds, reptiles, frogs, plants)
Fauna specialist studies (40 projects)
Faunal and ecosystems monitoring: (6 projects)
Biodiversity and Habitat integrity: (30 projects)
Vegetation studies (2 projects)

Lecturing & Training: Ecology (10 projects)

OTHER

Initiated the Olifants River Forum. Received the trophy for the ORF Top Project of the Year competition and awarded honorary life membership of the Olifants River Forum.
Completed the Environmental Impact Assessment short course at the University of Cape Town.
Submitted a proposal for the Limpopo floodplains to be declared as a Ramsar site.
Accredited for SASS4 Macro-invertebrate Biomonitoring Methods.
Completed: Wetland Introduction and Delineation – Centre for Environmental Management: University of the Free State
Scientific Advisor: Leadership for Conservation in Africa
10 scientific papers in refereed journals

Appendix 3: The complete SASS 5 form.

TAXON	Stones	Vegetation	GSM	Total
Porifera 5				
Coelenterata 3				
Turbellaria 3				
Oligochaeta 1				
Leeches 3				
Amphipoda 15				
Potamonautidae 3				
Atyidae (Shrimp) 8				
Palaemonidae 10				
Hydracarinae 8				
Notonemouridae 14				
Perlidae 12				
Baetidae 1 spp 4				
2 spp 6				
>2 spp 12				
Caenidae 6				
Ephemeridae 15				
Heptageniidae 10				
Leptophlebiidae 13				
Oligoneuridae 15				
Polymitarcyidae 10				
Prosopistomatidae 15				
Teloganodidae 12				
Tricorythidae 9				
Calopterydidae 10				
Chlorocyphidae 10				
Chlorolestidae 8				
Coenagrionidae 4				
Lestidae 8				
Platycnemidae 10				
Protoneuridae 8				
Zygoptera 6				
Aeshnidae 8				
Cordulidae 8				
Gomphidae 6				
Libellulidae 4				
Belostomatidae 3				
Corixidae 3				
Gerridae 5				
Hydrometridae 6				
Naucoridae 7				
Nepidae 3				
Notonectidae 3				
Pleidae 4				
Veliidae 5				
Corydalidae 8				
Sialidae 6				
Dipseudopsidae 10				
Ecnomidae 8				
Hydropsychidae 1= 4				
2spp = 6				
>2spp =12				
Philopotamidae 10				
Polycentropodidae 12				

Psychomyiidae/Xip. 8				
Barbarochthonidae 13				
Calamoceratidae 11				
Glossosomatidae 11				
Hydroptilidae 6				
Hydrosalpingidae 15				
Lepidostomatidae 10				
Leptoceridae 6				
Petrothrincidae 11				
Pisuliidae 10				
Sericostomatidae 13				
Dytiscidae 5				
Elmidae/Dryopidae 8				
Gyrinidae 5				
Haliplidae 5				
Helodidae 12				
Hydraenidae 8				
Hydrophilidae 5				
Limnichidae 8				
Psephenidae 10				
Athericidae 13				
Blepharoceridae 15				
Ceratopogonidae 5				
Chironomidae 2				
Culicidae 1				
Dixidae 13				
Emphididae 6				
Ephydridae 3				
Muscidae 1				
Psychodidae 1				
Simuliidae 5				
Syrphidae 1				
Tabanidae 5				
Tipulidae 5				
Ancylidae 6				
Bulininae 3				
Hydrobidae 3				
Lymnaeidae 3				
Physidae 3				
Planorbidae 3				
Thiaridae 3				
Viviparidae 5				
Corbiculidae 5				
Spaeridae 3				
Uniondae 6				
SASS Score				
No of families				
ASPT				

Estimated abundance: 1=1; A=2-10; B=11-100; C=101-1000; D=>1000

Appendix 4: The Nature of the Red Listed categories

All taxa listed as Critically Endangered qualify for Vulnerable and Endangered, and all listed as Endangered qualify for Vulnerable. Together these categories are described as 'threatened'. The threatened species categories form a part of the overall scheme. It will be possible to place all taxa into one of the categories (see Chart below).

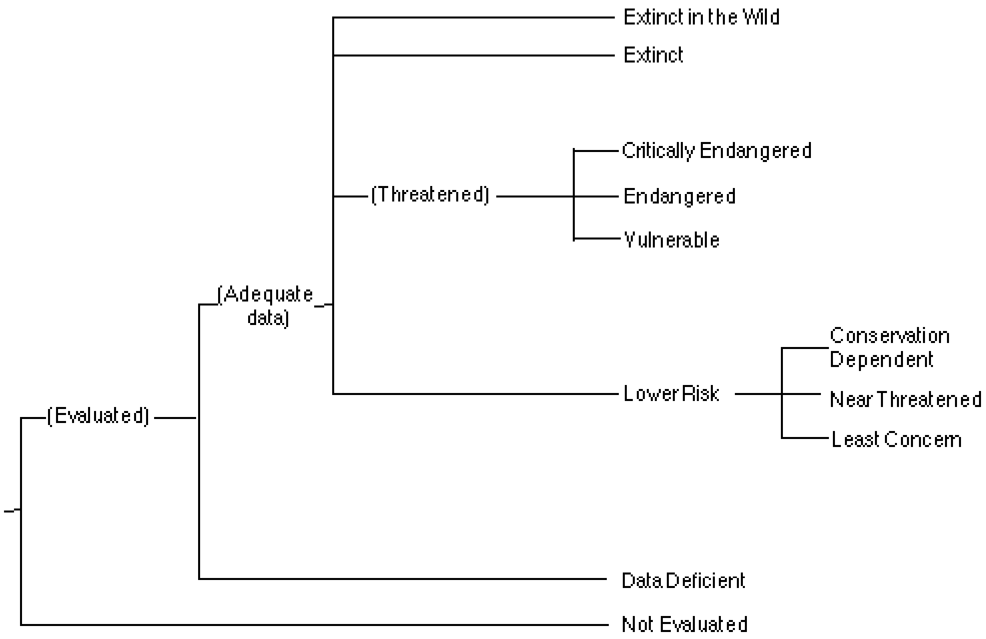

Chart: Red Listed categories

EXTINCT (EX) - A taxon is Extinct when there is no reasonable doubt that the last individual has died.

EXTINCT IN THE WILD (EW) - A taxon is Extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR) - A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria (A to E) as described below.

ENDANGERED (EN) - A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria (A to E) as described below.

VULNERABLE (VU) - A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria (A to E) as described below.

LOWER RISK (LR) - A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories:

1. **Conservation Dependent (cd).** Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the

cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.

2. **Near Threatened (nt).** Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
3. **Least Concern (lc).** Taxa which do not qualify for Conservation Dependent or Near Threatened.

DATA DEFICIENT (DD) A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED (NE) A taxon is Not Evaluated when it is has not yet been assessed against the criteria.

Appendix 5: FROGS: Available habitat, expected occurrence and observed presence of frog species during surveys (Jacobsen, 1989: Interpreted distribution map; Minter et al, 2004).

Frogs expected to occur in the available natural habitats in the Low's Creek project area are listed below. The words in **bold font** represent qualifying habitat (preferred habitat), and *underlined italics* disqualifying habitat (the reason why the organism will not occur in the area). The shaded cells indicate the species likely to occur in the riverine habitat, and the number inside a cell gives the number of individuals observed or definite signs of the species detected during surveys.

FROG SPP	All habitats	RSA STATUS	**Low's Creek**
Family: Breviceptidae			
Common rain frog (*Breviceps adspersus*)	Savannah biome: Semi-arid habitats with sandy to sandy-loam soils. Bushveld vegetation with a grassy ground layer and distinct upper layer of woody plants. *Breeds in burrows in open and closed woodland with sandy soils. No standing water needed.*	Least concern. Does not appear to be at risk – game and cattle farming and reserves.	
Family: Bufonidae			
Northern pygmy toad (*Poyntonophrynus fenoulheti*)	Savannah biome: Variety of bushveld vegetation types, sometimes in adjacent grassland. Occasionally found in sandy areas, usually occupy *rocky outcrops in savannah or woodland*. Refuge between rocks or on soil under stones. Breed in temporary pools on flat rocky outcrops or in stony, sometimes barren regions. Tadpole metamorphosis complete after 19 days.	Least concern. Not considered to be at risk – habitat well protected.	
Garman's toad (*Amietophrynus garmani*)	Various bushveld vegetation types in the savannah biome. Prefer well-wooded low-lying areas where there is relatively high rainfall (above 600mm/annum). Breeds in vleis, pans and dams in **open or wooded savannah. Occasionally in quiet backwaters of rivers and pools** along small, slow-flowing streams. Tadpole metamorphosis complete after 64-91 days.	Least concern Common and widespread – habitat not threatened; range may have expanded.	
African common toad (*Sclerophrys gutturalis*)	Savannah, Grassland & Thicket biome: Breeds in open shallow pools, vleis, dams, **rivers, streams or other more or less permanent water.** Common in suburban gardens and farmland. Excavate burrows in soft ground. Tadpole metamorphosis complete after 5-6 weeks.	Least concern. Population trend: increasing. Not threatened. Relatively secure as it is widely distributed, locally abundant and highly adaptable to human settlement.	2
Hallowell's toad (*Sclerophrys maculatus*)	**Associated with riverine habitats**; medium and larger rivers. Savannah and grassland, larger river valleys. Call from amongst reeds, grass or rocks next to or in rivers and streams - fast flowing water. Breeding habitat is riverine; alongside rivers in small shallow inlets and puddles created by rising and falling water, also rock pools. Breeds in rivers and streams in savannahs. Eggs in marginal pools and backwaters.	Least concern	
African split-skin toad (*Schismaderma carens)*	Wide variety of vegetation types in savannah biome, also in Rocky Highveld, and Grassland. Breeds in permanent, often fairly deep, muddy - **pools, dams or waterholes in open or wooded savannah.** Wanders to forage. Hibernates at a considerable distance from water, under stones, logs and piles of dead vegetation. Tadpole metamorphosis complete after 37-52 days. Breeds in permanent, often fairly deep, muddy - pools, dams or waterholes in open or wooded savannah.	Least concern. Not threatened. Adapts in disturbed areas. Tadpole survives in polluted water.	1

Family: Heleophrynidae			
Marbled snout-burrower (*Hemisus marmoratus)*	Savannahs: Semi-arid environments. Marshy ground and in **sandy riverbanks in bushveld savannah** throughout sub-Saharan Africa. Breeds at the margins of pans, waterholes and isolated pools that form in riverbeds where there are exposed mud banks. Shallow, temporary water bodies.	Least concern.	
Family: Hyperoliidae. Subfamily: Hyperoliinae			
Golden banana frog (*Afrixalus aureus)*	Breeds in dense grass, sedges or bushes at the edges of shallow <u>*semi-permanent pans*</u>.	Least concern.	
Mozambique forest tree frog (*Leptopelis mossambicus)*	Breeds in wooded savanna, sand forest and mangrove swamps in the **vicinity of streams** and pans. Burrows underground during dry periods.	Least concern.	
Painted reed frog (*Hyperolius marmoratus taeniatus)*	Aestivates under stones and logs. Canopy of surrounding trees or emergent vegetation. Call sites: emergent reeds and sedges, trees, grasses, bushes, floating vegetation. Breeds in almost **any permanent body of water in the lowveld** and coastal regions. Temporary ponds, pans and vleis; permanent water bodies: marshes, reedbeds, sluggish rivers and streams.	Least concern	3
Waterlily Frog (*Hyperolius pusillus)*	Open <u>*grassy pans, ponds, vleis and dams in open savannah*</u> and grassland; often found sitting on floating vegetation, such as water lily leaves. Breeds in pans and vleis especially where there are water lilies and other floating plants. Eggs are laid in clutches in a single layer between overlapping lily leaves on the water's surface or in clusters around aquatic vegetation.	Least concern.	
Tinker Reed Frog (*Hyperolius tuberilinguis)*	**Breeds in reed beds on the periphery of swamps or rivers**, or dense vegetation surrounding inundated pans. Breeds in moderately deep waters with dense vegetation along rivers or in pans, pools and dams in low-lying areas of savannah; especially in coastal bushveld or grassveld. Eggs laid loosely attached to reeds or grass stems above the water line.	Least concern. Does not acquire additional protection	1
Family: Hyperoliidae Subfamily: Kassininae			
Bubbling kassina (*Kassina senegalensis*)	Wide variety of vegetation types in savannah and Grassland biomes. Breeds in both **temporary and permanent water bodies**: ponds, vleis, well-vegetated shallow pans, marshes and deeper dams in grassland. Tadpole metamorphosis slow: 2-3 months.	Least concern. Not threatened. Widely distributed and abundant. Does not require conservation attention. Dams improve breeding habitat. Population trend: stable.	2
Family: Microhylidae Subfamily: Phrynomerinae			
Banded rubber frog (*Phrynomantis bifasciatus*)	Variety of bushveld vegetation types in savannah biome. Hot semi-arid environments (50-1450m). Breeds in <u>*shallow temporary pans and pools*</u>, or inundated grass in savannah and Acacia. Also, small shallow dams.	Least concern. Common throughout it range – not threatened.	

Family: Phrynoatrachidae			
Dwarf Puddle Frog **(***Phrynobatrachus mababiensis)*	Open to wooded savannah; less frequently grassland; high & low altitudes. Summer rainfall: 500-1000mm p.a. Calls from water's edge well concealed by vegetation. Breeds in any moist, marshy area, vlei, including those at edges of pans among emergent vegetation in permanent, semi-permanent and temporary habitats: shallow stagnant water amongst emerging vegetation on the edges of grassy pans, small dams and ponds, and in the **backwaters of slow-flowing streams** and shallow stagnant water. Eggs laid in a dense mass among emergent vegetation on water.	Least concern. Not threatened.	1
Natal dwarf puddle frog (*Phrynobatrachus natalensis*)	A variety of vegetation types in the savannah and Grassland biome. Shelter under rocks near breeding sites. **Fairly deep water - slow-flowing streams**. Temporary pans and pools, vleis and dams, and even small, slow-flowing streams. Breeding sites usually have vegetation or other types of cover along their banks. Eggs on water surface, hatch in 3-4 days; metamorphosis 4-5 weeks.	Least concern. Not threatened. Abundant and often near human habitation. Population trend: stable.	
Family: Ptychadenidae			
Anchieta's ridged frog (*Ptychadena anchietae*)	Savannah biome. Found sheltering amongst grass and plant and plant debris on edges of breeding sites. Adults occur in the **grassy edges of rivers and streams**, escape into the water. Temporary pans, shallow pools in riverbeds, waterholes, and more permanent vleis.	Least concern. Does not appear to be at risk.	3
Sharp-nosed Grass Frog (*Ptychadena oxyrhynchus)*	Moist open savannah and woodland. Breeds in sedge pans, vleis, inundated grasslands, pools in rock outcrops and other *temporary pools*.	Least concern.	
Mozambique ridged frog (*Ptychadena mossambica)*	Savannah species; bushveld vegetation types, open grassland. Conceal themselves in grass tussocks near vleis, seepage areas and pans. Floodplains of rivers and *inundated grassland*. Dry season: deep cracks in dry mud of pans. Call from vegetation from water edge. Breeds in shallow water of vleis, pans, floodplains and inundated grasslands.	Least concern.	
Family: Xenopodinae			
Muller's platanna *(Xenopus muelleri)*	Breeding = non-breeding habitat. Wide variety of permanent bodies of water, including pans, lagoons and **quiet regions of lowland rivers**. Tolerant to high temperatures. Burrow into dry mud to aestivate when pools dry up.	Least concern.	
African clawed frog (*Xenopus laevis)*	Most of the biomes. Restricted to aquatic habitats. Historically occurred in streams, rivers and their pools. Currently in man-made water bodies. **Breeds in any more or less permanent bodies of water.** Eutrophic waters seem to produce the highest densities. Burrow into dry mud to aestivate when pools dry up. Washed down during heavy rains into dry river courses. Breeds in remnant pools. Breeding and non-breeding habitats the same. Hatch in 2-3 days; metamorphosis within 2 mounths.	Least concern. Not threatened. Not threatened in any part of its range. Unprotected. Population trend: Increasing. Common and widespread.	

Family: Pyxicephalidae			
Boettger's dainty frog (*Cacosternum boettgeri)*	Nama Karoo, succulent Karoo, grassland and thicket. Wide variety of vegetation types. Favors open areas with short vegetation and grassy areas. Forest clearings - absent from dense forest. Pans or **along river courses**. Aestivates in cracks, under logs and stones and in animal burrows or unused termitaria. Call from: concealed positions under vegetation or other cover at water level, also from exposed position. Breeds in any small, temporary water body: marshy area, vlei, pools in inundated grassland, rain-filled depression or shallow pan. Eggs attached to vegetation below surface of water. Tadpole hatch in 2 days, complete metamorphosis in about 2-3 weeks.	Least concern. Not threatened. Not threatened. Generalist, adapting well to disturbance. Unaffected by moderate eutrophication. Population trend: unknown.	
Delelande's river frog (*Amietia delalandii*)	Grassland and savannah biomes; grassland streams and forest fringes. Wide range of wetland habitats. Adults occur in the grassy **edges of rivers and streams**, escape into the water. Banks of slow flowing streams or other permanent bodies of water favouring those with aquatic vegetation. Edges of pools, dams, streams and slow-flowing rivers. Jump in water and hide in soft mud to escape. Spend day floating amongst vegetation or basking on rocks above water level. Call from floating vegetation or from shallow water at the edge. Breeds in both standing and flowing water: edges of pools, streams and slow-flowing rivers. Both standing water in flat areas and running water transversing slopes of more than 14 degrees. Tadpoles complete development in 9-12 months but take up to 2 years if food is in short supply or water is very cold.	Least concern. Not threatened. Widespread – found in all rivers, ponds, farm dams and other wetlands in its range. Not generally threatened. Population trend: stable.	2
Edible bullfrog (*Pyxicephalus edulis*)	Several bushveld vegetation types. Flat, low-lying areas in open grassy woodland that become flooded after heavy rain or contain *shallow seasonal pans*. Breeds in rain-filled pools.	**Least concern. NEMA (Tops): Protected species.**	
Marbled sand frog (*Tomopterna marmorata)*	Various habitats in subtropical savannah. Breeds in quiet **areas of rivers or streams** with sandy substrates.	Least concern. Not threatened	
Common sand frog (*Tomopterna cryptotis*)	Variety of habitats in open savannah and grassland, including arid areas. Open arid landscapes with sandy soils form the habitat of this species. The frogs spend most of the year buried in the soil; hibernate half a meter or more beneath the soil surface. Males call from exposed sites at the banks of streams, pools and puddles. They call at least partially from subterranean refuges, too. The frogs spawn in small temporary waters. They are usually nocturnal, but occasionally diurnal during periods of heavy rainfall. Breeds in *temporary rain pools and vleis*.	Least concern. Not threatened. Unprotected. Widespread. Secure. Population trend: stable.	
Natal sand frog (*Tomopterna natalensis*)	Variety of vegetation types in the Grassland and savannah biome. Annual rainfall: 300-1000mm. Call from: exposed positions near water edge on bare rock, sand or mud. Breeds in shallow permanent streams, **rivers, and other places where water flows slowly**, but also in standing water: furrows or vleis in grassland. Eggs laid in running water. Metamorphosis within 2-3 weeks.	Least concern. Not threatened. This widespread species does not appear to require conservation action. Population trend: stable.	1
Family: Rhacophoridae			
Grey foam-net treefrog (*Chiromantis xerampelina)*	Savannah biome. Breeds over temporary pans, **vleis and rivers** in constructing foam nests. Found around seasonal or permanent bodies of open water in a variety of bushveld vegetation types in the savannah biome.	Least concern.	

Appendix 6: REPTILES: Available habitat, expected occurrence and observed presence of reptile species during surveys (Jacobsen, 1989; Interpreted distribution map - Branch, 1988; Atlas and Red List - Bates, et al 2014).

Reptiles expected to occur in the available natural habitats in the Low's Creek project area are listed below. The words in **bold font** represent qualifying habitat (preferred habitat), and *underlined italics* disqualifying habitat (the reason why the organism will not occur in the area). The shaded cells indicate the species likely to occur in the riverine habitat, and the number inside a cell gives the number of individuals observed or definite signs of the species detected during surveys.

SPECIES	Total habitat	Status	Low's Creek
Family Pelomedusidae			
Marsh terrapin (*Pelomedusa subrufa)*	Grassland, Closed woodland, Rivers, Seasonal pools, Pans. Slow-moving and still water, including natural temporary veld pans and pools (seasonal waters) *away from perennial rivers and dams (permanent water - crocodiles).* Basking - at water's edge, exposed rock, and protruding log or mud bank; fresh or stagnant waterbodies (tolerates wide variation in water quality). Bury themselves up to 5 cm deep in soil, mud or debris to aestivate during winter. Lays eggs in moist soil above high water mark; dig with hind feet.	Regional: Least Concern (2014). Secure, protected	
Serrated hinged terrapin *(Pelusios sinuatus)*	**Perennial rivers** and more permanent waterholes, pans and dams; upland Savanna and lowveld. Basking on sandbank protruding rock or submerged log or back of sleeping hippo and crocodiles. Lays egges up to 500m from nearest water.	Regional: Least Concern (2014).	
Family Testudinidae (Land tortoises)			
Leopard tortoise (*Stigmochelys pardalis*)	Montane grassveld, fynbos, valley bushveld, arid and mesic Savanna. Level areas in *open woodland and scrub or wooded grassland*. A shelter in crevices in rock outcrops, under rocks or in burrows dug into old termitaria or earthen banks. Aestivates – in old termitaria or tightly fitting burrows, excavate under rocks, logs – scrape into earth embankments.	Protected. Widespread. Vulnerable but secure. Global: Least Concern (2014).	
Family: Crocodylidae			
Nile crocodile (*Crocodylus niloticus*)	Larger rivers, lakes and swamps. River mouths, estuaries and mangrove swamps. Young - dig burrowto shelter; spend lot of time out of water and eat small prey. Sub-adults prefer swamps and backwaters, eating fish, terrapins, birds and small mammals. Nest on sunny sand bank above floodwater level with good drainage and cover nearby.	**Regional: Vulnerable (2014). NEMBA TOPS (2015): Protected, suggested Vulnerable; SARCA (2014): Vulnerable.**	

Family:Gekkonidae			
Haacke's flat gecko (*Afroedura multiporis haackei*)	Khandizwe Hills, KNP. Solitary or semi communal. *Inhabits cracks in exfoliating granite, cracks in shale*, occasionally found in houses. Usually in sites with the opening facing downwards, protected from rainwater. Nocturnal, foraging among boulders close to its daytime retreat.	Global: Least Concern (2014). **Endemic to South Africa**	
Turner's giant gecko *(Chondrodactylus turneri)*	Terrestrial, restricted to rock outcrops. Semi-desert and arid Savanna, entering moist habitats. Large nocturnal and rupicolous gecko common in the western arid region and extending into savanna habitats. It inhabits **rock outcrops and hollow trees**. Eggs laid in small hole in sand or rock cracks.	Global: Least Concern (2014).	
Common dwarf gecko *(Lygodactylus capensis capensis)*	Well-wooded dry Savanna: Open woodland and well-wooded dry Savanna country. Diurnal and arboreal gecko. Inhabiting trees with holes or loose bark, which provides shelter. Also shelters **among rocks and dead vegetation**. Marked preference for Baobab, Acacia and Mopane – plenty suitable rough bark as cover. Eggs are laid in rock cracks, crevices, under stones or under loose bark. Forage in low scrub and on dead trees. Observed clinging, head down, near base of tree waiting for prey.	Protected. Widespread, abundant. Under no threat.	3
Wahlberg's velvet gecko (*Homopholis wahlbergii*)	Land type varied - mesic and arid Savanna, Coastal bush. **Living in holes of old tree trunks, holes in dead trees and branches**, under bark, in holes in baobab trees, empty swallow nests in caves and rock overhangs, or amongst rocks and boulders – latter case prefer those lying in riverbeds near the water; rock fissures, particularly on overgrown koppies along riverbeds. Feeding both day and night but forage away from their retreat only at night. Eggs are laid in a rock cracks or/ crevices or beneath loose bark and in holes in trees.		
Common tropical house gecko (*Hemidactylus mabouia*)	Varied, arid and mesic Savanna, and coastal bush. Arboreal in wild and very territorial. **Common under loose tree bark and in the hollows of trees** (particularly baobab), in the crowns of palms, and in rock cracks and crevices. In fact, in any dark convenient place on or above the ground (also piles of rubble). In the wild the eggs are laid under a rock or in a crevice and sometimes in a communal depository. Mainly nocturnal.		1
Van Son's gecko (*Pachydactylus vansoni*)	Land type: Varied – karroid veld, grassland and mesic Savanna. Terrestrial; inhabits rocky outcrops and more frequently - **tunnel under rotting rocks or logs on soil**; disused termitaria, occasionally low rock cracks. Solitary, nocturnal. At night – emerge to forage, it moves about on the ground in search of food. Eggs laid in soil under rocks or stones, under bark; or logs; in old termitaria in summer.	Protected. Status is secure.	
Speckled gecko (*Pachydactylus punctatus*)	Prefer dry Savanna, also found in arid desert: *Open grass country, bushveld or boulder-strewn koppies and mountain slopes and hillsides*. Terrestrial; in suitable rupicolous surroundings very common under rotting logs, stones, in rock crevices or other cover. Largely nocturnal. Lay eggs on sand under logs, stones or among debris.		

Family Typhlopidae			
Bibron's blind snake *(Afrotyphlops bibronii)*	<u>*Highveld and coastal grassland*</u>. Under stones and in termitaria. Underground.	Partially protected. Widespread. Secure and out of danger.	
Schlegel's giant blind snake (*Megatyphlops schlegelii)*	Varied, coastal bush to sandveld. Deep underground. Variety of veld types, <u>*mostly sandy soil.*</u> Large adults deeper underground than smaller specimens, come to surface only after heavy rains have flooded them out.		
Family Leptotyphlopidae			
Long-tailed thread snake (*Myriopholis longicauda)*	Lowveld. Moist Savanna. Subterranean habits, wide range of mesic soils. **Under decaying hardwood stumps and loose boulders.** Under rocks on soil at altitudes of 200-1400m.	Least concern. Widespread and common.	
Incognito thread snake *(Leptotyphlops incognitus)*	Varied: grassland, coastal bush, mesic and arid Savanna. Burrow underground. Lives underground and only wriggle to surface after being flooded by heavy rains from their underground retreats. In or **under rotting logs, among the roots of grass and small bushes.** In particularly in or near termitaria where there is an abundance of termites.		1
Peter's thread snake *(Leptotyphlops scutifrons scutifrons)*	Varied, grassland, coastal bushland, mesic and arid Savanna. Burrow underground. Usually taken **under stones, under rocks on soil, under rotting logs**, among grass roots.	Least concern. Partially protected. Secure.	
Distant's thread snake *(Leptotyphlops distanti)*	Varied, coastal bush, grassland and **Savanna**. Burrow underground. Usually taken under stones.	Least concern	
Family Boidae			
Southern African python (*Python natalensis*)	Open Savanna regions, particularly rocky areas and riverine scrub. **Moist, rocky, well-wooded valleys, reed-beds** or even bush country, seldom venture far from permanent water. Eggs are laid in hollow tree trunks, antbear holes, caves or old termite hills. Fond of water in which they may lie and hunt. Dive into deep pools, remain submerged for long periods.	**NEMBA TOPS (2015): Protected; SA Red Data (1988): Vulnerable. SARCA (2014): Least concern.**	
Family Colubridae			
Brown water snake *(Lycodonomorphus rufulus)*	Small streams, pans and vleis. Water-living and confined to rivers, streams and other permanent water or the immediate vicinity thereof. Under cover around water margins. Under rocks, debris, holes in the ground. Among swampy vegetation. **Small streams**, pans and vleis.	Partially protected. Widespread. Secure. Least concern.	
Spotted house snake (*Lamprophis guttatus*)	Karroid areas to mesic Savanna. Variety of habitats: Rocky and <u>*mountainous areas*</u>. Under rocks or in cracks/crevices between rocks at altitudes ranging from 800-2300m. Rock crevices, exfoliating flakes of rock, under rocks on rock.	Partially protected. Uncommon but secure.	
Brown house snake *(Boaedon capensis)*	Wide distribution: Highveld grassland and arid karroid regions. Terrestrial Nocturnal. Eggs being laid in **decaying vegetable matter, termite hills or other suitable location**. Variety of habitats: Moribund termitaria or any form of shelter. Tolerant of urban sprawl.	Partially protected. Widespread, adaptable. Under no threat.	

Cape wolf snake *(Lycophidion capense capense)*	Varied: Grassland and Savanna (open woodland), entering coastal bush and fynbos in Cape. Well-vegetated situations. **Damp situations under stones and vegetable debris**. Under rocks, logs, in moribund termitaria and under debris.	Partially protected. Widespread, considered secure.	
Common file snake (*Gonionotophis capensis capensis*)	Open woodland, mainly Savanna; entering coastal forest and arid regions. **Shelters under large rocks, logs or other debris.**		
Black file snake (*Gonionotophis nyassae*)	Savanna, entering coastal forest. **Shelters under large rocks, logs or other debris.**		
South African slug-eater *(Duberria lutrix)*	Highveld grassland & Savanna, entering coastal bush and fynbos. **Variable habitats – moist areas**. Under stones, rotting logs, under plant litter. Moribund termitaria.	Partially protected. Currently secure.	
Mole snake *(Pseudaspis cana)*	Sandy scrubland in SW Cape, <u>*highveld grassland, mountainous and desert regions*</u>. Open woodland. Abandoned animal burrows: Rodent burrows, larger animal burrows.	Partially protected. Uncommon, vulnerable.	
Eastern bark snake (*Hemirhagerrhis nototaenia)*	Savanna or **woodland-Savanna** areas up to 1550m. Under rough bark of trees, often associated with Mopane bush.		
Two-striped shovel-snout (*Prosymna bivittata*)	Open woodland and scrub (200-1400m); Acacia Savanna, entering sandveld. Semi-fossorial - Burrowing species - Sandy localities, burrow in loose soil. **Under rocks on soil or under rotting logs.**	Partially protected. Rare. Secure.	
East-African shovel-snout (*Prosymna stuhlmannii*)	Savanna, extending into wooded hills. Fossorial: **Under stones, logs, or heaps of decaying vegetable matter.** In termitaria and other similar locations.		
Striped grass snake *(Psammophylax tritaeniatus)*	Open grassland and Savanna. <u>*Highveld grassland to open bushveld*</u> and scrub veld (300-1600m). Holes in moribund termitaria, under rocks, piles of grass. Flee to nearest shrub or clump of grass or might flee into water – submerge to over 5min. Eggs laid under rock or other suitable cover.	Partially protected. Widespread, under no immediate threat.	
Rufous beaked snake (*Rhamphiophis rostratus*)	Thorn- or **bushveld country - rocky** surroundings.		
Western yellow-bellied sand snake (*Psammophis subtaeniatus*)	Open woodland and scrub in arid areas, open dry Savanna, thorn- or bushveld. **Dry rocky hillsides in crevices between rocks**, large termitaria, under loose bark or dead logs.	Partially protected. Widespread, under no immediate danger.	1
Olive grass snake (*Psammophis mossambicus*)	Coastal plains and upland Savanna. **Bush along streams and rivers rather** than the more open dry area. Mainly ground-living – in grass; may resort climbing on tops of bushes and shrubs in order to bask in sun. Pursued: quick moving, dash into thick cover where it lies still. Eggs are laid in piles of dead leaves or other similar location.		
Bibron's stiletto snake *(Atractaspis bibronii*)	Variable: grassland, scrub and open woodland to coastal forest in semi-arid to quite moist climates (sea level to 1700m), highveld grassland to semi desert. Occasionally found on surface on warm rainy nights in summer. Moribund termitaria. **Rotting logs, under logs on soil, under stones, and crevices at ground level or under debris.**	Partially protected. Considered secure.	
Black-headed centipede-eater *(Aparallactus capensis)*	Varied: Highveld and montane grassland, open woodland, open scrub veld, grassland and coastal bush. Open bush or Savanna country. Found in moribund termitaria, which offer shelter, warmth and food. **Under stones, under logs, among roots of shrubs and grasses.**	Partially protected. Common, not threatened or endangered. Adequately protected.	

Kwa-zulu Natal purple-glossed snake *(Amblyodipsas concolor)*	Moist, well-wooded or forested areas – sea level to 1500m. Semi-fossorial; solitary, often lying buried just below humic soil surface – head partly exposed. **Under rocks and rotting logs.**	**Endemic to South Africa.** Least concern.	
Common purple-glossed snake (*Amblyodipsas polylepis polylepis*)	Open woodland and scrub to coastal forest at altitudes from sea level to 1300m, Savanna, entering dry forest. Fossorial (burrowing snake) and slow moving. In burrows or **piles of vegetation**, not found under rocks or logs. Seen on surface after heavy rains has fallen and soil becomes water-logged.		
Spotted bush snake *(Philothamnus semivariegatus)*	Open woodland, scrub and coastal forest, open forest or Savanna: Open forest or bush, even dry and far removed from water, however **more frequently where water is** – swims with ease. Coastal plain, along streams and rivers or along river courses. On rocky hillsides and mountains, shrubs and bushes on rocky ridges. Holes in trees or under loose bark. In crevices between or under rocks. In holes in large termitaria of Macrotermes. Take refuge to trees if disturbed.	Partially protected. Widespread, currently secure.	1
South-eastern green snake *(Philothamnus hoplogaster)*	Varied: Coastal plains (bush), fynbos to higher inland Savanna (Arid and mesic Savanna) and even montane forest. Home near water bodies where it hunts for frogs, frequenting marshes, ponds, rivers, reedbeds, pans, vleis and streams. Under logs, stones and under debris. Favous damp localities such as reed swamps, **riverine thickets and flood plains of lakes and rivers.**	Partially protected. Widespread, not common.	
Marbled tree snake (*Dipsadoboa aulica*)	Riparian and coastal forest. **Under some debris under large shady trees**; hollow logs, under bark, piles of vegetation.		
Rhombic egg-eater *(Dasypeltis scabra)*	Widespread in **most veld types**: from sea level to an altitude of 2300m. Common in grassveld and bushveld. Absent only from true desert and closed-canopy forest. Mainly terrestrial but climb trees in search of birds' eggs. Any place where it can find shelter: Moribund termitaria, rock crevices, rock faces, heaps of rubble, rotting logs.	Partially protected. Widespread, common. Secure.	
Red-lipped snake *(Crotaphopeltis hotamboeia)*	Most habitats: Savanna and open woodland; Grassland to coastal forest but not in desert. **Preference for damp localities**. Marshy areas. Under virtually any available cover: Under rocks, in termitaria. Eggs laid in vegetable matter.	Partially protected. Occurs widely. Considered secure.	
Eastern tiger snake (*Telescopus semiannulatus semiannulatus*)	Savanna and sandveld: **Well-wooded areas** from sea level to 1600m. May be found in grassland. Terrestrial, old dead trees, under rocks, in crevices, in small shrubs and weavers' nests.	Partially protected. Uncommon, low densities. Secure.	
Southern twig snake (*Thelotornis capensis capensis*)	Savanna woodland: Open or **closed woodland** or coastal forest from sea level to 1200m. Almost exclusively arboreal: Live amongst the branches of trees. Entering holes in evergreen trees on slope during cold periods. May hibernate in hole in tree and even hole in ground.	Partially protected. Widespread, considered secure.	

Boomslang (*Dispholidus typus typus*)	**Common in most wooded regions** outside actual rainforests. From closed woodland through more open areas to scrub, from sea level to 1700m. Diurnal, mostly arboreal; move through branches of trees, shrubs and bushes. Mating takes place in trees and eggs are deposited in holes or hollows of trees, woodpeckers' nests or leaf litter on ground wherever suitable conditions exist. Take shelter in holes in trees and large termitaria and hibernate in holes in trees.	Partially protected. Widespread, secure.	
Family: Elapidae			
Snouted cobra (*Naja annulifera*)	Savanna: Usually in drier regions – bush- and lowveld. Permanent or semi-permanent home or retreat. Animal or other **hole in the ground or in a tree**, in termite hills or under outcrops of rocks or boulders. Eggs laid in some suitable, sheltered hole or cavity in the ground or in trees.	Partially protected. Widespread, generally common. Secure.	
Mozambique spitting cobra (*Naja mossambica*)	Savanna: Rocky outcrops and hillsides in fairly closed woodland at altitudes from sea-level to 1750m **along rivers or localities near water**. Cleared areas in former forests. Holes in termitaria and other small animal burrows.	Partially protected. Widespread, common. Status is secure.	
Black mamba (*Dendroaspis polylepis*)	Savanna & open coastal bush below 1500m: Lower lying, drier more **open woodland and scrub to wooded grassland**, moist Savanna and lowland forest (900m-1200m). Ground living snake, also at home in bush, shrubs or trees - in thickets, commonly on hillsides and outcrops, granite hillocks, termite mounds, hollow tree trunks. Female will find a good place to lay eggs, burrow must be damp but not wet, and warm, but not too hot (termite nests).	Partially protected. Widespread, mostly uncommon. In need of greater conservation effort.	
Family: Viperidae			
Puff adder *(Bitis arietans arietans)*	Widespread: Fynbos, grassland, scrub and woody Savannas, from sea level to 1800m. Absent only from desert, dense forest and mountain tops. **Any sort: rock on rock, rock on soil, logs, moribund grass.**	Partially protected. Widespread, status is secure.	
Snouted night adder (*Causus defilippii*)	Open to closed woodland from sea level to an altitude of 1200m. Under rocks on soil or under **rotting logs, often associated with rocky outcrops**, burrowing.		
Rhombic night adder *(Causus rhombeatus)*	Mesic Savanna. In undergrowth, **under stones or logs**, in termitaria. Forages at night.	Partially protected. Widely distributed, uncommon. Status currently secure.	
Family: Amphisbaenidae			
Van Dam's dwarf worm lizard *(Zygaspis vandami vandami)*	Alluvial sands with mesic Savanna. Usually found under stones on sandy or **humic soils.**		

Family: Scincidae			
Mozambique dwarf burrowing skink (*Scelotes mossambicus*)	Prefers rocky grassland and alluvial sand. Found under stones on mountain slopes, or logs on **alluvial sand or loamy soils**.		
Giant legless skink (*Acontias plumbeus*)	Lowveld in woodland and alluvial **sandy areas, forested areas**. Fossorial: Usually found below soil surface in sandy soil admixed with vegetable matter, accumulated leaf litter and humic soils in damp situations. Under stones, logs and other rotting vegetation, termitaria and among roots of trees.	Least concern. Protected. Uncommon, widely distributed. Status currently secure.	
Rainbow rock skink (*Trachylepis margaritifer*)	Rock-living form: Confined to rocky outcrops and koppies in bushveld country: Sandstone, granite, rhyolite, dolerite and basalt, in vertical and horizontal crevices. Granite domes and other hard rock surfaces (paragneiss and some sandstone).	Protected. Status currently secure and under no threat.	1
Striped skink (*Trachylepis striata*)	Variety of bushveld and Savanna types, and a wide range of ecological conditions from sea level to high mountain tops, desert to tropical bush. Although mainly arboreal, they also inhabit rocky koppies and will cross open ground readily. Among rocks and boulders, on the ground and in trees.	Protected. Widespread, adaptable. Considered secure.	3
Variable skink (*Trachylepis varia)*	Varied: Very adaptive, **wide variety of habitats**: from sea level to high mountain slopes: Bushveld, open woodland and scrubby grasslands without rocks and grassland. Desert, karroid veld, montane grassland, Savanna, coastal bush, mesic thicket. Terrestrial and diurnal: Amongst rocks and stones at rocky or stony localities but avoids extensive rocky areas. Broken ground, rocks and tree bases.	Protected. Widespread. Considered secure.	1
Sundevall's writhing skink (*Mochlus sundevallii sundevallii*)	Sandy Savanna and open bushveld country. A nocturnal fossorial to terrestrial species - lead largely a sub-terrestrial existence. In search of food, they often burrow to the surface of the ground. Shelter under stones, **rotting logs, accumulations of dead leaves** and other debris. Eggs laid in a suitable nook underground, particularly termitaria.	Protected. Widespread. Under no immediate threat.	
Wahlberg's snake-eyed skink (Panaspis *wahlbergi*)	Arid & mesic Savanna. From highveld grasslands and mountain tops through the bushveld and into the lowveld. **Forage among grass and leaf-litter, seeking prey under fallen leaves.** Shelter among grass tussocks, grass roots, under stones and rotting logs, in moribund termitaria and among leaf-litter in shady places under shrubs, in termite hills, and on broken ground. Eggs laid under a stone or log or sheltered, under stones and rotting logs or among fallen leaves and brushwood lying in shady places, lying on moist ground or among the roots of a tree or shrub, grassy spots, shrubs and trees. Rocky outcrops and rocky hillsides.	Protected. Widespread. Considered secure.	

Family: Lacertidae			
Common rough-scaled lizard *(Meroles squamulosus)*	Arid and mesic Savanna found in both sand- and bushveld country. Open woodland, scrub and grassland, at altitudes of 250-1400. More common in areas with *sandy substrates, sandy flat clearings*. Particularly on sandy soils where there it shelters in holes in the ground or where it can burrow itself. Forage among grass tufts or edge of bushes.	Protected. Widespread. Currently secure.	
Spotted sandveld lizard (*Nucras intertexta*)	Arid Savanna – Kalahari sand: *Open dry Savanna*. Holes in the ground, under rocks on soil, among grass tussocks and in leaf litter.	Protected. Widespread. Secure.	
Ornate sandveld lizard *(Nucras ornata)*	Variety of habitats: open grassy or stony flats to sand- or bushveld country: sandy soils. **Rocky hillsides and outcrops in open woodland** and grassland. Forage singly among grass tussocks and in leaf litter. Shelter in holes in the ground and under rock on soil.		
Family: Gerrhosauridae			
Yellow-throated plated lizard *(Gerrhosaurus flavigularis)*	Wide range of habitat: Scrub- or bush-covered flats near coast to high mountain slopes and plateau; including highveld, bushveld and lowveld. Bushveld, lowveld, grasslands (highveld) Savanna. **On stony hillsides**, sandy flats, **woodland** and grassland. Burrows of considerable lengths dug in ground under suitable sheltering bushes, shrubs, under boulders etc. Also shelters in rodent burrows, under rocks (lay half buried in soil), moribund termitaria. Escape to suitable refuge through low matted vegetation. Lays eggs in small chamber dug in leaf litter or on soil under a stone or rock in a hole which the female excavates, buried and left to incubate.	Protected. Status – secure.	1
Common Giant plated lizard *(Gerrhosaurus validus validus)*	Arid and mesic Savanna, open woodland (up to 1400m): Hills and outcrops in bushveld country. **Terrestrial and rupicolous** (rock-living); gregarious: confined to granitic and other boulder-strewn hills and outcrops. May forage several hundred meters from base of outcrop in which they live, quickly retreat back to suitable crevice or burrow in rocky retreats. Shelter in deep Crevices or Cracks between and under rocks on outcrops. Upper slopes of large granite koppies. Lays eggs in soil-filled rock crevices.		
Rough-scaled plated lizard (*Gerrhosaurus major major*)	Arid and mesic Savanna. Lowveld in open to fairly dense woodland – around rocky outcrops or isolated koppies in bushveld country. Rocky outcrops –**crevices or hollows between rocks and boulders.** Disused warrens of animals such as antbears, warthogs, small animal burrow - springhares, etc. old termitaria. Seldom found far from burrow – retreat at sign of danger. Cracks in small, well-vegetated rock outcrops and also in old termitaria. Lays eggs under log in moist soil, or in rock crack.		
Black-lined plated lizard (*Gerrhosaurus nigrolineatus*)	Open Savanna woodland, particularly gravelly soils, **bushveld country**. Deserted animal and other suitable holes, burrows of other animals, especially those of rodents. Disturbed: rush through vegetation back to burrow.		

Family: Cordylidae			
Jones' girdled lizard *(Cordylus jonesii)*	Bushveld or open woodland (300-1500m), dry **Savanna: Under loose bark of dead trees or in the hollows or holes of living trees or dead stumps**, in the dried leaves of aloes, in woodpiles and decaying logs. Under stones, dead logs and brushwood, where suitable trees are not available, amongst rocks at ground level.	Protected. Widespread in TVL. Secure.	
Barberton girdled lizard *(Smaug warreni barbertonensis*)	Montane, **well-wooded rocky outcrops**.	**IUCN Least concern. Endemic**	
Common girdled lizard *(Cordylus vittifer)*	Rock outcrops in Grassland. **In cracks in small rock outcrops.**	Protected. Widespread, status is secure.	
Wilhelm's flat lizard *(Platysaurus intermedius wilhelmi)*	Lowveld; mesic highveld grassland. Commonly occurs on granite outcrops and inselbergs where it uses open, exposed rock with associated boulders. **Narrow rock crevices are important for refuge.** Vegetation surrounding rock outcrops is frequently quite dense and juveniles may escape predators by running into it.	**Endemic to South Africa.** Least concern.	
Family: Varanidae			
Rock monitor *(Varanus albigularis albigularis)*	Savanna and open bush or forest country, open woodland, rocky hillsides, ridges and outcrops. Moister Karroid areas. Terrestrial. Dig tunnel under rock overhangs. Cracks and fissures between or under rocks, or in disused animal burrows or in hollow trees or holes in trees. **Expert climbers: tree and rocks**. Great wanderers – even far from water. Eggs deposited in holes in suitable soil dug to 150-230 mm - cover and camouflage nest. Eggs in live termite nest, hollow tree, usually hole in soft moist sand.	Protected by Provincial legislation (CITES, Appendix 11). Widespread, status considered secure.	
Water monitor *(Varanus niloticus niloticus)*	Near water: rivers, dams, pans and major lakes. **Major river valleys**. Shelter in holes in banks, in animal burrows or in crevices between rocks or under rocks, marginal vegetation. Basking in sun on rocks, outcrops, tree stumps, branches of overhanging trees or amongst vegetation on banks - never far from water. Escape into water – swim swiftly. Forage in marginal vegetation. Hibernate in large rock crag on rocky cliff or koppie bordering river. Young – marginal reed beds. Eggs deposited in hole dug deep into a living termite nest or sandbank by female, roughly covered over – termites seal up securely.	Protected by Provincial legislation (CITES, Appendix 11). Widespread, status considered secure.	1
Family: Agamidae			
Distant's ground agama (*Agama aculeata distanti*)	Semi-desert and Savanna: Open highveld (Grassland) and <u>*sandy thornbush*</u> (woodland) country with suitable rodent and other small animal burrows for shelter. Utilize rodent and other small animal burrows for shelter; burrows in termitaria; under stones and debris, partly buries in soil.	**Endemic to South Africa.** Least concern. Protected. Widespread in TVL. Sparsely distributed. Secure.	
Family: Chamaeleonidae			
Common flap-necked chameleon (*Chamaeleo dilepis dilepis*)	Various kinds of woodland: Savanna woodland; and wooded grassland, along streams. Wooded areas; branches of trees; branches of shrubs; Open forest and bush country, Savanna woodland. Lays eggs in tunnel in damp soft soil at a sheltered spot. Diurnal, arboreal species, common in suitable habitat.	Protected. Widespread, out of danger.	

Appendix 7: BIRDS: Available habitat, expected occurrence and observed presence of bird species during surveys (Gibbons, 1997; Harrison et al, 1997; Hockey et al, 2005 – latest name changes).

Birds expected to occur in the available natural habitats in the Low's Creek project area, are listed below. The words in **bold font** represent qualifying habitat (preferred habitat), and <u>*underlined italics*</u> disqualifying habitat (the reason why the organism will not occur in the area). The shaded cells indicate the species likely to occur in the riverine habitat, and the number inside a cell gives the number of individuals or definite signs detected during surveys.

BIRD	All habitats	SA status	Low's Creek
Grebes			
Little Grebe *(Tachybaptus ruficollis)*	More permanent waters: *lakes, ephemeral pans and dams*; emergent or overhanging vegetation, weedy shores. Backwaters in slow flowing rivers and streams. More permanent water. Infrequent: slow-flowing streams. Rarely in estuaries and sheltered bays. Nest - floating heap of water plants, either on open water or concealed in vegetation.	Common resident or nomad	
Cormorants			
White-breasted cormorant (*Phalacrocorax lucidus)*	Coastal and fresh waters: Dams and impoundments**, streams and rivers**. Mainly aquatic, in both salt and freshwater. Interior - streams and rivers. Colonial nester. Nest fixed to tree - islands, trees along rivers.	Common resident	
Reed cormorant (*Microcarbo africanus*)	Virtually **all freshwater habitats** except fast flowing streams. Prefers gently sloping shores. Also, estuaries, lagoons and sheltered coastal waters. Freshwater wetlands (any size) and water bodies: ephemeral habitats, major rivers and fast-flowing streams with pools, artificial wetlands: dams, sewage works. Nest in fork of tree over water or on an island. Also, in large reed bed or on ground or rocky outcrop on islands.	Common resident	1
Darters			
African Darter (*Anhinga rufa*)	Freshwater wetlands, **rivers and streams**; avoids fast flowing and turbulent water; adapted to artificial wetlands. Still and slow-moving freshwater bodies with open water. Scarce on fast flowing rivers and in areas with dense floating vegetation. Prefers areas with dead trees, rocks or banks where it can rest after feeding. Nest built in tree fork, often over water or on an island; also in large reed bed.	Common resident	
Egrets, herons and bitterns			
Grey heron (*Ardea cinerea*)	**Bodies of shallow open water**. Wetlands – rivers, dams, pans, marshes and estuaries – provided there is sufficient shallow water to feed in. Mountainous areas: keep to valleys. Tall trees, reed beds and cliffs for roosting. Also, marine intertidal zone, estuaries, lagoons. Rarely in dry grasslands. Tall trees, reed beds and cliffs for breeding and roosting. Nest placed in tree fork on bush or 1.5-2.0m above water in a reed bed.	Relatively uncommon; resident Breeding resident. Numbers augmented by Palearctic migrants Expansion in range – artificial water bodies. Common.	

Little egret (*Egretta garzetta*)	Open **areas of shallow water**: margins of lakes, dams, rivers, marshes, saltpans, estuaries and mangrove swamps. Breeds near water in trees or bushes. Edges of rivers and lakes, estuaries, pans, marshes, and saltpans. Also, mangroves, open coastal. Nest placed in tree or bush above water or reed bed.	Fairly common resident	
Intermediate egret (*Egretta intermedia*)	Shallow water or wet grasslands. Margins of lakes, rivers, saltpans and estuaries; especially seasonal water bodies, marshes and flooded grasslands. **Prefers shallow water**, but also forages in dry grassland close to water. Breeds in reed beds or trees.	Uncommon to locally common; local movements, possibly migratory in part	
Western Great Egret (*Egretta alba*)	Shallow open water at lakes, **rivers**, floodplains, flooded grasslands, marshes, saltpans and estuaries. Breeds in reed beds or trees. Nest on platform 2-3m above water in reed bed or 1-5m up in a tree standing in water or island.	Uncommon resident	
Black-headed heron (*Ardea melanocephala*)	Open habitats, <u>*preferring grasslands*</u>. Pastures and field of stubble near wetlands. Tall trees for breeding and roosting.	Common resident	
Goliath heron (*Ardea goliath*)	Open water: lakes, dams, large wide **rivers** and estuaries with extensive shallows and where there are extensive reeds or papyrus. Nests on islands. Shallow margins of large water bodies. Nest in tall tree, but also on ground on islands, mats of trampled reeds, and in flooded bushes or trees.	Uncommon resident generally, but common and conspicuous on larger rivers.	
Purple heron (*Ardea purperea*)	Larger water bodies and wetlands: **Reed beds**, marshes, reed-fringed rivers and lakes; flooded areas with tall grasses, rushes and sedges. Dense emergent vegetation, especially reed beds fringing shallow wetlands; also mangroves. Nest in reed beds on platform.	Uncommon to common resident	
Western Cattle egret (*Bubulcus ibis*)	Terrestrial; open short grassland. Nests in **trees and reed beds**.	Very common resident	3
Squacco heron (*Ardeola ralloides*)	**Freshwater habitats**: dense emerging/fringing vegetation in the quiet backwaters of ponds and the edges of slow-flowing rivers and streams. Adequate reed cover and a few bushes or trees are prerequisites. Flooded grasslands and ephemeral pans with emergent vegetation. Nest: A platform placed in bush or tree over water or in reed bed. <1m above water.	Uncommon to locally common resident	
Straited heron (*Butorides striata*)	**Densely vegetated rivers**, estuaries, streams, lakes, ponds, swamps and mangroves. Wooded areas around margins of rivers, streams, lakes, estuaries, mangroves reed beds, and swamps where vegetation overhangs water. Occasional - mudflats, temporarily flooded grassland and seashore. Nest placed on lateral branch of tree or dense shrub, 0.3-7m above ground or water.	Uncommon resident	
Black-crowned night heron (*Nycticorax nycticorax*)	**Dense vegetation along the edges of shallow, still or slow-moving water** such as rivers, lakes, pans, marshes or seasonal floodplains. Well-vegetated and slow-moving water - estuaries, mangroves. Roosts in trees and reed beds. Nest: Usually in reed beds; less often in tree or bush over water.	Common resident	
Little bittern (*Ixobrychus minutus*)	Breeding birds **confined to *Typha* and *Phragmites* reedbeds** in standing water. Migrants in sedges or rank emergent vegetation in shallow water. At edges of wooded streams and rivers. Rank vegetation along ponds. Nest placed in live bulrushes or dense reeds above water.	Non-breeding Palaeactric migrant	
Dwarf Bittern *(Ixobrychus sturmii)*	Seasonal freshwater wetlands: Pans, floodplains, and pools – with **dense overhanging foliage along the margins**	Summer breeding migrant - Rain migrant – dependant on rainfall. Rare, locally common during breeding season. Sparse distribution. Status: Intermediate – not globally threatened.	

Storks			
Yellow-billed stork (*Mycteria ibis*)	Dams, large marshes, swamps, estuaries, margins of lakes and **rivers**, seasonal wetlands. Wetlands, including alkaline and freshwater lakes, rivers, pans, flood plains, flooded grasslands, small pools or streams. Nest placed on top of tree (Acacia, fig) 3-7m above ground or water.	**IUCN 2016 Status: Least concern. SA Red Data (Taylor 2015): Endangered.** Non-breeding infra-African migrant.	
African Openbill *(Anastomus lamelligerus)*	Various open aquatic habitats – swamps, floodplains, ephemeral pans, rice fields, **river shallows** and lake edges. Wetlands, including flood plains, temporarily flooded pans, marshes, swamps, ponds, river shallows, streams, lake edges, lagoons, intertidal flats. Breeds at sites with suitable water levels for feeding. Thin platforms of sticks and twigs lined with grasses, aquatic plants and sedges alongside other birds in branches of temporarily flooded trees, especially Acacias or reed beds (0.3-10m above water).	**SA Red Data (Barnes 2000): Near threatened.** Endemic to tropical sub-Saharan Africa. Uncommon to locally common Intra-African trans-equatorial migrant.	
Black stork (*Ciconia nigra*)	Shallow water: streams, **rivers**, marshes, floodplains, coastal estuaries, flooded grassland; large and small dams; dry land. Shallows of rivers, pools in dry riverbeds. Uncommon in seasonal pans lacking fish. Nest up cliff above water: 10-100m.	**IUCN 2016 Status: Least concern. SA Red Data (Taylor 2015): Vulnerable, TOPS (2007): Vulnerable.** Uncommon to rare, nomadic.	
Abdim's stork (*Ciconia abdimii*)	<u>*Grasslands*</u>, pastures and cultivated fields.	**IUCN 2016 Status: Least concern. SA Red Data (Taylor 2015): Near threatened.** Non-breeding intra-African migrant, very common.	
Wooly-necked stork (*Ciconia episcopus*)	Wetlands: **along rivers**, flood plains, pans, swamp forests, mangrove swamps, lagoons, estuaries, dams and tidal mudflats. Also, short grass close to water, especially on flood plains and pan edges. Nest: platform well-concealed on fork of horizontal branch, often overhanging water; in large leafy tree, 10-50m above ground.	**SA Red Data (Barnes 2000): Near threatened.** Uncommon to rare resident	
White stork (*Ciconia ciconia*)	Open woodland, grassland, <u>*grassy Karoo and wetland areas*</u>.	Non-breeding Palaeactric migrant	
Marabou Stork *(Leptoptilos crumeniferus)*	Both aquatic and terrestrial habitats, preferring open and semi-arid areas. **Natural wetlands in woodland vegetation types**.	**SA Red Data (2000): Near threatened.** Rare vagrant over most of southern Africa; elsewhere locally common.	
Spoonbills			
African spoonbill (*Platalea alba*)	Shallow aquatic habitats: freshwater wetlands, marshes, pans, temporary flooded grasslands, floodplains, **rivers**, dams. Almost exclusively shallow aquatic habitats, favouring lake and river margins, seasonally and permanent pans, coastal lagoons and estuaries. Favours swamps with stands of tall reeds and sedges. Nest almost always on partly submerged trees, bushes, reeds, or rocky islets.	Locally common nomadic	
Ibis			
Glossy ibis (*Plegadis falcinellus*)	Grassland habitats, associated with freshwater habitats: shallow inland waters, lake and river-edge marshes, seasonal pans, flooded grassland. Riparian marshes, shallow rivers. **Favours swamps with stands of tall reeds and sedges.** Nest in most dense patches of reeds or rushes, large reed bed islands.	Locally common to rare Increasing in numbers.	

Hadeda Ibis (*Bostrychia hagedash*)	Open moist grasslands & savannah, along **well-vegetated river courses**; also marshes, flooded grasslands, edges of large wetlands, gardens.	Very common resident	5
African Sacred ibis (*Threskiornis aethiopicus*)	Grassland habitats, associated with **freshwater habitats**: marshes, estuaries and dams.	Common to very common resident	
Hamerkop			
Hamerkop (*Scopus umbretta*)	Large perennial water bodies (lakes, dams and rivers), vleis and ephemeral wetlands, **perennial and seasonal rivers with pools**. Edges and shallow waters of lakes, pans, swamps and marshes, rivers, streams and seasonally flooded ponds, including relatively small puddles. Nest in sturdy tree or on cliff ledge. Adjacent to or over water.	Common resident	
Ducks & geese			
White-faced whistling duck (*Dendrocygna viduata*)	**Inland waters**, mainly in savannah and grassland. Expanses of shallow water with emergent vegetation: backwaters of larger rivers, grassy floodplains, small ephemeral pans. Feeds in water - usually in shallows of permanent or seasonal wetlands, or flooded grasslands; on land - natural grasslands. Ephemeral wetlands. Dense grass or sedges - sometimes over water or island. Dense, long grass or sedges near water edge. Grassy island surrounded by shallow water.	Common resident. Nomadic when breeding. Not threatened.	
White-backed duck (*Thalassornis leuconotus*)	**Quiet, clear inland waters** with emergent of floating vegetation, natural pans, open vleis, floodplains and river backwaters. Diving to bottom muds in open water. Seasonal pans and floodplains. Ephemeral pans with stable water levels and isolated stands of sedges, rushes or reeds, and are well covered with aquatic grasses.	Uncommon resident or nomadic at times. Not threatened.	
Egyptian goose (*Alopochen aegyptiaca*)	**Inland waters: rivers,** dams, lakes, marshes, pans, and estuaries with some exposed shoreline; wetland edges. Rich aquatic plant growth. Naturally: Restricted to flood plains and large rivers with broad sandbanks. Currently: Crop fields and cereal fields. Nests usually on ground, typically in dense vegetation or among rocks; often on small islands in water bodies. Always near water. Also, old nests of other birds.	Very common resident	1
Spur-winged goose (*Plectopterus gambensis*)	**Inland waters** / wetland: larger bodies of water, floating vegetation; croplands. Flightless moult: Dams and dense swamp. Breeding: smaller system or secluded bay, emerging fringing vegetation. Rivers - shallow areas in open. Nest: Shallow scrape in ground near water. Island, dense grass or reeds, sometimes in burrow.	Common to very common resident	
Knob-billed duck (*Sarkidiornis melanotos)*	**Inland waters**: seasonal flooded pans and vleis. Rivers - shallow areas in open. Nest in cavity of tree (dead, hollow), rotten palm stump, old hamerkop nests. 4-12m above ground.	Locally common; seasonal movements	
African black duck (*Anas sparsa*)	**Rivers with running water**, pools with wooded banks. Mainly perennial rivers and streams, from fast-flowing mountain streams to wide sandy river mouths, preferring shallow stony bottom streams with wooded banks. Moult: lodged branches undercut banks. Nest on ground in dense grass or other ground cover on riverbank, or in lodged flood debris, tangled roots or hollow stump.	Uncommon, localized resident.	
Yellow-billed duck (*Anas undulata*)	**Inland waters**: Sluggish or still waters and still waters of rivers and streams; mostly with marginal vegetation such as reeds. Avoid fast flow and saline/ acidic water bodies. Usually floats near emergent aquatic vegetation, occasionally on open water. Breeds on a variety of freshwater wetlands. Shallow seasonal water bodies. Nest amongst rushes reeds, dense grass or sedges, often within dense patch of vegetation, screened from above. Close to water - within 20m.	Very common resident	

Red-billed teal (*Anas erythrorhyncha*)	Shallow, permanent or temporary eutrophic fresh water with grassy surroundings.	Common resident but nomadic	
Southern pochard (*Netta erythrophthalma*)	Deep, permanent or seasonal freshwater *pans, vleis,* clear water; emergent vegetation and seasonal floodplains.	Common to very common resident	
Finfoot			
African Finfoot *(Podica senegalensis)*	Quiet wooded streams and **rivers flanked by thick riparian vegetation** and overhanging trees. Forest and woodland areas: Streams and rivers lined with reeds, overhanging trees and shrubs. Avoids stagnant and fast flowing water. Perennial watercourses, clear water. Reclusive species that seldom ventures into open water. Climbs up and roosts in branches overhanging water. Forages close to water's edge and riverbanks, usually under overhanging vegetation. Nest: 1-2.5m above water on an overhanging branch, well concealed. Also, on flood debris and in rushes above water level.	**IUCN 2015: Least concern; SA Red Data (Taylor 2015): Vulnerable.** Uncommon resident; probably rare.	
Jacanas			
African Jacana *(Actophilornis africanus)*	Aquatic habitats: seasonal pans and floodplains; **along fringes of slow-flowing, meandering rivers** – emergent, floating hydrophytes to forage. Permanent, seasonal and ephemeral shallow, freshwater wetlands and margins of slow-flowing rivers with low emergent vegetation. Favours areas dominated by water lilies and pondweed. Walks on floating plants or swim when hydrophytes provide insufficient support. Nest: Platform of aquatic plants over still water, exposed or well-hidden when vegetation is available.	Common to abundant resident; local movements apparent	
Vultures			
African White-backed Vulture *(Gyps africanus)*	Drier woodlands, mopane, arid Kalahari; **tall trees for roosting and nesting**	**IUCN 2014: Endangered; NEMBA TOPS (2015): Endangered species; SA Red Data (Barnes 2000): Vulnerable.** Common nomadic	
Secretary bird			
Secretary bird (*Sagittarius serpentarius*)	*Open country*: Savanna, open woodland, grassland and dwarf shrubland. Avoids mountain fynbos, forests, dense woodland and very rocky or hilly or mountainous areas.	**IUCN 2017 VU Vulnerable; SA Red Data (Taylor 2015): Vulnerable. NEMBA (TOPS 2007): Vulnerable species.**	
Hawks and eagles			
Western Osprey *(Pandion haliaetus)*	Inland and coastal waters. Widespread. Coastal along the seashore, and at estuaries and lagoons; inland on lakes and *large rivers*.	Mostly uncommon non-breeding Palaearctic migrant. Some may breed.	
African Cuckoo Hawk *(Aviceda cuculoides)*	**Forest** and dense woodland, indigenous or exotic.	Uncommon to fairly common resident. Probably rare.	
Black-winged Kite *(Elanus caeruleus)*	Wide distribution: Most abundant in grassland and fynbos with **cultivated areas**.	Common resident & nomad	
Yellow-billed Kite (*Milvus parasitus*)	**Great variety of habitats**: especially woodlands (higher rainfall areas)	Common breeding Palaearctic migrant	

African fish eagle (*Haliaeetus vocifer*)	Widespread. Coastal along the seashore, and at estuaries and lagoons; inland on lakes and large rivers. Usually associated with **large water bodies**, either flowing or still, including estuaries. Sometimes along open coastline. May remain on seasonally dry rivers once last pools dry up, subsisting on birds and scavenging carcasses. Absent from rivers that flow for only a few weeks a year. Nest in tall tree (including dead and drowned trees) or on cliff. 12-15m above ground.	Uncommon resident	
Brown Snake Eagle (*Circaetus cinereus*)	Arid woodland. Breeds and **roosts in trees**.	Uncommon to fairly common resident.	
African Harrier-Hawk *(Polyboroides typus)*	Mainly in forests. Dense woodland, **tall riparian vegetation** and well-wooded ravines. Partial to stands of alien trees.	Locally common resident	
Lizard Buzzard *(Kaupifalco monogrammicus)*	Savannah and woodland, especially *mature broadleaved deciduous woodland*.	Fairly common resident; somewhat nomadic	
Dark Chanting Goshawk *(Melierax metabates)*	Woodland and savannah: *avoids forests* and arid savannah. Nest: Platform of sticks 4.5-9.0m above ground in vertical fork of tree within canopy. Usually perch on top of tree, scanning ground for prey.	Common resident	
Gabar Goshawk (*Micronisus gabar*)	Open woodland: *Acacia* parkland and **Acacia-dominated riparian zone**.	Common resident	
African Goshawk *(Accipiter tachiro)*	Mainly indigenous forest; also **dense riverine woodland** and exotic plantations.	Common resident	
Shikra *(Accipiter badius)*	All woodland types – nests in **open woodland**.	Common resident	
Little Sparrowhawk *(Accipiter minullus)*	Forest and woodland types: Dense vegetation - forests, **riparian bush** and thickets.	Uncommon resident	
Ovambo Sparrowhawk *(Accipiter ovampensis)*	Mosaic of **tall woodland** and open areas. Ecotone between woodland and grassland.	Uncommon to local common resident	
Black Sparrowhawk *(Accipiter melanoleucus)*	Forest, **wooded kloofs and gorges**, exotic plantations (especially Eucalyptus) in grassveld.	Uncommon to fairly common resident; numbers increasing - able to exploit exotic plantations	
Common Buzzard *(Buteo buteo)*	Open country: dwarf shrubland, grassland, savannah, open woodland, thornveld & fynbos. Also found in **dense woodland**.	Common non-breeding Palaeactric migrant	
Jackal Buzzard *(Buteo rufofuscus)*	*Mountainous and hilly areas*: grass and other short vegetation. Nests on cliffs and in trees.	Locally common	
Tawny Eagle *(Aquila rapax)*	Woodlands, lightly **wooded areas: needs trees**.	**IUCN 2015 Status: Least concern. SA Red Data (Taylor 2015): Endangered; NEMBA TOPS (2015): Endangered species; Common** resident	
Steppe Eagle *(Aquila nipalensis)*	**Woodland** and open savannah, including semi-arid savannah	Common but unpredictable nonbreeding Palaearctic migrant	
Verreaux's Eagle *(Aquila verreauxii)*	*Rocky habitats in hills* and mountains with nest sites; vegetation types associated with mountainous regions - Alpine grasslands. Need dassies as food.	Locally fairly common resident	

Wahlberg's Eagle *(Hieraaetus wahlbergi*)	Woodland – flat areas: river lines and **riparian woodlands**. Breeding in tall riparian trees in grassland and woodland	Common intra African breeding migrant	
African Hawk-Eagle *(Aquila spilogaster)*	Woodlands: breeds on hill slopes or **along river courses in tall trees**.	Uncommon to fairly common resident	
Martial Eagle *(Polemaetus bellicosus)*	Open grassland and scrub. Large trees for nests. Wide range of vegetation types: deserts, **densely wooded and forested areas**.	**IUCN 2015 Status: Near threatened; SA Red Data (Taylor 2015): Endangered; NEMBA TOPS (2015): Endangered species.** Fairly common to uncommon resident	
Long-crested Eagle *(Lophaetus occipitalis)*	Woodland: exotic plantations, **forest edge**, cultivated land with orchards, grassland and vlei.	Fairly common, but much reduced in southern parts of range; resident	
Crowned Eagle *(Stephanoaetus coronatus)*	Dense indigenous forest, including **riverine gallery forest**; may range far from forest to hunt.	**IUCN 2015 Status: Near threatened. SA Red Data (Taylor 2015): Vulnerable. NEMBA (TOPS 2007): Vulnerable species.** Common resident in suitable habitat, but numbers declining through deforestation	
Falcons, hobbies and kestrels			
Rock Kestrel *(Falco rupicolus)*	Wide variety of habitat types: arid to mesic conditions. Mountainous areas for breeding. *Montane grassveld with rocky outcrops.*	Common resident	
Amur Falcon *(Falco amurensis)*	Open and high-rainfall (sour) grasslands. Also, *open areas* in woodland.	Very common non-breeding Palaearctic migrant	
Eurasian Hobby *(Falco subbuteo)*	Mostly *lightly wooded country*; avoids arid zones and forests.	Uncommon non-breeding Palaearctic migrant	
Lanner Falcon *(Falco biarmicus)*	*Open habitats*. Most frequent in open grassland, open or cleared woodland, and agricultural areas. Cliff-nester, also in old nests in trees or electricity pylons and buildings.	IUCN 2017 Status: Least concern (Global). **SA Red Data (Taylor 2015): Vulnerable;** Fairly common resident	
Francolins and spurfowl			
Coqui Francolin *(Peliperdix coqui)*	*Savannah or well-grassed woodland*, sandy areas with good bush cover: grassy clearings and along edges of woodland.	Common resident	
Crested Francolin *(Dendroperdix sephaena)*	**Woodlands with dense scrub component**. Favours areas with bush encroachment in savannahs and tolerates poor grass cover.	Very common resident	
Shelley's Francolin *(Scleroptila shelleyi)*	*Acacia savannah with good grass cover*, edges of cultivated lands, often on stony ground.	Fairly common resident.	
Natal spurfowl (*Francolinus natalensis*)	Woodland types: savannah with scrub understorey, especially along water courses, to thickets and coastal forest. **Dry riparian vegetation** and wooded hills.	Common resident	4
Swainson's Spurfowl *(Pternistes swainsonii)*	Wide variety of habitats. Tall grass in open country (grassland) or woodland. Adjacent to cultivation or **close to water**.	Very common resident	

Guineafowl			
Helmeted Guineafowl (*Numida meleagris*)	Savannah mixed with cultivation. Inhabiting most **agricultural regions**	Very common resident	
Sandgrouse			
Double-banded Sandgrouse *(Pterocles bicinctus)*	Acacia and other savannahh, dry bushveld, mopane woodland, stony and eroded areas, rocky desert hills with *scrub and tussocky grass*	Common resident	
Quails			
Common Quail *(Coturnix coturnix)*	Catholic use of habitats: *Prefer perennial grasslands*, less than 0.5m in height, fallow weedy fields, and grassland regenerating after burning.	Common resident or migrating	
Harlequin Quail *(Coturnix delegorguei)*	Relatively short to medium-long, *rank, open grass* with scattered bush cover. Fallow lands and grassy clearings in woodlands, dry floodplains.	Locally common breeding migrant	
Kurrichane Buttonquail *(Turnix sylvatica)*	*Open grassveld*: neither very tall nor very dense. Savannah. Fallow lands.	Uncommon resident	
Crake and rails			
Black crake (*Amaurornis flavirostris*)	Rank grass, sedges, reedbeds, bulrushes, papyrus, swampy thickets, bushes and other vegetation **beside flowing, still or open fresh** and estuarine waters. Occurs in tangled growth in which birds climb, roost and nest. In thin cover along very small streams in arid regions. Nest well-hidden and placed in vegetation just above water, sometimes on ground in grass tuft near water or floating among stiff grass stems.	Common resident	
Flufftails			
Buff-spotted Flufftail *(Sarothrura elegans)*	**Evergreen forest** and adjoining thickets, overgrown gardens.	Fairly common resident	
Red-chested flufftail (*Sarothrura rufa)*	Wide range of freshwater, marshy habitats, from seasonally wet grassland and sedge meadow to permanently flooded reedbeds. Wetland vegetation types, dense cover, firm ground or short vegetation. Marshy, boggy areas, reed-fringed pools, swamps, vleis, dambos, **marshy vegetation fringing rivers, streams,** lakes. Isolated wetland patches in grassland, woodland and forest. Requires permanent dense cover.	Fairly common resident	
Coot, moorhens and gallinules			
Common Moorhen (*Gallinula chloropus*)	Wetlands with emergent fringing vegetation, including lakes, dams, ponds, pans, **rivers, streams**, canals, swamps and marshes. Flooded grassland. Temp ponds on floodplains. Sheltered sites with some open water, avoids very open situations. Nest usually well concealed in sedges, reeds or bulrushes, lower branches of tree, all above water level.	Common resident	
Red-knobbed coot (*Fulica cristata*)	*Open freshwater* of lakes, lagoons, ponds, pans and vleis, floodplains, reedy swamps. Occasionally on rivers and tidal lagoons. Favouring wetlands with emergent vegetation and pondweed. Spend much time swimming on open water. Nest on shallow (>1m) to deep water, out in the open or among emergent vegetation, sometimes on water lily leaves or mat of reeds.	Abundant resident, highly nomadic	

Korhaans and bustards			
Kori Bustard *(Ardeotis kori)*	*Open plains* of karoo, highveld grassland, Kalahari sandveld, arid scrub, Namib Desert, lightly wooded savannah, bushveld.	**NEMBA TOPS (2015): Protected species; SA Red Data (Barnes 2000): Vulnerable.** Rare to uncommon resident; some populations locally migratory; common in game reserves.	
Red-crested Korhaan *(Lophotis ruficrista)*	*Bushveld and scrub* in woodland biomes: Acacia-dominated and broadleaved savannahs.	Common resident	
Black-bellied Bustard *(Lissotis melanogaster)*	*Bushveld, savannah*, grassland, vleis, cultivated lands.	**SA Red Data (Barnes 2000): Near threatened.** Uncommon resident; some local southward movement in winter	
Plovers and lapwings			
Three-banded plover (*Charadrius tricollaris*)	**Any freshwater habitat with an open shoreline**. Open shores of any freshwater habitat, favouring pools, streams and seeps. Also, at tidal pools, estuaries and lagoons. Nest: Simple scrape in sand, dry mud or shingle, usually close to water.	Common resident, nomadic	
Blacksmith plover (*Vanellus armatus*)	Moist short grasslands and mudflats on edges of pans, lakes, **rivers**, and estuaries. Nest: typically, close to water or in seasonally inundated areas.	Common resident, nomadic	
African Wattled plover (*Vanellus senegallus*)	Wet short grasslands and marshes near vleis, streams and on **river floodplains**. Waterlogged grasslands at seeps, streams, edges of marshes and flood plains; exposed areas around lakes and pans. Nest: Usually on bare ground or open short or burnt grassland.	Locally common resident	2
Senegal Lapwing *(Vanellus lugubris)*	*Open, short-grass* savannah, often in recently burned areas.		
Crowned Lapwing *(Vanellus coronatus)*	Dry, short and over-grazed or burnt *grassveld*. Widespread in a number of grassland and woodland types. Absent from mountainous and desert areas.	Common resident, nomadic	
Sandpipers & other waders			
Marsh sandpiper (*Tringa stagnatilis*)	Freshwater wetlands, coastal lagoons and tidal estuaries. **Shallow water over muddy substrate**.	Fairly common non-breeding Palaeartic migrant	
Common Greenshank (*Tringa nebularia*)	Aquatic habitats: coastal sites and inland wetlands with shallow margins. Vleis, pans, and **rivers**.	Common non-breeding Palaearctic migrant	
Wood sandpiper (*Tringa glareola*)	Marshy shorelines: ephemeral pans, vleis, marshes, streams, floodplains and upper reaches of estuaries. Muddy, sandy or gravel borders of dams and ponds, inundated short grassland, sandy and **muddy riverbeds**, natural pans, mixed rocky and sandy beaches, salt marshes, estuaries, tidal and non-tidal lagoons and mangroves. Marsh-like conditions favoured over open shorelines.	Common non-breeding Palaearctic migrant	
Common sandpiper (*Actitis hypoleucos*)	Any aquatic habitat, but **favours streams and rivers shores** with sandy, gravelly, stony or rocky substrata, estuaries, tidal creeks in salt marsh, mangroves. Open water edges: streams, rivers, marshes, vleis, coastal lagoons and upper reaches of tidal estuaries. Prefer wet conditions adjacent to water rather than wading in water.	Fairly common non-breeding Palaeartic migrant	

Dikkops or thick-knees			
Water Thick-knee *(Burhinus vermiculatus)*	Primarily freshwater wetlands, especially **large rivers**, lakes and dams. Also, mangrove swamps, estuaries and open beaches. Favours site with open sand banks; also, rocky areas, but avoids heavily vegetated wetland margins. Nest: Simple scrape in ground, close to water but fairly open position	Locally common resident.	2
Spotted Thick-knee *(Burhinus capensis)*	Various types of grasslands; whole of SA highveld. *Open grassland* and savannah, edges of woodland, semi-desert with scrub, stony slopes of low hills, cultivated land. Sparse ground cover where stony.	Common resident	
Coursers			
Bronze-winged Courser *(Rhinoptilus chalcopterus)*	Woodland and savannah. Largely nocturnal; roosts under bushes during the day. *Woodland with shrub layer*, Acacia savannah. At night move to open grassland, roads, tracks and clearings.	Uncommon to locally common; resident in north; migratory in south.	
Temminck's Courser *(Cursorius temminckii)*	*Open woodland*, edges of vleis, grassy plains, dry pans, bare or overgrazed veld, fallow lands and airfields. Recently burnt short grass.	Uncommon to locally common nomadic resident	
Terns, gulls & other seabirds			
Grey-hooded gull (Chroicocephalus *cirrocephalus)*	*Shallow, open water*.	Common to abundant resident or local migrant	
Doves and pigeons			
Common pigeon (*Columba livia*)	*Urban areas*, less often farmland.	Abundant resident; introduced.	
Speckled Pigeon (*Columba guinea)*	*Mountains, cliffs, rocky gorges, boulder-strewn hills*. Inhabitant of cliffs and crags fly out to forage on open ground. Artificial structures. Roosts on cliff ledges, in caves and sometimes on trees. Nests placed on ledge of cliff, in cave, gulley or rarely in trees.	Common to abundant resident, nomadic	
African Olive-Pigeon *(Columba arquatrix)*	Afromontane, lowland and coastal forests, **riverine forests**.	Locally common resident	
Lemon Dove *(Columba larvata)*	**Understory** of evergreen forest and thickets; also exotic plantations.	Common resident, but easily overlooked.	
Laughing dove (Spilopelia *senegalensis*)	Open **savannah**, Acacia thornveld and grassland; avoids natural high-altitude grasslands.	Very common resident	3
Ring-necked Dove (*Streptopelia capicola*)	**Catholic choice of habitats**: all vegetation types, except forests.	Very common resident	
Red-eyed Dove (*Streptopelia semitorquata*)	Tall trees in the vicinity of water. **Riparian woodland**, forest verges and other well-wooded country.	Common resident	2
Emerald-spotted Wood Dove (*Turtur chalcospilos*)	Various deciduous woodland types & moister thornveld; thickets or **drainage lines** and in valleys – taller denser growth.	Common resident	1
Tambourine Dove (*Turtur tympanistria*)	Lowland evergreen forest, **riverine woodland**, dense thickets; less often on edges of montane forest.	Fairly common resident	4
Namaqua Dove *(Oena capensis)*	Dry to semi-arid open woodlands and savannahs. *More open habitat*.	Common resident, nomad	

African Green-Pigeon (*Treron calva*)	Well-wooded areas, along **permanent rivers. Fig trees** for food. Nests in drier woodlands.	Common resident, nomad	7
Parrots, lovebirds and parakeets			
Brown-headed Parrot (*Poicephalus cryptoxanthus*)	Woodland and **riverine forest**. Nests in hole in tree; up to 10m above ground. Gregarious in small groups in dead or leafy trees.	Common resident	
Louries & Turacos			
Livingstone's Turaco *(Tauraco livingstonii)*	Forest and dense, **riparian woodland**.		
Knysna Turaco *(Tauraco corythaix)*	Evergreen and **riverine forest**, dense thickets.	**SA Endemic.** Fairly common resident	
Purple-crested Turaco (*Tauraco porphyreolophus*)	Closed woodland, particularly riverine woodland, secondary forest, patches where woodland intergrades with forest, coastal forest, dense scrub and thickets on termitaria. **Riverine forest**, evergreen thickets, woodland, dense thornveld, savannah, parks and gardens. Nest: Mid or upper canopy in densely branched, well-foliaged tree, commonly entwined with creepers, isolated tree 3-9m above ground in well-wooded habitats.	Fairly common resident	4
Grey go-away-bird (*Corythaixoides concolor*)	Open woodland, ***Acacia* woodlands, near water**.	Common resident	
Coucals			
Burchell's Coucal (*Centropus burchellii*)	Rank and tangled growth. **Reedbeds, marshes, and thickets**, coastal bush. Along drainage lines, edges of wetlands.	Common resident	4
Cuckoos			
Jacobin Cuckoo *(Clamator jacobinus)*	<u>*Dry open savannahs*</u>, Acacia. Dry to moist woodlands.	Fairly common non-breeding Palaeartic and Indian migrant	
Levaillant's Cuckoo *(Clamator levaillantii)*	Dense, closed humid woodland, scrub and **woody growth along streams**. Well-developed woodland – Acacia & broadleaved.	Uncommon breeding intra African migrant	
Red-chested Cuckoo (*Cuculus solitarius*)	Forest and **well-wooded habitats: riparian growth**, thickets and evergreen forests. Trees around habitation.	Common intra African breeding migrant	
African Cuckoo (*Cuculus gularis*)	**Variety of woodlands** – broadleaved and *Acacia*.	Uncommon breeding intra African migrant	
Klaas's Cuckoo (*Chrysococcyx klaas*)	Forest, **moist woodland** and savannah. Trees around habitation.	Fairly common resident and intra African breeding migrant	
African Emerald Cuckoo *(Chrysococcyx cupreus)*	Canopy of evergreen and **riverine forest**	Fairly common breeding intra-African migrant	
Diederik Cuckoo (*Chrysococcyx caprius*)	**Variety of habitats**: from forest edge to semi desert. Not in forests and uncommon in mopane.	Very common intra African breeding summer visitor	2
Black Cuckoo *(Cuculus clamosus)*	Forest edges, woodland riverine bush exotic plantations farmland, suburban areas. Acacia woodland, **riparian thickets** and mixed thornveld.	Fairly common intra African breeding migrant	

Owls			
Western Barn owl (*Tyto alba*)	Wide range of vegetation types. Northern woodlands. **Needs large trees to roost**. Nomadic owls moving in response to rodent population explosion.	Locally common resident	
African Scops-Owl *(Otus senegalensis)*	Range of woodland types; <u>*tall, scattered trees*</u>.	Common resident	
Southern White-faced Owl *(Ptilopsus granti)*	Woodland, savannah, arid thornveld, **riverine bush.**	Fairly common resident	
Spotted eagle-owl (*Bubo africanus)*	Broad range of habitats. Man-made structures. <u>*Rocky areas, woodland, forest edge savannah*</u>, semi desert. Towns.	Common resident	
African Wood Owl *(Strix woodfordii)*	Evergreen and **riverine forest**, dense woodland, coastal bush, pine plantations; seldom in savannah.	Locally fairly common resident	
Pearl-spotted Owlet *(Glaucidium perlatum)*	Relatively <u>*open woodlands*</u> (not tall dense woodlands) Sparse grass cover & trees for nests.	Common resident	
Marsh owl (*Asio capensis*)	<u>*Open grasslands, marshlands*</u> and short scrub with high rodent populations preferred.	Uncommon to rare. IUCN Least concern	
Nightjars			
Fiery-necked nightjar (*Caprimulgus pectoralis*)	Dense <u>*broadleaved woodland*</u>, savannah, coastal bush, fynbos and alien plantations. Ground, preferring areas where there is dense leaf litter.	Common partial migrant	
Freckled nightjar (*Caprimulgus tristigma*)	Favours areas of bare granite, Karoo sandstone, quartzite, mica-schist and weathered basalt substrata on hills, escarpments, <u>*boulder-strewn hillsides*</u>, in ravines nd along dry, rocky riverbeds. Bare rocky outcrops and escarpments with well-wooded slopes. Requires some vegetation cover. By day roosts 0n exposed rock or among vegetation, in spite of ground temperatures sometimes reaching 60 degrees C. Nest: Natural hollow on bare rock where stone chips and wind-blown debris of plant material accumulated.	Locally common to very common resident	
Square-tailed Nightjar *(Caprimulgus fossil)*	Scrub with open sandy ground in savannah and **riverine bush**. Eggs laid on bare ground among plant debris. Often under thorn bush.	Common resident in Lowveld.	
Pennant-winged Nightjar *(Macrodipteryx vexillarius)*	Wide variety of habitats when on migration; roosts on ground, but often perches on branches after flushing; breeds in <u>*broad-leafed woodland*</u>.		
Swifts and spinetails			
African Palm-Swift (*Cypsiurus parvus*)	Governed by the distribution of the <u>*flabelliform palms*</u>, nests underside dead leaves.	Locally common resident	
Alpine Swift *(Tachymarptis melba)*	Overall vegetation types: Especially over Alpine <u>*grassland*</u> and Fynbos – breeding sites. Dry vertical cracks in overhanging cliffs.	Common breeding intra-African migrant	
African Black Swift *(Apus barbatus)*	<u>*Montane habitats*</u>: nesting – horizontal cracks on cliffs or in caves. Forage - open country.	Breeding intra-African migrant	
Little Swift *(Apus affinis)*	Overall vegetation types: prefers open grasslands and Karoo, not high-altitude alpine grasslands. **Occur over water** and nests under dry overhangs.	Very common partial migrant	

Horus Swift *(Apus horus)*	Anywhere: common in more humid south and east. Associated with ***high altitude grasslands***. Nests in sandbanks.	Common breeding intra African migrant	
White-rumped Swift (*Apus caffer*)	Forage over open ground. Cliffs. **Anywhere**: common in more humid south and east.	Very common breeding intra African migrant	
Mousebirds			
Speckled mousebird *(Colius striatus)*	Forest, subtropical thicket and mesic woodland. Ecotones: **Edges of forests and closed woodland, wooded drainage lines** and gardens.	Common resident	6
Red-faced Mousebird *(Urocolius indicus)*	*Savannah woodlands*, moist woodlands, shrubland. Avoiding forest and open grassland.	Very common resident	
Trogons			
Narina Trogon *(Apaloderma narina)*	Evergreen and **riverine forests**, dense woodland, moist thornveld, coastal bush, valley bushveld, wattle plantations. Nests in natural hole in tree or dead stump. Forages by sallying from perch, catching prey of leaves, branches or from air.	Uncommon to common mostly resident; possibly breeding migrants from further north	
Hoopoe and woodhoopoes			
African Hoopoe *(Upupa africana)*	Catholic use of habitats. Tall savannah thornveld. Woodland. *Bare ground and short grass*.	Sparse to common resident	
Green Wood-Hoopoe (*Phoeniculus purpureus*)	Arboreal. Most woodland types. Edges of **evergreen forests**.	Common resident	
Common Scimitarbill (*Rhinopomastus cyanomelas*)	Tropical and subtropical arid woodland. *Absent from closed canopy woodland.*	Fairly common resident	
Kingfishers			
Half-collared Kingfisher *(Alcedo semitorquata)*	Clear **fast flowing perennial streams**, rivers and estuaries; clear water and well-wooded banks; often near rapids; narrow and secluded with dense marginal vegetation. Broken escarpment terrain. Well-vegetated lake shores and coastal lagoons. Breeds along perennial, clear-water streams and rivers that have wooded edges. Nests in low alluvial banks (1-1.5m high) along river edge. Face onto river or open pool and are screened or concealed to some extent by overhanging vegetation, roots or other growth. Riverbanks to excavate nest tunnels.	**IUCN 2017 Status: Least concern; SA Red Data (Taylor 2015): Near threatened.** Uncommon resident.	
Malachite kingfisher (*Alcedo cristata*)	Strictly **aquatic environments** – availability of fish. River and stream banks – flanked by trees, shrubs and recumbent riverine grasses and weedy vegetation. Prefer well-vegetated, slow-flowing rivers and streams, but not with canopy closed over river. Sheltered shores, coastal lagoons, tidal estuaries, mangrove swamps. Perennial or seasonal wetlands. Small water courses in breeding season when steep banks required for nest tunnels. Burrow: Earthen bank - along stream, earth mound, soil around upturned roots of fallen tree, wall of aardvark burrow. Low (<1m high).	Common resident	
African Pygmy Kingfisher *(Ispidina picta)*	Woodland habitats; *dry land and not necessarily near water*. Coastal woodland and more open evergreen forest.	Locally fairly common breeding intra African migrant	
Grey-headed Kingfisher *(Halcyon leucocephala)*	*Well-developed woodland*; *Acacia* & mopane. Mesic woodland habitat for breeding.	Uncommon to locally fairly common breeding intra African migrant	
Woodland Kingfisher (*Halcyon senegalensis*)	Well-developed woodland; **tall riverine *Acacia* stands** & mopane; grass understorey heavily grazed.	Common breeding intra African migrant	

Brown-hooded Kingfisher (*Halcyon albiventris*)	Edges of evergreen forests, woodland and **riverine woodland**.	Common resident	2
Striped Kingfisher (*Halcyon chelicuti*)	*<u>Open woodlands</u>*, broadleaved & *Acacia* mesic and arid conditions.	Common resident	
Giant kingfisher *(Megaceryle maxima*)	**Any water body with sufficient food and overhanging branches** to hunt from, - streams, rivers, estuaries, seashores. Perch under canopy in trees alongside streams or at edges of pools. Large rivers and small streams. Nests in hole made in high alluvial bank, usually one overhanging a flowing river. Seldom less than 2m in height, usually 3m, upper third of bank.	Fairly common resident	
Pied kingfisher (*Ceryle rudis*)	**Aquatic environments – availability of fish.** Any water body with small fish, including large rivers and perennial streams, estuaries, lakes, temporarily flooded areas, rocky coasts and intertidal zone of coast. Less common along well-wooded, fast flowing streams. Nest: Burrow in vertical alluvial sandbank being cut by flowing water, sometimes quite close to the water level. Usually positioned in the least accessible positions available: over water, in a high bank, and near the top of the bank.	Common resident	2
Bee-eaters			
White-fronted bee-eater *(Merops bullockoides)*	**Associated with watercourses**. Typically associated with vertical sandy or lateritic riverbanks and watercourses - in woodlands (broadleaved and mixed woodland) and in wooded grassland. Also, at eroded gullies, perennial rivers and seasonal streams with wooded banks. Need sandbanks for nesting. Sandy riverbanks or erosion gully clear of vegetation.	Locally abundant resident	18
Little Bee-eater *(Merops pusillus)*	Semi-arid to high rainfall areas. *<u>Open spaces to forage</u>* – low bushes or reeds. Savannah and light woodland.	Common resident	
European Bee-eater (*Merops apiaster*)	**Variety of woodland** and shrubby habitats, avoids relatively mesic and arid conditions. Nest in riverbanks or erosion gullies.	Common non-breeding Palaearctic migrant & breeding migrant	3
Southern Carmine Bee-eater *(Merops nubicoides)*	Open woodland & savannahs; **floodplains** & arid Acacia steppe; nests in freshly cut sand cliffs. Disperses to open grassy places in variety of woodland types.	Common to abundant non-breeding intra-African migrant	
Rollers			
European Roller (*Coracias garrulus*)	Woodlands, bushveld and grasslands. *<u>Open woodland</u>*.	IUCN 2018 Least concern; **SA Red Data (Taylor 2015): Near threatened;** Fairly common non-breeding Palaearctic migrant. Population trend: decreasing.	
Lilac-breasted Roller *(Coracias caudatus)*	Ecotone between light woodland and *<u>open grassy areas</u>*. savannah and open woodland (broadleaved & Acacia)	Common resident	
Purple roller *(Coracias naevius)*	*<u>Uniform bushveld</u>* and woodland (broadleaved & *Acacia*).	Fairly common resident	
Hornbills			
Southern, Red-billed Hornbill *(Tockus rufirostris)*	*<u>Woodland with sparse ground cover</u>*. Broadleaved and mixed woodlands, well-developed *Acacia* woodland.	Very common resident	
Southern, Yellow-billed Hornbill *(Tockus leucomelas)*	Variety of dry, *<u>open savannah woodlands</u>* (broadleaved & Acacia)	Very common resident	

African Grey Hornbill (*Lophoceros nasutus*)	*Taller woodland* (broadleaved & Acacia) in dry and humid savannahs. Bushveld.	Common resident	
Trumpeter Hornbill *(Bycanistes bucinator)*	Forest, dense woodland with tall trees, **riverine bushveld**. Patches of warm, coastal, lowland forests, especially along rivers. Lower altitudes - montane forests, in moist woodlands and mangroves, and along riparian forest strips in arid savannah. Mobile in search of fruit. Nesting in stand of large trees on hillside, along watercourses, in hills or in isolated stand of trees in dry savannah. Nest in natural cavity in tree trunk or large branch, 2-13m above ground.	Locally common resident; some local seasonal movements.	
Barbets & tinker barbets			
Yellow-rumped Tinkerbird *(Pogoniulus bilineatus)*	*Woodland: broad-leaved*. Forages like warbler in vegetation. Nests in hole excavated in dead trunk or underside of sloping branch of tree. Perches in high tree while calling.	Common resident	
Yellow-fronted Tinkerbird (*Pogoniulus chrysoconus*)	Broad-leaved woodland, **moist woodland** – mixed woodland and rocky hills.	Common resident	
Acacia Pied Barbet *(Tricholaema leucomelas)*	*Arid savannahs*, soft-wooded trees (Acacia) present, wooded drainage lines in grassland.	Common resident	
Black-collared Barbet (*Lybius torquatus*)	Miombo, moist wooded areas, along east facing slopes of the Transvaal escarpment, eastern coastal areas. Drier savannahs: restricted to **riverine vegetation**. Coastal bush, woodland, forest edge, riverine forest, parks, gardens.	Very common resident	6
Crested Barbet (*Trachyphonus vaillantii*)	Savannah, **woodland and thickets** – broadleaved woodlands. Mixed woodland and Acacia habitats. Thornveld, thickets in woodland, riverine bushveld, exotic plantations, parks, gardens.	Common resident	
Honeyguides & honeybirds			
Scaly-throated Honeyguide *(Indicator variegatus)*	**Canopy of evergreen and taller riverine forest**, bushveld, thickly wooded valleys, exotic plantations.	Fairly common to uncommon local resident.	
Greater Honeyguide (*Indicator indicator*)	*Arid and moist woodland*: Wide range of woodland types.	Fairly common resident	
Lesser honeyguide *(Indicator minor)*	Wide range of wooded habitats: savannahs with scattered trees to forest fringes, **riverine woodland;** exotic plantations, gardens.	Locally common resident	
Woodpeckers			
Golden-tailed Woodpecker (*Campethera abingoni*)	Wide spectrum of **woodland and savannah** types.	Fairly common resident	2
Cardinal Woodpecker (*Dendropicos fuscescens*)	Wide variety of **woodland and savannah**.	Common resident	
Bearded Woodpecker *(Dendropicos namaquus)*	More arid *savannah types*. Savannah and woodland, tall trees in open park-like settings. Broadleaved woodland with tall trees and dead ones.	Fairly common resident	
Olive Woodpecker *(Dendropicos griseocephalus)*	Evergreen forest, dense coastal and **riverine bush**; also, into fynbos when foraging.	Fairly common resident inland; scarce on coast.	

Wryneck			
Red-throated Wryneck *(Jynx ruficollis)*	*Grassland biome*: Sour and Mixed grasslands, not Alpine grasslands; needs trees for nesting. Only found in grassland where trees are present, even exotics. Forage on open ground, absent where trees are too dense or absent. Thornveld, open bushveld, exotic plantations, farmyards, gardens.	Locally fairly common; generally uncommon; migratory in south, resident in north.	
Larks			
Monotonous Lark *(Mirafra passerina)*	Wide variety of fairly *dry and open woodlands* with bare and stony patches; open shrubby *Acacia* and mopane woodlands, mixed broadleaved woodlands, ground cover fairly scarce.	Common resident and nomad	
Rufous-naped Lark (*Mirafra africana*)	Variety of habitats: *bare patches, sparse grass cover*, suitable perches. Open grassland with termitaria or scattered bushes and bare patches, open savannah woodland with sparse grass cover between trees, bare patches in fallow fields and cultivated lands.	Locally common resident. Common & conspicuous spp. No evidence of range contraction. Not threatened by habitat destruction.	
Flappet Lark (*Mirafra rufocinnamomea*)	Open woodland, savanna and grassland with scattered trees. Prefers rocky broad-leaved woodland. Woodlands: clearings or **drainage lines**.	Fairly common resident	
Sabota Lark *(Calendulauda sabota*)	Wide range of savannah habitats; arid *open shrubland on rocks and sands*, semi-arid Acacia savannahs on clays, calcrete and sands, on rocky slopes with tall shrubs, bushes and trees, on edges of wooded drainage lines, mixed woodlands on stony soils.	Common resident	
Swallows & martins			
Brown-throated Martin *(Riparia paludicola)*	**Associated with water: Streams, large rivers,** dams, estuaries and open wetlands. Forage over dryland habitats far from water. Wetlands in fairly open habitats. Extensive sandbanks along rivers support colonies with hundreds of widely spread burrows. Usually in sandy or friable soil in vertical sandbanks along rivers.	Common resident	2
Grey-rumped Swallow *(Pseudhirundo griseopyga)*	*Dry or burnt grassland*, bare ground at edges of vleis, clearings in woodland, fallow lands, polo fields, golf courses.	Common resident or local migrant	
Barn Swallow (*Hirundo rustica*)	All habitats: more common in higher-rainfall eastern half: *moister grassland, woodlands* and fynbos.	Abundant non-breeding Palaearctic migrant	
White-throated Swallow *(Hirundo albigularis*)	Vicinity of wetlands, **especially rivers** and other expanses of open water where suitable nesting sites are available.	Common, but localized breeding intra-African migrant	
Wire-tailed Swallow *(Hirundo smithii)*	Always associated with **water bodies, including large rivers, streams**, flood plains, adjacent open grassland, open miombo, mopane woodlands, thornveld and forest edges. Rivers, streams and dams, usually in woodland and around buildings. Breeds widely in lower-lying mesic savannahs but is confined to the vicinity of permanent water, especially larger rivers. Nest: Usually close to overhang, 0.3-15.0m above ground or water. On low rock faces or the undersides of tree stumps in water.	Common resident; seasonal movements at higher elevations.	
Greater Striped Swallow *(Cecropis cucullata)*	Wide variety of fairly open habitats: semi-arid Karoo, fynbos, *grassland and lightly wooded savannah.*	Common breeding intra-African migrant	
Lesser Striped Swallow *(Cecropis abyssinica*)	Variety of woodland and *savannah habitats*.	Common breeding intra-African migrant	

Red-breasted Swallow *(Cecropis semirufa)*	*Open savannah*; sweet grassveld.	Scarce breeding intra-African migrant	
Rock Martin *(Ptyonoprogne fuligula)*	*Habitats with rock formations*: Rocky terrain. Rocky hills, cliffs, quarries. Nest attached to vertical surface of rock face supported by ledge below.	Common resident	
Common House-Martin *(Delichon urbicum)*	Wide variety of habitats: fynbos, *grassland, savannah woodland* and cultivated areas. Hilly open country.	Locally common non-breeding Palaearctic migrant	
Black Saw-wing (*Psalidoprocne pristoptera)*	**Streams, vleis and clearings** in forest, dense woodland and exotic plantations.	Breeding intra-African migrant, locally fairly common, resident in some areas.	
Cuckooshrikes			
Grey Cuckoo shrike *(Coracina caesia)*			
Black Cuckoo shrike (*Campephaga flava*)	Canopy of moist woodlands, both broadleaved and *Acacia* woodland. Moist, arid and **riparian woodlands.**	Uncommon resident	
Drongos			
Fork-tailed Drongo (*Dicrurus adsimilis*)	Wide range of vegetation types: Open bush and woodland; **edges of forest patches**; Highveld – alien trees.	Common resident	1
Orioles			
Eurasian Golden Oriole *(Oriolus oriolus)*	Lush foliage in shady tree canopies. Broadleaved trees. **Riverine strips.**	Fairly common non-breeding Palaearctic migrant	
Black-headed Oriole (*Oriolus larvatus*)	**Moist woodland; evergreen** or lightly deciduous. Afromontane Forests. Overfly extensive unsuitable habitat – grassveld.	Common resident	1
Crows and ravens			
Pied Crow (*Corvus albus*)	Wide variety of biomes: *unrelated to vegetation*, not in southern Kalahari.	Very common resident	
Bulbuls			
Dark-capped Bulbul (*Pycnonotus tricolor)*	Wide range of habitats: **moister woodland** and savannah, **riverine bush, forest edge** & regenerating forest (not inside) dense montane scrub, scrubby vegetation, alien plantations. Not in open grassland.	Very common resident	5
Sombre Greenbul *(Andropadus importunus)*	Forest, coastal and **riverine bush**, dense thicket.	Common resident.	3
Terrestrial Brownbul *(Phyllastrephus terrestris)*	Evergreen forest, mainly in lowlands, **riverine bush** and forest, dense thickets.	Sparse to fairly common resident.	
Tits			
Grey Penduline Tit *(Anthoscopus caroli)*	Well-developed *broadleaved woodland*.	Fairly common resident	
Southern Black Tit (*Parus niger*)	*Broadleaved woodlands*.	Common resident	

Babblers			
Arrow-marked Babbler (*Turdoides jardineii*)	Thickets or strips of **denser vegetation along seasonal drainage lines**. Broadleaved and mixed woodlands.	Very common resident	
Thrushes			
Kurrichane Thrush (*Turdus libonyana*)	Woodland and thickets. **Moist broadleaved** and mixed woodland habitat.	Common resident	3
Groundscraper thrush (*Psophocichla litsitsirupa*)	*Open parkland woodlands*; broad-leaved and Acacia woodland – understorey poorly developed & patches of bare ground. Miombo, open overgrazed woodland, plantations.	Fairly common resident	
Karoo thrush (*Turdus smithi*)	Mostly in **riparian woodland** in semi-arid Karoo and introduced woodland on the Highveld; common garden bird.	Locally common resident.	
Chats			
African Stonechat *(Saxicola torquata)*	Grassland biome: *High altitude grasslands* down to sea level, moist, open country with rank growth of grass and herbs.	Common resident and altitudinal migrant	
Familiar Chat *(Cercomela familiaris)*	Broad range of *open vegetation types*, broken ground and rocky habitats. Rocky mountain slopes, rocky hills and outcrops, valley slopes, eroded gullies, sparse woodland along drainage lines. Nest: Positioning highly opportunistic; in cavity in wall of erosion gully; on rock face, in old burrow or other burrowing-nesting species.	Common resident	
Mocking Cliff Chat (*Thamnolaea cinnamomeiventris*)	Vicinity of *rocky outcrops* in wooded country. Open well-faulted rock faces with scattered trees and shrubs. *Ficus* trees. Well-wooded rocky ravines, gullies, cliffs, boulder-strewn hillsides and along streams or rivers in valley bottoms where there are large boulders. Nest: Usually placed in nest of striped swallow under rock overhang or in cave.	Locally common resident	
Robins			
White-starred Robin *(Pogonocichla stellata)*	Breeding populations restricted to Afromontane evergreen forest. Avoids forests without tangles of undergrowth. Altitudinal migrants favour dense cover along **drainage lines**.		
White-throated Robin-Chat *(Cossypha humeralis)*	**Thickets that line dry water courses** in the bushveld and thornveld. Open woodland – closed thickets under large shade trees. Termite mounds & fire-free places on rocky hills.	Locally common resident	
White-browed robin-chat *(Cossypha heuglini)*	**Dense riverine bush, evergreen thickets.** Sing from low perch in tree or bush. Riverine forest with broken canopy and dense evergreen thickets, lakesides with shady trees and shrubs, Acacia woodland on flood plains. In dry areas restricted to evergreen thickets fringing river courses. Nests amongst dense shoots of coppicing bush or tree, hollow stump, tangled creepers, hollow in bank, cavity among tree roots on bank, up to 2m above ground.	Locally common resident	2
Red-capped robin-chat (*Cossypha natalensis*)	Evergreen forests and woodland, **riparian growth**, deciduous thickets, riverine forests. Keeps to undergrowth of forests, forages on ground (dusk), moves seasonally to higher forest strata when fruit ripen. Sing from low perch. In general, favours linear habitats (e.g., along wet and dry watercourses). Nest in hollow stump, rock crevice, hanging creeper or ground.	Scarce to common. Mostly resident.	
Chorister Robin-Chat *(Cossypha dichroa)*	**Evergreen forest**, especially in mist belt.	**South African endemic.** Locally common resident; some seasonal altitudinal movement at higher elevations.	

Scrub-Robin			
White-browed Scrub Robin *(Erythropygia leucophrys)*	*Woodland and bushveld habitats*. Patches of dense undergrowth in thornveld and broadleaved woodland.	. Common resident	
Warblers			
Papyrus yellow warbler *(Chloropeta gracilirostris)*			
Little rush warbler *(Bradypterus baboecala)*	Associated with **tangled vegetation around wetlands**; not usually over open water.	Locally fairly common resident and nomad.	2
Cape Grassbird *(Sphenoeacus afer)*	Rank *vegetation with long grasses*, restios or ferns, in tangled scrub, low sparse shrubland and in hilly grasslands with scattered bushes. Avoids areas in which the woody component becomes too high or dense.	Locally common resident	
African reedwarbler (*Acrocephalus baeticatus*)	Usually in **moist or wet areas, including edges of reeds**, bulrushes, sedges, tall herbs and forbs, and tall grass and shrubs along riverbanks. Marshland: Outskirts of reed-beds where there is a mixture of grass, sedges, rushes and tall willow herbs. Nests bind to reeds, grass, sedges, well-hidden; 0.3-3.0m above dry or damp ground but usually over water.	Common breeding intra-African migrant	
Marsh Warbler *(Acrocephalus palustris)*	Thickets and marshland: **Fringes of reedbeds, waterside weeds**, woody thickets on anthills and leafy vegetation along rivers. Dense lush thickets with rank herbaceous undergrowth, usually away from water.	Uncommon to fairly common non-breeding Palaearctic migrant	
Great reed warbler (*Acrocephalus arundinaceus*)	**Marshland: Phragmites** and tall grass.	Locally common non-breeding Palaearctic migrant	1
Lesser swamp warbler (*Acrocephalus gracilirostris*)	Marshland: **Phragmites over water. Reeds and bulrushes** in standing water in estuaries, lagoons, rivers, marshes. Nest on upright reed stems, sedge, bulrush, arum lily.	Locally common resident	
Icterine warbler (*Hippolais icterina*)	Thornveld: **Canopy or mid-level**.	Fairly common non-breeding Palaearctic migrant	
Willow Warbler *(Phylloscopus trochilus)*	Any woodland: edges of **evergreen forests**, savannahs, gardens, parks, exotic plantations. Anywhere with trees and bushes i.e., adequate tree cover; Adequate tree cover.	Fairly common non-breeding Palaearctic migrant	
Fan-tailed grassbird *(Schoenicola brevirostris)*	Vleis, marshy grassland, moist grassy hillsides, **boggy drainage lines**, coarse high grassland.	Sparse and local; resident below about 1000m; at higher elevations breeding migrant. Indeterminate.	
Garden warbler (*Sylvia borin*)	**Dense thickets: Inside thickets**.	Fairly common non-breeding Palaearctic migrant	
Apalis			
Bar-throated Apalis *(Apalis thoracica)*	Adaptable, catholic: Wooded habitats. Interior of **evergreen or semi-evergreen forests**, forest fringes, woodland, Karoo scrub, grassveld – where suitable woodland or bush occurs, e.g., along drainage lines.	Common resident	
Yellow-breasted Apalis *(Apalis flavida)*	**Riverine forest**, moist bushveld, mixed woodland, mature thornveld, thickets, middle to lowland evergreen forest, regenerating scrub.	Locally fairly common resident.	2

Camaroptera			
Green-backed Camaroptera *(Camaroptera brachyura)*	Evergreen forests: lowland, **riparian**, montane and temperate forest. Small patches of forest or dense secondary growth and thickets. Forest edges tangled riverine bush; gardens, parks. Forages low down in undergrowth, even on ground, hopping restlessly around. Rather secretive. Nests in low herbs, bush or leafy tree, from ground level to 1.3m above ground.	Common resident	2
Wren-Warbler			
Stierling's Barred Warbler (*Calamonastes stierlingi*)	*Large-leaved woodland*; thickets on termite mounds. Forages mostly on or near ground, disturbed, ascend to canopy. Nests of spider webs in drooping leaves.	Common resident	
Eremomela			
Green-capped Eremomela *(Eremomela scotops)*	*Canopy of woodland* and bushveld. Forages in groups among leaves of woodland canopy. Nest suspended and well-hidden among leaves at ends of branches.	Fairly common resident	
Crombec			
Long-billed Crombec (*Sylvietta rufescens*)	*Woodland; scrubland*. Catholic in use of different woodland – not found in unwooded grassland and forest interiors.	Common resident	
Cisticolas			
Red-faced Cisticola (*Cisticola erythrops*)	Tall rank vegetation in marshes, **along streams and rivers** and bordering reedbeds in lowveld. Sometimes in weeds, rank growth and edges of canefields away from water. Skulks in dense undergrowth. Nests sewn into broad leaves of herb or shrub up to 50cm above ground.	Locally common to fairly common resident	4
Lazy Cisticola *(Cisticola aberrans)*	*Rocky slopes with grass*, dense scrub and occasional trees and thickets. Valley bottoms and in gullies. Rank grass, shrubs and bracken on damp ground, edges of forests.	Locally common resident	
Rattling Cisticola (*Cisticola chiniana*)	*Tree savannah* – Acacia woodland where grassland interspersed with trees & thickets or shrub. Fringes of dense woodland and in coastal scrub patches.	Very common resident	
Levaillant's cisticola (*Cisticola tinniens*)	**Marshland: Streamside** where there is short grass, sedges and rushes with clumps of taller growth. Marshy areas along rivers and streams, edges of reedbeds, moist grassland, and seasonally flooded endorheic ponds. Nest: Bond with spider web between leaves and stems of forbs and herbs. 0.1-1.0m above ground or water.	Very common resident	
Croaking Cisticola (*Cisticola natalensis*)	*Rank open moist grassland*, edges of vleis, usually with scattered bushes or trees; also, in clearings and edges of forest and regenerating secondary growth.	Common resident or local migrant	
Neddicky (*Cisticola fulvicapilla*)	*Dune scrub, in scrub and rank grass* on hill slopes, on the edges of woodlands and plantations, in secondary growth and in thornveld savannah. Understorey of woodlands. Tolerant of alien vegetation. Avoid dense grassland – cannot feed on ground level. Especially Valley Bushveld.	Very common resident	
Zitting Cisticola *(Cisticola juncidis)*	*Natural grasslands and weedy areas*, edges of vleis, dams, pans, and salt marshes. *Eragrostis* grass pastures, cereal cropland, edges of cultivation, fallow lands, and any open areas with rank grass. Associated with wetlands.	Common resident	

Prinias			
Tawny-flanked prinia (*Prinia subflava*)	Marshland: In reeds and sedges in vleis. Relatively tall and **dense patches of vegetation: rank** grass on edges of roads or farmlands, drainage lines and edges of dams and rivers, scrubby patches within woodland savannahs, secondary thickets, reeds and sedges in wetlands, ecotones between grassland and dense, tall woodlands and forests. Suburban and rural gardens.	Very common resident. Readily adapts to modified habitats. Distribution not changed.	4
Karoo Prinia *(Prinia maculosa)*	Scrub and rank growth along **drainage lines.** Karoo and fynbos shrubland and mixture of grassland and scrub. Fallow land and edges of forests and alien plantations.	Common resident	
Flycatchers			
Blue-mantled Crested Flycatcher *(Trochocercus cyanomelas)*	Middle to lower layers of coastal, lowland and mid-altitude evergreen forest (even small forest patches; also, thickets in **riverine forest**.)	Uncommon and local resident; may have seasonal movements.	
African Paradise Flycatcher (*Terpsiphone viridis*)	Woodlands: evergreen forests and broadleaved woodlands. Riverine strips, **riparian vegetation**.	Common breeding intra-African migrant	1
Pale Flycatcher *(Bradornis pallidus*)	Mainly <u>*broad-leaved woodland*</u> and savannah with well-developed understory. Less often Acacia savannah. In fork of densely foliaged tree, near trunk or far out on branch, 1.5-4m above ground. Perches on lower outer branch at edge of clearing, dropping to ground to catch prey.	Common resident	
Southern Black Flycatcher (*Melaenornis pammelaina*)	Woodlands near **surface water; taller vegetation**, not necessarily clumped, open space at ground level.	Common resident	1
Fiscal Flycatcher *(Sigelus silens)*	<u>*Fairly open vegetation*</u> with trees or intermittent scrub.	Common resident	
Spotted Flycatcher *(Muscicapa striata)*	<u>*Open woodland*</u>; habitat where bare branches alternate with open space. Open habitat with less well-structured middle and lower stratum.	Common non-breeding Palaearctic migrant	
African Dusky Flycatcher (*Muscicapa adusta*)	Evergreen and **riverine forest**, patches of forest in dense woodland; exotic plantations, well wooded gardens.	Locally common; some populations resident, most locally migratory	
Ashy flycatcher *(Muscicapa caerulescens)*	Edges of lowland evergreen forests, upper strata of **riverine woodland**, thickets in drier woodland, moister savannah, wooded gorges.	Locally common resident	1
Grey Tit-Flycatcher *(Myioparus plumbeus)*	Dense vegetation, upper strata. **Riverine strips**. Holes in trees for nests.	Uncommon resident	
Batis			
Cape Batis *(Batis capensis)*	Afromontane forests. Lower levels of **evergreen forests,** isolated forest fragments: undergrowth tangles and canopy. Densely wooded gorges and exotic plantations in summer; in winter may spread to more open woodland and savannah.	Common resident; some seasonal altitudinal movement.	
Chinspot Batis *(Batis molitor)*	Major woodland types. Acacia spp. <u>*Valley bushveld, thornveld and karroid*</u> broken veld.	Common resident	

Wagtails			
African pied wagtail (*Motacilla aguimp*)	Along margins, rocky patches and **sandbanks of large rivers**, pans and dams. Usually near water, preferring wide rivers and open water bodies with sandy banks or exposed rocks and boulders. In drier areas restricted to perennial rivers. Nest usually built close to water, on ground, in grass tussock, reeds or other vegetation, including flood debris and tree stump over water, in crevices or on rock ledge or cliff.	Common to scarce; mostly resident; non-breeding migrant to much of Transvaal in winter.	
Cape wagtail *(Motacilla capensis)*	Almost anywhere where there **is water with open** ground nearby. Wide range of natural environments: require merest trickle of water; open streams in forest habitats, rivers and waterfalls. Nest concealed in vegetation on ground, often in recess in a steep bank or donga, or in bush or tree.	Common resident	
Mountain wagtail (*Motacilla clara)*	Largely restricted to small **streams and rivers** in hilly, forested country, preferring stretches with emergent rock and where water flows over flat rocks. Especially fond of waterfalls. Also, along rivers through woodland and dense thicket, including valley bushveld. Fast-flowing well-wooded rocky streams and rivers, larger forested rivers; sometimes also smaller quiet tributaries, or streams in forest with pools and waterfalls. Forced to move if rivers dry up completely. Nest built 1-5m above water in a niche in stream bank, rock face, boulder among flotsam on branch over water or in a tree. Often near deep pool or behind waterfall.	Sparse resident on permanent streams and rivers; nomadic on seasonal tributaries.	
Longclaws			
Yellow-throated Longclaw (*Macronyx croceus*)	Rank grass, edges of vleis, **swampy drainage lines**, with scattered trees and bushes or in savannah or light woodland.	Locally common resident; some irregular local movement away from breeding areas in winter.	2
Pipits			
Striped Pipit *(Anthus lineiventris)*	Broadleaved woodland; rocky outcrops and gorge like situations; alongside **small woodland streams**. Deeply incised drainage lines. Rock faces.	Locally fairly common resident	
African Pipit *(Anthus cinnamomeus)*	<u>*Grasslands*</u>: open stretches fringing pans, lightly wooded savannah, dry floodplains with short vegetation and recently burnt open veld. Avoids dense rank growth. Fallow fields.	Common resident	
Long-billed Pipit *(Anthus similis)*	Slopes in relatively arid and eroded, <u>*broken veld*</u>, often steppe-like with erosion scars, stones and outcrop rock interspersed with grass clumps and low scrub. Low trees and light woodland on stony ground.	Locally common resident	
Shrikes			
Red-backed Shrike *(Lanius collurio)*	<u>*Medium dense thornveld*</u>. Open habitats with fewer smaller trees for males; females – skulk in taller woodland. Fallow land with coppicing Acacia bushes, pockets of scrub.	Fairly common non-breeding Palaearctic migrant	
Common Fiscal *(Lanius collaris)*	<u>*Open spaces with exposed perches*</u>, short or sparse ground cover and trees for nesting. Scarce in Arid Woodland, Marula and Knobthorn savannah, Alpine Grassland.	Common resident	
Magpie Shrike *(Urolestes melanoleucus)*	Acacia savannah and broadleaved woodland. <u>*Open savannah with short grass*</u>.	Common resident	

Southern White-crowned Shrike *(Eurocephalus anguitimens)*	*Woodland and savannah*, often with baobab trees. Forages by watching from perch and dropping to ground for prey. Nests on horizontal branch or fork several meters above ground. Some local or nomadic movements.	Fairly common to common resident	
Brubru *(Nilaus afer)*	*Savannah woodlands*. Acacia and broadleaved woodland. From tall, well-developed, mixed woodlands, forest edges, scattered scrubby areas.	Common resident	
Black-backed puffback (*Dryoscopus cubla*)	Indigenous woodland and forest. **Dense woodland**.	Common resident	3
Black-crowned Tchagra (*Tchagra senegala*)	*Scrub and woodland habitats*. Mesic broadleaved woodlands.	Common resident	
Brown-crowned Tchagra *(Tchagra australis)*	*Woodland and scrub* – restricted to undergrowth. Acacia-, mopane- and broadleaved woodland.	Common resident	
Southern Boubou *(Laniarius ferrugineus)*	Dense tangled undergrowth, **thickets along watercourses** in wide range of woodland types; all woodlands and forest types. Forests and exotic plantations. Grasslands - thickets along watercourses.	Common resident.	
Orange-breasted Bushshrike *(Chlorophoneus sulfureopectus)*	Woodland. **Mixed riparian woodland**.	Very common resident	
Olive Bushshrike *(Chlorophoneus olivaceus)*	Canopy of evergreen forest, tall dense bush, **riverine forest.**	Locally fairly common to common resident.	
Gorgeous Bushshrike *(Chlorophoneus quadricolor*)	Dense thickets at edges of lowland to mid-altitude **evergreen forest** and fairly dry woodland; dune forest; riverine bush, tangles of secondary growth. Forages low down in undergrowth and on ground, creeps into densest vegetation when disturbed. Nest 0.6-1.5m (usually 1m) above ground in tangled creeper or dense bush, well hidden.	Locally common to fairly common resident	
Grey-headed Bushshrike *(Malaconotus blanchoti)*	*Woodland of medium density*.	Uncommon resident	
White-crested Helmet-Shrike *(Prionops plumatus)*	Deciduous broadleaved woodland – breeding. Otherwise – *Acacia savannah*.	Common resident	
Retz's Helmet-Shrike *(Prionops retzii)*	Deciduous woodlands when breeding. Non-breeding: disperses into Acacia savannah and other *dry woodland types*. Forages mainly on larger branches and on trunks of trees. Nests 3-20m above ground on stout horizontal branch of large tree (especially *Pterocarpus rotundifolia*).	Fairly common to common resident or nomad	
Starlings			
Red-winged Starling *(Onychognathus morio)*	*Cliffs and rocky areas*. Common in highland areas; less common on plains. Rocky outcrops and gorges in highland grassland, visits forests to feed on fruit. Nest: Typically on rock ledge.	Common resident	
Cape Starling *(Lamprotornis nitens)*	Wide range of vegetation types: Not a grassland or forest bird. Depends on trees or tall vegetation for nests. *Woodland species*.	Common resident	
Greater Blue-eared Starling *(Lamprotornis chalybaeus)*	Open woodland, savannah, **riverine forest**, bushveld. Usually with fairly tall dense ground cover. Forages mostly by running about on the ground. Nests in natural hole in tree. Roosts communally in trees or reedbeds.	Common resident	

Burchell's Starling *(Lamprotornis australis)*	*Savannah woodland*; large trees and stretches of uncovered open ground.	Very common resident	
Violet-backed Starling (*Cinnyricinclus leucogaster*)	*Open woodlands*; mixed broadleaved woodlands.	Fairly common to scarce breeding intra-African migrant	
Wattled Starling *(Creatophora cinerea)*	*Dry grasslands and dry open country*; nests in thorn trees.	Locally abundant nomad	
Oxpeckers			
Red-billed Oxpecker (*Buphagus erythrorhynchus*)	*Variety of woodlands*; needs holes in trees for nesting. Food supply on game and cattle.	**SA Red Data (Barnes 2000): Near threatened.** Common resident	
Sunbirds			
Western Olive Sunbird *(Cyanomitra [o.] obscura)*			1
Amethyst Sunbird *(Chalcomitra amethystina)*	Broadleaved **woodland** types. Gardens and stands of alien trees.	Common resident	
Scarlet-chested Sunbird *(Chalcomitra senegalensis)*	Woodland, savannah, **riverine bush**, gardens.	Common resident; some seasonal fluctuations in some areas.	1
Collared Sunbird *(Hedydipna collaris*)	**Riverine and lowland evergreen forest**; coastal bush, especially with tangled creepers. Nest suspended to drooping branch of leafy tree or shrub at edge of forest.	Locally common resident	1
Southern double-collared sunbird (*Cinnyris chalybeus*)	**Evergreen forest and bush**, Eucalyptus plantations, gardens.	Locally common to fairly common resident.	
Greater Double-collared Sunbird *(Cinnyris afer)*	Moist habitats with trees or tall scrub; *not into forests* – edge or top of canopy. Coastal, montane and riverine scrub, Protea savannah. Mountainous or hilly country. Afromontane and Valley Bushveld.	Common resident. **South African endemic**.	
White-bellied Sunbird *(Cinnyris talatala*)	Wide range of woodland and bush types – **moist woodlands**. Open savannah.	Common resident	3
Marico Sunbird *(Cinnyris mariquensis)*	*Acacia thornveld*. Woodlands dominated by Acacia. Aloe.	Common resident	
White-eyes			
Cape white-eye *(Zosterops capensis)*	Catholic choice of habitat: **Evergreen and coastal forests**, fynbos, riverine bush, thickets. Drainage lines. Wooded areas in grassland and alien plantations.	Very common resident and local migrant	5
Sparrows			
House Sparrow *(Passer domesticus)*	*Human dwellings.*	Very common resident, introduced	

Southern Grey-headed Sparrow *(Passer diffusus)*	Various woodland types: ***broadleaved and Acacia***. Alien tree populations.	Common to abundant resident and nomad	
Northern Grey-headed Sparrow *(Passer griseus)*	Diversity of *fairly open habitats* up to 2500m; commensal with man.		
Yellow-throated petronia (*Gymnoris superciliaris*)	*Broadleaved woodland and savannah.*	Mostly common resident	
Weavers			
Lesser Masked Weaver *(Ploceus intermedius)*	Acacia savannah, bushveld, dry woodland, **riverine trees,** usually near water. Forages mostly in canopies of trees and by probing flowers. Nests suspended from branch on inside or outside of tree, often over water up to 18m above ground. Sometimes also in reeds or low bushes. In small colonies of 10-20 nests.	Locally common resident	
Spectacled Weaver (*Ploceus ocularis*)	Tall woodland or other tall vegetation, edge of forest patches and in **riverine woodland** and thickets.	Fairly common resident.	1
Holub's Golden Weaver *(Ploceus xanthops)*	Rank vegetation, reeds and bushes along **streams and rivers**, forest edge.	Uncommon resident; possibly altitudinal migrant in Mozambique highlands.	3
Southern Masked weaver (*Ploceus velatus*)	Nests in reeds, bushes and trees **along watercourses**. Also, in trees near homesteads and in other vegetation away from water.	Common resident	6
Village weaver *(Ploceus cucullatus)*	Near water; different woodland vegetation types **along river valleys**. Open thornveld, but not in forests and treeless grasslands. Edges of riverine forests, usually near water. Wide range of woodland types along river valleys. Breeds in mesic savannah especially along rivers. Nesting colonies usually in large trees, 3-10m above ground, commonly overhanging water.	Very common resident	
Red-headed Weaver *(Anaplectes melanotis)*	Woodland, bushveld, savannah, usually **not far from water**. Forages off foliage. Nest attached to branch of tree, usually several meters from the ground.	Common to fairly common resident, summer breeding visitor to some areas	
Thick-billed weaver *(Amblyospiza albifrons)*	Forest types: **riparian forest**, reeds or bulrushes near forests. In breeding season at marshes, rivers, with rank grass, reedbeds and papyrus. Nest between two or more upright stems of bulrush, reeds or papyrus.	Resident but disperse widely after breeding	
Quelea			
Red-billed Quelea (*Quelea quelea*)	Most vegetation types. *Woodlands and grasslands*. Annual grasses and surface water.	Abundant nomad. Expanded range and increased in numbers.	10
Widows			
Fan-tailed Widowbird *(Euplectes axillaris)*	*Open moist grassland*, edges of vleis, rank grassy hillsides, marshes, edges of sugarcane fields.	Common resident; nomadic in winter	
White-winged Widowbird *(Euplectes albonotatus)*	*Woodland and grassland*: rank growth on the margins of open grassy areas, usually near water. Overgrown edges of cultivated areas. Seasonally inundated floodplains and tall grasslands.	Locally fairly common resident and nomad	
Red-collared Widowbird *(Euplectes ardens)*	*Mosaic of grass* and bush: typical of grassland with scattered trees or bushes.	Locally common resident and nomad	

Bishops			
Southern red bishop (*Euplectes orix*)	Primarily grassland birds: Nests in **reedbeds**. Rarely found far from water, strikingly absent from areas without permanent surface water. Found in areas cleared for cultivation. Typically, where there is access to perennial water. Nests in reeds, sedges, or bulrushes standing in water, usually 1-2.5m above water.	Very common resident and nomad. Artificial wetlands increased numbers. Common to abundant.	
Pytilia			
Green-winged Pytilia *(Pytilia melba)*	Acacia savannah; open <u>*grassland close to cover*</u>; mixed thorn and broadleaved savannah with thickets. Broadleaved woodland with grassy patches and thickets or thorny shrubs.	Fairly common resident	
Mannikin			
Bronze Mannikin *(Lonchura cucullata)*	Edge habitats; dependent on water. **Moist wooded areas.**	Very common resident	9
Red-backed Mannikin *(Lonchura nigriceps)*	**Riverine forest**, moist thickets, edges of coastal, lowland to midland evergreen forest, sometimes with tall grass.	Locally fairly common to common	
Firefinches & bluebills			
Red-billed Firefinch *(Lagonosticta senegala)*	Woodland, savannah, **riverine and thicket vegetation** – near water.	Common resident and nomad	1
African Firefinch (*Lagonosticta rubricata*)	Moist, wooded habitats. **Forest margins** and bracken-briar. Riverine forest, bush and thickets.	Common resident	6
Jameson's Firefinch *(Lagonosticta rhodopareia)*	Broadleaved woodlands – open grassy areas with **thickets; watercourses**. Rank grass, edges of thickets, secondary growth, cultivated lands, edges of riverine forest, bushy gullies and rocky hillsides.	Common resident.	
Waxbills			
Common Waxbill (*Estrilda astrild*)	Rank grasslands, reed beds, croplands, coastal estuaries, inland wetlands and dams, along ephemeral and **permanent rivers**.	Common resident	22
Blue Waxbill (*Uraeginthus angolensis*)	<u>*Arid thorn savannahs*</u>. Reliable on availability of surface water.	Common resident. No changes from past distribution; common	
Swee Waxbill *(Estrilda melanotis)*	Edges of **evergreen forests**, exotic plantations, gardens, bushy hillsides, farmyards, thick streamside bush.	Common resident; some seasonal altitudinal movement.	
Orange-breasted waxbill *(Amandava subflava)*	<u>*Tall-grass savannah*</u> at forest edge, secondary growth, villages and plantations.		
Indigobirds			
Village Indigobird *(Vidua chalybeata)*	Thorn savannah, edges of broadleaved woodland, **riverine scrub and woodland**.	Common nomad	
Dusky Indigobird *(Vidua funerea)*	Edge habitats. Savannah & open woodland. Edges of montane and **riverine forests**. Moist areas with forest.	Locally common nomad	

Whydahs			
Pin-tailed Whydah (*Vidua macroura*)	Wide range of open ***mesic habitats***. Edge habitats with man. Wetlands.	Very common resident and nomad	
Canaries			
Cape Canary *(Serinus canicollis)*	Broad spectrum of vegetation types: Grassland, fynbos, Karoo, woodland. Frequents "***waste" and "disturbed" ground.*** Fallow fields. Require trees or shrubs for breeding.	Very common resident and nomad	
Yellow-fronted Canary *(Crithagra mozambicus*)	Wide variety of woodland habitats: lightly wooded thornveld, moist broadleaved woodlands, along **river courses.** Avoid *Acacia* woodlands. Alien plantations.	Common resident	16
Streaky-headed Seedeater *(Crithagra gularis)*	Vegetation associated with ***mountains and hilly topography***: Fynbos, wooded valleys. Well-wooded areas; drier deciduous woodland and miombo. Avoids open grassland, arid *Acacia* woodland. Edges of evergreen forests and scrub on mountain slopes.	Fairly common resident and nomad	
Buntings			
Cinnamon-breasted Bunting *(Emberiza tahapisi)*	***Rocky ridges and hillsides***, eroding stony slopes and gullies, bare stony areas. Mountain sides, granite and dolerite outcrops with scattered bushes or trees, almost bare rocky and stony patches in woodlands on hills and plains, eroding stony slopes and gullies, dry watercourses. Nest placed in shallow scrape in ground at base of grass tuft, against rock or clod on rocky slope, on earth bank, in crevice in small rock face, on open stony ground, or among scattered rocks in a hollow.	Locally common resident	
Golden-breasted Bunting (*Emberiza flaviventris*)	Open broadleaved and mixed ***woodlands and savannah***.	Common resident	

Appendix 8: MAMMALS: Available habitat, expected occurrence and observed presence of mammal species during surveys (Friedman & Daly 2004; Child MF, et al 2016).

Mammals expected to occur in the available natural habitats of in the Low's Creek project area are listed below. The words in **bold font** represent qualifying habitat (preferred habitat), and *underlined italics* disqualifying habitat (the reason why the organism will not occur in the area). The shaded cells indicate the species likely to occur in the riverine habitat, and the number inside a cell gives the number of individuals or definite signs detected during surveys.

MAMMAL	HABITAT	Status (SA) Year assessed.	**Low's Creek**
Order: Insectivora			
Family: Soricidae			
Dark-footed forest shrew (*Myosorex cafer*)	Montane grasslands; wet sponges in mistbelt. Dense scrub and grass in damp areas fringing mountain streams. Moist densely vegetated habitat, *mountainous country*. Nest on bank of stream in heavy overhead cover of grass and undergrowth. Runways of vlei rats.	**SA Red Data (2016): Vulnerable.** IUCN 2016: Least concern. TOPS: None.	
Forest shrew (*Myosorex varius*)	*Highveld*: In moist, densely vegetated habitat; burrows under rocks and uses rodent/mole rat burrows. Dense grass along the banks of streams.	Least concern.	
Greater dwarf shrew (*Suncus lixus*)	Very little known of this species	Data deficient	
Least dwarf shrew (*Suncus infinitesimus*)	Commonly associated with termitaria. *Terrestrial*.	Intermediate	
Lesser dwarf shrew (*Suncus varilla*)	*Reliant on termite mounds.*	Data deficient	
Swamp musk shrew (*Crocidura mariquensis)*	**Moist habitats, thick grass along riverbanks**, in reedbeds and in swamp. Tangled masses of semi-aquatic grasses along fringes of water. Litter piles deposited by receding floods. Runways of vlei rats. Nests deep in clumps of tussock grasses on slightly raised patches of ground on fringes of swamp.	**SA Red Data (2016): Near threatened**. IUCN 2016: Least concern. TOPS: None.	
Tiny musk shrew (*Crocidura fuscomurina)*	All latitudes, **wide tolerance**. Terrestrial. Cover such as debris, fallen trees, wood piles or dense grass clumps.	Data deficient	
Makwassie musk (*Crocidura maquassiensis)*	*Subtropical/tropical dry*. Temperate, montane, grassland, rocky areas, coastal forests.	Vulnerable	
Reddish-grey musk shrew (*Crocidura cyanea*)	Dry terrain: Among rocks, in dense scrub and grass. Grassland and **thick shrub bordering streams.** Wet vleis with good grass cover.	Data deficient	
Greater red musk shrew (*Crocidura flavescens*)	Broken country with a dense cover of vegetation, areas of decaying leaf litter in damp places, thick undergrowth in vleis or **along the banks of streams**.	Least concern. Population trend: Unknown	
Lesser grey-brown musk shrew (*Crocidura silacea*)	Catholic in habitat requirements; **damp places.**	Data deficient	
Lesser red musk shrew (*Crocidura hirta*)	In damp situations **along rivers and streams**. Low bushes, dense undergrowth, piles of debris and fallen logs.	Data deficient	

Family: Pteropodidae			
Wahlberg's epauletted fruit bat (*Epomophorus wahlbergi*)	Tropical forests, penetrate up **river valleys** carrying evergreen riverine forests, mangrove forests, may be largely absent from densely forested areas; woodlands penetrating the rainforest zone, forests and forest edges in dryer savanna areas, deciduous woodland, woodland savannas (both wetter and drier miombo woodland as well as mopane woodland), thickets where there are fruit-bearing trees	IUCN (2015): Least concern. SA Red Data (2004): Least concern.	5
Peters's epauletted fruit bat (*Epomophorus crypturus*)	Evergreen forests in higher rainfall areas; evergreen **riverine forests** and forest edges in dryer savanna areas or in moist woodland where there are fruit-bearing trees. Populations exhibit considerable movements in search of food and may come into towns and feed on crops and fruit trees.	IUCN (2015): Least concern. SA Red Data (2004): Data deficient.	
Egyptian rousette (*Rousettus aegyptiacus*)	Almost all habitats. Totally dependent on the *presence of caves*. Roosts gregariously in caves. Distribution is influenced more by the availability of suitable roosting sites than vegetation associations. Rely on fruiting trees. Nomadic.	IUCN (2016): Least concern. SA Red Data (2004): Least concern.	
Family: Hipposideridae			
Percival's short-eared trident bat *(Cloeotis percivali)*	Savanna woodland. *Rest in caves*. Sufficient cover in the form of caves and mine tunnels for day roosting. Roost in narrow crevices. A clutter forages (in vegetation).	IUCN (2016): Least concern. **SA Red Data (2016): Endangered.** Very sensitive to disturbance.	
Sundevall's leaf-nosed bat (*Hipposideros caffer*)	Savanna woodland: Wide range of caves, sink holes and subterranean habitats (cavities); athropogenic roosts: mines and culverts. Colonies - dozen to hundreds. **Riparian locations**. Forage in and around thickets and well-developed undergrowth vegetation, avoiding open areas. Fly slowly through cluttered environment.	IUCN (2008): Least concern. SA Red Data (2016): Least concern.	
Family: Rhinolophidae			
Hildebrandt's horseshoe bat (*Rhinolophus hildebrandti*)	Savanna woodland; *roost in caves*, mines, disused buildings, cavities in rocks or large hollow trees	IUCN (2008): Least concern. SA Red Data (2004): Near threatened.	
Darling's horseshoe bat (*Rhinolophus darlingi*)	Woodland savanna: *Caves*, and amongst piles of loose boulders. It roosts in caves and subterranean habitats (mine adits) in medium-sized colonies. Also roosts in mine adits, medium-sized colonies, culverts.	IUCN (2008): Least concern. SA Red Data (2004): Near threatened. Population trend: Unknown.	
Geoffroy's horseshoe bat (*Rhinolophus clivosus*)	Savanna woodland: Forest fringes. Mountainous areas: Caves, rock crevices. **Riparian forests** and savanna woodlands. Temperate species. Riverine conditions and with well-watered terrain. Cave dweller. It roosts in caves and subterranean habitats (mine adits) in large colonies.	IUCN (2008): Least concern. SA Red Data (2004): Near threatened. Population trend: Unknown.	
Lander's horseshoe bat (*Rhinolophus landeri*)	Forests and savanna woodlands. **Riverine conditions** and with well-watered terrain. Cave dweller. Roost in caves, mine adits, and large hollow trees. Roost in small groups.	IUCN (2008): Least concern. SA Red Data (2004): Near threatened.	
Blasius horseshoe bat (*Rhinolophus blasii*)	Woodland; savanna: It roosts in *caves and subterranean habitats* (mine adits) in small groups.	IUCN (2016): Least concern. SA Red Data (2004): Vulnerable.	
Bushveld horseshoe bat (*Rhinolophus simulator*)	Savanna woodland; riparian forest and along **wooded drainage lines**. Dependent on substantial shelter in form of caves, small caverns in rocky outcrops, road culverts and mine adits. Roost in large groups.	IUCN (2008): Least concern. SA Red Data (2004): Least concern.	

Family: Emballonuridae			
Mauritian tomb bat (*Taphozous mauritianus)*	Savanna woodlands: open habitats, avoiding closed forests. Vertical surfaces of tree trunks, rock faces - in shade. **Dependent on surface water**.	IUCN (2008): Least concern. SA Red Data (2004): Least concern.	
Family: Nycteridae			
Egyptian slit-faced bat (*Nycteris thebaica*)	Open savannah woodland; karoo; avoids open grassland (plateau grasslands). Roosts during day: caves, hollow large trees or holes in the ground. *Caves (not deep) and subterranean habitats (aardvark burrows)*; temperate savanna and shrubland. Man-made structures: culverts under roads. Forages low above ground - susceptible to predation by owls, thus need tree cover.	IUCN (2008): Least concern. SA Red Data (2004): Least concern.	
Family: Molossidae			
Little free-tailed bat *(Chaerephon pumilus)*	Wide range of habitats. Lowveld and coastal areas, rarely above 1000m. Savanna, mountainous and arid areas. *Rocky environment* with an abundance of crevices. Narrow cracks in rocks and trees. Roosts: Crevices in trees, rocks or roofs. Gregarious.	IUCN (2014): Least concern. SA Red Data (2004): Least concern.	
Angola free-tailed bat *(Mops condylurus*)	**Catholic in habitat requirements**. Narrow crevices in rock faces and caves; hollows in trees.	IUCN (2008): Least concern. SA Red Data (2004): Least concern.	
Egyptian free-tailed bat (*Tadarida aegyptiaca*)	Open grassland: Roosts during day in rock crevices, exfoliating rocks, caves, hollow trees, behind loose bark of trees. Fly well above the canopy of the vegetation. Vegetation no influence but avoid forests. Desert, semi-arid scrub, savanna, grassland and agricultural land. Areas with **permanent water bodies**. Roosting in buildings, roofs of houses.	UCN (2008): Least concern. SA Red Data (2004): Least concern.	
Family: Vespertilionidae			
Natal long-fingered bat (*Miniopterus natalensis*)	Temperate of sub-tropical. Savannas and grassland. *Cave dependent* - winter hibernacula (at cooler and at higher altitudes) and summer maternity roosts. Availability of suitable roosting sites may be more critical than surrounding vegetation. Breeding strongly seasonal and varies in latitude. Females migrate between caves up to 150 km, congregate at maternity roosts.	IUCN (2016): Least concern. SA Red Data (2016): Least concern.	
Lesser long-fingered bat (*Miniopterus fraterculus*)	Temperate species. *Montane grassland of escarpment*. Cave dweller: Caves and subterranean habitats. Wide range of vegetational association.	IUCN (2008): Least concern. SA Red Data (2004): Near threatened.	
Welwitsch's myotis (*Myotis welwitschii*)	*Savanna woodland*; Mountains covered with woodland or woodland forest, sparsely distributed. Furled banana leaves hanging in bushes.	IUCN (2008): Least concern. SA Red Data (2004): Near threatened.	
Temminck's myotis (*Myotis tricolor*)	Savannah woodland, dry and moist savanna; mountainous areas: *Gregariously cave dweller*-availability govern distribution. Mediterranean-type shrubby vegetation. Possible also in tropical moist forest. The species roosts in caves and abandoned mines. It appears to prefer larger caves that are relatively undisturbed, usually ones that contain large pools of water.	IUCN (2008): Least concern. SA Red Data (2004): Near threatened. This is a common species with colonies often consisting of thousands of animals.	
Kuhl's bat (*Pipistrellus kuhlii*) = Dusky pipistrelle (Pipistrellus hesperidus)	Diverse habitats: well-watered terrain. **Streams and rivers**. Vertical narrow cracks in rocks.	IUCN (2016): Least concern. SA Red Data (2004): Least concern.	
Rusty pipistrelle (*Pipistrellus rusticus*)	Savanna woodland: **riverine associations and open water bodies**; mopane woodland with rocky habitat. Crevices and hollows in trees.	IUCN (2008): Least concern. SA Red Data (2004): Near threatened.	

Yellow-bellied house bat (*Scotophilus dinganii*)	Savanna woodland & mixed bushland; coastal forests; lower altitudes: Narrow crevices, holes and in hollow trees. **Tied to presence of trees**. Avoid open habitat - grassland and karoo scrub.	IUCN (2008): Least concern. SA Red Data (2004): Least concern. There appear to be no major threats to this species.	
Green house bat (*Scotophilus viridis*)	Low-lying, hot savannas, avoiding open habitats such as grasslands. Savannah woodland: **riverine conditions**. Roost in variety of shelters, including holes in trees and roofs of houses.	IUCN (2016): Least concern	
Cape serotine *(Neoromicia capensis*)	Very broad habitat tolerance, from forest to desert. Abundant in low-lying hot savannas; from arid semi-desert to montane grasslands, forests: **Under bark of trees**, base of aloe leaves. Crevices in rocks. Suburban situations - under roofs of houses.	IUCN (2014): Least concern. SA Red Data (2004): Least concern.	
Banana bat *(Neoromicia nana*)	Forest and woodland savanna; well-wooded habitats - **riparian vegetation**; forest patches in proximity of water: Near bananas or Strelitzia trees, rolled-up terminal leaves of banana plants; Also other leaves.	IUCN (2014): Least concern. SA Red Data (2004): Least concern.	
Schlieffen's twilight bat (*Nycticeinops schlieffeni*)	Low-lying savannah woodland: well-wooded places such as riparian vegetation **along rivers and drainage lines;** not in forests. Roosts in crevices in trees.	IUCN (2008): Least concern. SA Red Data (2004): Least concern.	
Family: Lorisidae			
Thick-tailed bush baby (*Otolemur crassicaudatus*)	Forests, thickets and well-developed woodland. Penetrate into dry terrain in **riverine forests** and woodland. During the day - in the thick foliage of trees.	Least concern	1
Southern lesser bushbaby (*Galago moholi*)	Woodland: Nocturnal; arboreal – holes in trees, thick foliage, disused bird nests. *Degraded open forest*	Least concern	
Family: Cercopithecidae			
Chacma baboon (*Papio ursinus*)	Widespread, diurnal: At night - Cliffs & **high trees**	Least concern	
Vervet monkey (*Cercopithecus aethiops*)	Woodland, diurnal: At night – **Heavy foliage in high trees**, rocky cliffs	Least concern	8
Family: Protelidae			
Aardwolf (*Proteles cristatus*)	Savannah woodland and in *scrub, grassland*. Open country, nocturnal, and solitary. Rests in hole in ground. Independent on water. Dependant on availability of termites.	Least concern	
Family: Hyaenidae			
Brown hyaena *(Parahyaena brunnea*)	Semi-desert, *open scrub and open woodland savanna*. Nocturnal, holes in ground.	**IUCN 2015: Near threatened; SA Red Data (Child 2016): Near threatened; NEMBA (TOPS 2007): Protected species.** Population trend: Decreasing.	
Spotted hyaena *(Crocuta crocuta*)	*Open savanna plains*	**NEMBA (TOPS 2015): Protected species.**	
Family: Felidae			
Leopard (*Panthera pardus*)	Widespread. Broken country or **forests**. Nocturnal & solitary.	**IUCN (2016): Vulnerable. SA Red Data (Child 2016) Vulnerable. NEMBA (TOPS 2015): Protected species.** Population trend: Decreasing.	

Lion (*Panthera leo*)	*Availability of prey.*	**IUCN (2012): VU Vulnerable. NEMBA (TOPS 2015): Vulnerable species**	
Caracal (*Felis caracal*)	Widespread – *open scrub & woodland*, open vleis and open grassland. Nocturnal & solitary. Litters born in holes in ground.	Least concern	
African wild cat (*Felis silvestris cafra)*	Widespread – Wide habitat tolerance. Rocky hillsides, **under bush, reed beds**, stands of tall grass. Litters born dense underbrush or other substantial cover.	Least concern	
Serval *(Leptailurus serval*)	Proximity to **water essential requirement**, coupled with availability of adequate cover; tall grass, underbrush or reed beds - during day. Wet grassland, vleis and reed beds.	**IUCN (2016) Least concern. SA Red Data (Child 2016): Near threatened; NEMBA (TOPS 2015): Protected species.** Population trend: Stable.	
Family: Canidae			
Wild dog (*Lycaon pictus*)	*Resident prey* and permanent water	**NEMBA (TOPS 2015): Endangered species; IUCN 2012: EN Endangered**	
Side-striped jackal (*Canis adustus*)	Savanna and well-watered conditions; tall grass. *Open forest*; savannah.		
Black-backed jackal (*Canis mesomelas*)	Widespread. Wide habitat tolerance. *Open terrain*. Litters born in holes in ground.	Least concern	
Family: Mustelidae			
Cape clawless otter (*Aonyx capensis*)	**Predominantly aquatic**; freshwater an essential requirement: Rivers, lakes, swamps and dams. Widespread. Tributaries of rivers into small streams - habitat with food. Litters born in holes in banks of rivers. Estuarine and sea water.	**IUCN (2016): NT Near-threatened; SA Red Data (Child 2016): Near-threatened; NEMBA (TOPS 2007): Protected species;** Population trend: Stable.	
Spotted-necked otter (*Hydrictis maculicollis*)	**Aquatic, confined to larger rivers**, lakes, swamps and dams with extensive areas of open water. Stay close to water edge. Lie up in holes of riverbanks, in rock crevices or in dense reed.	**IUCN (2016): NT Near-threatened; SA Red Data (Child 2016): Vulnerable; NEMBA (TOPS 2007): Protected species;** Population trend: Decreasing.	
African striped weasel (*Poecilogale albinucha*)	Savannah: Moist *grassland*. Litters born in burrows.	**SA Red Data 2016: Near threatened;** NEMBA (TOPS) 2016: None. IUCN, 2016: Least concern.	
Striped polecat (*Ictonyx striatus*)	Widespread. Wide habitat tolerance. *Scrub cover, open grassland*, and savannah woodland. Holes in the ground.	Least concern	
Honey badger (*Mellivora capensis*)	Widespread. Not in desert. Use crevices in rocky areas, will also dig refuges. Rocky koppies, scrub sandveld, open grassland, *open woodland*, riverine woodland and floodplain grassland.	**NEMBA (TOPS) 2007: Protected species.** IUCN (2014) Least concern. SA Red Data (Child 2016): Least concern. Population trend: Decreasing.	

Family: Viverridae			
Small-spotted genet (*Genetta genetta*)	Widespread. Open arid: *Woodland, open scrub* and dry grassland or dry vlei areas. Trees. Nocturnal – nests in holes in the ground or in hollow trees.	Least concern	
Large-spotted genet (*Genetta tigrina*)	**Better watered parts**: Woodland, open scrub and dry grassland or dry vlei areas. Trees. Nocturnal – nests in holes in the ground or in hollow trees.	Least concern	
African civet (*Civettictis civetta*)	Widely distributed – forest and woodland where **water is available**. Nocturnal & solitary. Litters born in holes or **dense underbrush**.	Least concern	
Slender mongoose (*Galerella sanguinea*)	Widespread. *Open areas*. Underbrush or holes in the ground, holes in termitaria.	Least concern	
White-tailed mongoose (*Ichneumia albicauda*)	Savannah woodland: **Well-watered areas**. Not in desert, semi-desert or forest.	Least concern	
Water mongoose (*Atilax paludinosus*)	**Well-watered terrain**: Rivers, streams, marshes, swamps, wet vleis, dams and tidal estuaries - adequate cover of reed beds or dense stands of semi-aquatic grasses. Coastally in mangrove swamps in brackish water.	Least concern	2
Selous' mongoose (*Paracynictis selousi*)	*Open country*, frequenting vleis, floodplain and grasslands.	Data deficient	
Large grey mongoose / Egyptian mongoose (Herpestes ichneumon)	On **fringes of rivers, swamps**, lakes and dams. Riverine under bush or reed beds.	Least concern	
Banded mongoose (*Mungos mungo*)	Wide habitat tolerance. Essential habitat requirement: woodland, under bush, substrate detritus such as fallen logs and other vegetable debris. *Acacia woodland*.	Least concern	
Dwarf mongoose (*Helogale parvula*)	Widespread. Dry open woodland and on grassland where there is substrate litter and *termitaria*. Lives in permanent holes – termitaria, burrows deeply.	Least concern	
Family: Elephantidae			
African elephant (*Loxodonta africana*)	All vegetation types. *Open forests.*	**IUCN (2010): Vulnerable. NEMBA (TOPS 2015): Protected species;** SA Red Data: Least concern	
Family: Rhinocerotidae			
Southern white rhinoceros (*Ceratotherium simum*)	*Savanna habitats*: Well-watered undulating open woodland with abundant grass.	**IUCN (2014): NT Near-threatened. NEMBA (TOPS 2015): Protected species.** Population trend: Decreasing	
Family: Orycteropodidae			
Aardvark (*Orycteropus afer*)	Widespread. Wide habitat tolerance. *Open woodland*, scrub and grassland. Nocturnal. Lives in extensive burrows.	IUCN (2014) Least concern; SA Red List 2016: Least concern; NEMBA (TOPS 2015): None.	

Family: Procaviidae			
Rock dassie (*Procavia capensis*)	Widespread where there is rocky habitat. ***Outcrops of rock*** – rocky crevices. Krantzes, rocky koppies, hillsides, piles of loose boulders – accompanied with bushes and trees to provide browse. Crannies and crevices provide shelter. Granite formations with piles of huge boulders, from which overlying soil has been washed away. Sandstone krantzes with loose, rocky, overhanging slabs. Erosion gulleys.	Least concern	
Family: Suidae			
Bushpig (*Potamochoerus larvatus)*	Forests, thickets, **riparian underbrush, reed beds** or stands of tall grass where there is water. Nests of grass in secluded places. Linear forest (DRC).	Least concern	1
Warthog (*Phacochoerus africanus)*	*Open areas* of grassland, floodplain, vleis and around waterholes and pans. Deserted antbear holes. Linear forest.	Least concern	
Family: Hippopotamidae			
Hippopotamus (*Hippopotamus amphibius*)	Suitable deep, open, permanent water (deep enough to allow it to submerge totally) with gently sloping sandbanks must be available and **adjacent food supplies**. Open stretches of permanent water. Temporary resting places during flooding in oxbows or up in tributaries of major rivers.	**IUCN (2014): VU Vulnerable.**	2
Family: Giraffidae			
Giraffe (*Giraffa camelopardalis*)	Most *savanna habitats*.		
Family: Bovidae			
Blue wildebeest (*Connochaetes taurinus*)	Open short grass plains or lightly wooded *open savanna habitats*.	IUCN (2014) Least concern; SA Red List 2016: Least concern; NEMBA (TOPS 2007): None.	
Tsessebe (*Damaliscus lunatus*)	Ecotone of *woodland and grassland* where water is available	**NEMBA (TOPS 2015): Protected species.** IUCN (2014): Least concern	
Cape common duiker (*Sylvicapra grimmia grimmia*)	Widespread. Presence of bush. *Woodland* with ample under bush, grassland of medium and tall grass. Rest in bushes or tall grass.	Least concern	
Red duiker (*Cephalophus natalensis)*	Forest, dense thickets, **thickly wooded ravines** and dense coastal bush where there is surface water.	IUCN Least concern	1
Klipspringer (*Oreotragus oreotragus*)	Restricted to *rocky areas*. Mountainous areas with krantzes, rocky hills or outcrops, extensive areas of rocky koppies, gorges with rocky sides. Rocky shelter and steep rock faces. Boulder-strewn riverbeds.	Least concern	
Steenbok (*Raphicerus campestris)*	Widespread. *Open country*: Open grassland with stands of tall grass, scattered bushes or scrub and forbs. Avoid densely wooded areas.	Least concern	
Sharpe's grysbok (*Raphicerus sharpei)*	*Open forest.* Thick woodland, riverine forest, thick bush and broken country with bush cover.	**NEMBA (TOPS 2015): Protected species; IUCN Least Concern**	
Impala (*Aepyceros melampus*)	*Woodland savanna*: Widespread in light open woodland – surface water.	Least concern	
Sable antelope (*Hippotragus niger niger*)	*Open woodland*. Areas with a well-developed field layer. Dependent on the availability of water.	**NEMBA (TOPS 2015): Vulnerable species**	
Cape buffalo (*Syncerus caffer*)	All habitats with a plentiful supply of *grass*, shade and water.	Least concern	

Kudu (T*ragelaphus strepsiceros*)	Widespread in *savanna woodland*. Areas of broken, rocky terrain with woodland cover & open water.	Least concern	
Nyala (*Tragelaphus angasii*)	Dry savanna woodland with mosaic of open ground, **thickets and woodland**.	Least concern	
Bushbuck (T*ragelaphus scriptus*)	Riverine and **thickets near water**.	Least concern	1
Eland (*Taurotragus oryx*)	*Arid semi-desert* areas as well as better-water environments, montane situations and in various types of woodland. Avoid forests and open grasslands	Least concern	
Grey rhebok (*Pelea capreolus*)	*Rocky hills*, rocky mountain slopes and mountain plateau with good grass cover.	Least concern	
Reedbuck (*Redunca arundinum*)	*Open water* with cover; stands of tall grass or reed beds	TOPS NEMBA (2007): Protected.	
Mountain reedbuck (*Redunca fulvorufula*)	Dry, *grass-covered*, stony slopes of hills and mountains; some form of trees and bushes	Least concern	
Waterbuck (*Kobus ellipsiprymnus*)	Savanna habitats with medium and tall grass in the **close proximity of water**.	Least concern	
Order: Manidae **Family: Pholidota**			
Temminck's ground Pangolin (*Smutsia temminckii*)	Wide habitat tolerance, *absent from forests*. Day – piles of leaves or other vegetable debris, holes in the ground	**IUCN (2016) Vulnerable. SA Red Data (Child 2016): Vulnerable. NEMBA (TOPS 2015): Vulnerable species.** Population trend: Decreasing.	
Order: Rodentia			
Family: Hystricidae			
Cape Porcupine *(Hystrix africaeaustralis)*	Widespread: All types of country apart from swampy areas, very moist forests and barren desert areas. Nocturnal. Shelter - resting in caves, rock cavities, holes in ground. *Absent from forest*. Use abandoned antbear and other types of holes in the ground or lie up under the roots of trees exposed by erosion.	Least concern	
Family: Sciuridae			
Tree squirrel (*Paraxerus cepapi*)	Widespread in woodland: Savanna woodland including a wide variety of *woodland types*. Trees with suitable nest holes are favoured. Diurnal – resting in holes in trees.	Least concern	
Family: Thryonomyidae			
Greater Canerat *(Thryonomys swinderianus)*	Forest belts and open woodland wherever there is tall and matted grass or reeds growing in damp or wet places. **Reed beds** or areas of dense tall grass with thick reed or cane-like stems. In vicinity of rivers, lakes and swamps - never found far from water. Resting place densest part of reed bed. Cover - matted tussock grasses, holes in stream banks, under root systems of trees adjacent to grass and reeds. Use existing holes or simply use matted vegetation.	Least concern	3

Family: Bathyergidae			
Common Molerat *(Cryptomys hottentotus)*	*Loose sandy soils to stony soils and hills* to montane and escarpment conditions. Tendency to loose sandy soil - especially alluvial soils along major rivers and streams. Karroid veldtypes, coastal rhenoster bushveld, coastal forests, thornveld, mopaneveld, savanna and pure grassveld, as well as temperate and transitional forests, scrub and bushveld.	Least concern	
Family: Cricrtidae			
Bushveld gerbil (Gerbilliscus leucogaster)	Widespread – Survives regardless of vegetation type or degree of cover present, having been recorded in open grasslands, *Acacia woodland or scrub*, and mopane woodland. Commonly encountered on old, cultivated lands. Occur on hard ground but prefer light sandy soils or sandy alluvium.	Data deficient	
Highveld Gerbil *(Gerbilliscus brantsii brantsii)*	Widespread – light sandy soils or sandy alluvium substrate with some scrub or grass cover. Peaty soils around *marshes and pans*. Prefer sandy soils, irrespective of the type of vegetation cover. Nocturnal – lives in burrows under low bushes	Least concern	
Vlei Rat Fynbos type *(Otomys irroratus)*		Least concern	
Angoni Vlei Rat *(Otomys angoniensis)*	Savanna woodlands and grasslands – in drier areas in wet vleis, swamps and swampy areas along rivers. **Fringes of rivers with reed beds**, sedges and semi-aquatic grasses. Nests in tussock grass near permanent water; above water level on raised ground.	Least concern	
Laminate Vlei Rat *(Otomys laminatus)*	Tied to moist habitats - *grasslands in submontane* and coastal areas.	**SA Red Data (2016): Near threatened. Endemic.**	
Family: Muridae			
Mesic four-striped mouse (*Rhabdomys dilectus*)	Widespread – *grass cover*: Diurnal – burrows under grass. Wide variety of habitat types (broad niche species). Prefers grassland, habitat includes bushy and semi-dry vlei country as well as dry riverbeds, high grassveld areas, the edges of forests and the bases of hills.	Least concern	
Water Rat *(Dasymys incomtus)*	Wet habitat: **Streams, rivers**, reed beds, swamps and is partially aquatic. Long grass close to water, semi-aquatic grasses, in swampy areas along rivers and streams, or in in grassy or bracken covered areas close to water. Between reeds and among rotting vegetation. Fringes of marshes and backwaters. Nest: Constructed in a depression on the sloping ground bordering the swampy edge of the river.	**SA Red Data (Child 2016): Near threatened; IUCN (2016):** Least concern. Population trend: Unknown.	
Pouched mouse (*Saccostomus campestris*)	Widespread and catholic, wide habitat tolerance: In burrows, sandy soil or sandy alluvium, open short grass fringes of pans, rocky koppies, fringes of **lowland forests**. Exclusively terrestrial, predominantly solitary and nocturnal.	Least concern	
Grey climbing mouse (*Dendromus melanotis*)	*Grassland with high grass.*		
Chestnut climbing mouse (*Dendromus mystacalis*)	*Grassland with high grass.*		
Brant's climbing mouse (*Dendromus mesomelas*)	**Tall grass or rank vegetation near water.**	Least concern	

Fat mouse (*Steatomys pratensis*)	Grassland and savannas over sandy soils or sandy alluvium. On sandy ground in scrub or in sandy alluvium on the fringes of swamps, **streams and rivers**. Open woodland and abandoned cultivated lands.	Least concern	
White-tailed mouse (*Mystromys albicaudatus*)	*Highveld and montane grassland*. Nocturnal – lives in burrows or cracks in the ground. Sandy soil with good cover.	**IUCN (2008): EN Endangered; SA Red Data (Child 2016): Vulnerable. NEMBA (TOPS 2007): None.** Population trend: Decreasing.	
Tete Veld Rat *(Aethomys ineptus)*	**Check:** Widespread – Grassland *with open shrub association*, open woodland, fringes of pans. Temperate grassland and savanna: Rocky crevices and piles of boulders. Sandy ground or sandy alluvium, or hard ground – holes or rock crevices and piles of boulders.	Least concern	
Bushveld Namaqua rock mouse *(Micaelamys namaquensis subsp. alborarius)*	Widespread – where there are *rocky koppies, outcrops* or boulder-strewn hillsides - preferred areas. Cracks and rock crevices of rocky koppies or outcrops (prefers crevices and does not burrow), or on piles of stones in the veld, low lying ridges and stony country and is often plentiful in old ruins.	Least concern	
Acacia rat *(Thallomys paedulcus)*	*Acacia woodland*: Living in crevices in the trunks, under loose strips of bark or in holes in the ground between the roots of the tree (Especially Acacia). Nocturnal.	Least concern	
Single-striped Mouse *(Lemniscomys rosalia)*	Savanna woodland to *dry open scrub*. Common factor: Grassland - excavates burrows under the cover of matted grass.	Data deficient	
Southern multimammate mouse (*Mastomys coucha*)	Wide habitat tolerance (pioneer species - drought, burn, ploughing), fond of *grassland* where there is some cover of low scrub. In dry watercourses or fringes of swamps. In riverine associations running westwards into arid country. Frequents the fringes of pans where there are calcareous outcrops nearby.		
Multimammate mouse *(Mastomys natalensis)*	Wide habitat tolerance (pioneer species - drought, burn, ploughing), from sea level to high-lying ground, absent from arid areas: Fond of *grassland* where there is some cover of low scrub.		
Woodland mouse (*Grammomys dolichurus*)	Predominantly arboreal: in forests and **thickets, usually in damp places**; constructs nests of grass or leaves in dense underbrush	Least concern	
Pygmy Mouse *(Mus minutoides)*	In all types of vegetation. Wide variety of habitats. Nocturnal and terrestrial, not communal. Fairly damp country where there is *high grass, bush or other cover*. Makes its own burrows in soft ground. Normally finds shelter under piles of debris, fallen tree trunks/logs and similar type of cover, also boulders or holes in termite mounds.	Least concern	
Family: Gliridae			
Rock Dormouse *(Graphiurus platyops)*	*Rocky terrain*. A rock-frequenting dormouse. Near or on rocky outcrops. In association with dassies. Also, dry scrub thickets or dry riverbeds, frequenting trees when no rocks available. Live in rock crevices, under exfoliation of granite bosses and in piles of boulders.	Data deficient	
Woodland Dormouse *(Graphiurus murinus)*	Widespread in woodland. *Wooded areas*. Large trees provide holes for shelter. Live in holes in trees or under loose bark.	Least concern	

Family: Leporidae			
African savanna hare (*Lepus victoriae*)	Savannah woodland and in scrub, tall grass. Absent from forest, desert and open grass*. Open forest, savanna.*	Least concern	
Hewitt's red rock rabbit (*Pronolagus saundersiae*)	*Top of rocky outcrops*	Least concern	
Natal red rock rabbit *(Pronolagus crassicaudatus)*	*Rocky habitat*: Rocky terrain or boulder-strewn areas – rest deep in rock crevices	Least concern	
Family: Macroscelididae			
Rock elephant shrew (*Elephantulus myurus*)	*Rocky areas*: Rocky koppies or piles of boulders – sufficient holes crannies and crevices in rocks for shelter. Absent on granite domes. Needs broken and exfoliated granite. Prefer rocky habitat with overhanging ledges or vegetation. Cover from aerial predation. Keep to shady cover of overhanging rocks or bushes/trees.	Least concern	

Appendix 9: Ecological Water Requirements (obtained from IWR Water Resources report, 2020)

Summary of IFR rule curves for: Lows Creek Dam
Regional Type: Lowveld
EWR = B

Data are given in m^3/s mean monthly flow.

Month % Points

Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.154	0.147	0.132	0.109	0.081	0.058	0.043	0.036	0.033	0.033
Nov	0.203	0.195	0.177	0.147	0.110	0.075	0.052	0.041	0.038	0.038
Dec	0.479	0.395	0.316	0.236	0.138	0.091	0.063	0.051	0.050	0.050
Jan	0.336	0.296	0.253	0.200	0.131	0.087	0.059	0.048	0.048	0.048
Feb	1.298	1.048	0.822	0.600	0.327	0.208	0.137	0.108	0.104	0.104
Mar	0.401	0.384	0.348	0.287	0.212	0.142	0.095	0.073	0.067	0.067
Apr	0.266	0.254	0.228	0.186	0.138	0.097	0.070	0.058	0.054	0.054
May	0.229	0.217	0.192	0.154	0.113	0.080	0.060	0.050	0.047	0.047
Jun	0.228	0.217	0.195	0.160	0.120	0.086	0.064	0.052	0.047	0.046
Jul	0.196	0.185	0.164	0.133	0.099	0.071	0.054	0.045	0.041	0.040
Aug	0.170	0.162	0.145	0.120	0.091	0.066	0.049	0.041	0.037	0.036
Sep	0.151	0.144	0.128	0.104	0.077	0.056	0.043	0.037	0.035	0.034

Reserve Flows without High Flows

Oct	0.130	0.124	0.112	0.093	0.070	0.051	0.039	0.033	0.031	0.031
Nov	0.127	0.122	0.112	0.094	0.073	0.053	0.039	0.033	0.031	0.031
Dec	0.153	0.146	0.132	0.108	0.081	0.057	0.042	0.037	0.036	0.036
Jan	0.182	0.175	0.160	0.134	0.100	0.069	0.049	0.041	0.041	0.041
Feb	0.299	0.285	0.256	0.208	0.152	0.104	0.075	0.063	0.062	0.062
Mar	0.279	0.268	0.244	0.203	0.153	0.107	0.075	0.060	0.056	0.056
Apr	0.266	0.254	0.228	0.186	0.138	0.097	0.070	0.058	0.054	0.054
May	0.229	0.217	0.192	0.154	0.113	0.080	0.060	0.050	0.047	0.047
Jun	0.228	0.217	0.195	0.160	0.120	0.086	0.064	0.052	0.047	0.046
Jul	0.196	0.185	0.164	0.133	0.099	0.071	0.054	0.045	0.041	0.040
Aug	0.170	0.162	0.145	0.120	0.091	0.066	0.049	0.041	0.037	0.036
Sep	0.151	0.144	0.128	0.104	0.077	0.056	0.043	0.037	0.035	0.034

Natural Duration curves

Oct	0.347	0.273	0.220	0.209	0.202	0.190	0.183	0.161	0.153	0.108
Nov	0.984	0.532	0.440	0.359	0.278	0.239	0.216	0.197	0.162	0.123
Dec	1.378	0.982	0.668	0.553	0.426	0.332	0.280	0.235	0.202	0.127
Jan	2.053	1.191	0.803	0.642	0.534	0.448	0.347	0.302	0.228	0.149
Feb	2.720	1.517	1.000	0.628	0.550	0.438	0.343	0.285	0.256	0.136
Mar	1.777	0.963	0.728	0.609	0.463	0.399	0.299	0.261	0.220	0.153
Apr	1.161	0.806	0.617	0.544	0.478	0.390	0.297	0.255	0.220	0.147

May	0.717	0.612	0.493	0.463	0.377	0.321	0.258	0.224	0.198	0.134
Jun	0.637	0.459	0.421	0.363	0.336	0.285	0.239	0.212	0.193	0.131
Jul	0.459	0.366	0.321	0.280	0.261	0.235	0.217	0.190	0.175	0.123
Aug	0.355	0.299	0.250	0.235	0.220	0.209	0.198	0.183	0.157	0.112
Sep	0.309	0.243	0.228	0.216	0.208	0.201	0.197	0.174	0.150	0.116

APPENDIX 4.5.4:
FISHWAY DESIGN REPORT

LOUW'S CREEK DAM, MPUMALANGA

FISH MIGRATION REQUIREMENTS & FISHWAY CONCEPTUAL DESIGN REPORT

Prepared for:

MBB Consulting Engineers, Nelspruit

EnviRoss CC

Report authors: Dr M Ross (*Pr Sci Nat*), Dr T Ross

EnviRoss CC Report Ref:Enviross_LouwsCreek_Fishway_202103
Date: MARCH 2021
Version: 1ST DRAFT

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Declaration

<u>PROJECT:</u> LOUW'S CREEK DAM, MPUMALANGA: Fish Migration Requirements & Fishway Design Report.

We, the undersigned, declare the findings of this report free from influence or prejudice.

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1.Introduction & Background

An irrigation storage dam with an impoundment structure measuring approximately 10 m high has been proposed on Low's Creek, which will create a barrier to fish movement within the system.

The proposed design drawings of the impoundment structure and other site-related features, together with a river yield analysis and an extract of the aquatic specialist report that detailed the findings of the fish survey undertaken for the project have all been presented for review.

Enviross has been commissioned to provide a conceptual model design for a fishpass facility that would allow for freedom of movement for migratory fish within the river reach associated with the development site.

No site survey was undertaken by Enviross. The conceptual model and site interpretations are therefore based on data provided by a third party and background information available for the site.

2.Scope of Work

The Scope of Work was to review all the provided as well as other available data associated with the proposed dam development site to gain an understanding of the site conditions and the fish species that would be impacted by the proposed development.

The interpretation of the site and the target fish communities allow for the development of an appropriate style of fishpass.

Taking all of that information into consideration, a conceptual fishpass model was to be developed that would allow for ongoing ecological sustainability of the fish that are found within the river reach.

3.Assumptions & Limitations

The conclusions to overall perceived impacts have been based on a desktop survey that was reiterated by review of reports and data of a third party.

EnviRoss CC did not undertake any baseline data collection and no field survey was not undertaken. No verification of the field and site data that are presented for analysis was therefore undertaken.

The various factors to consider when designing a fishway requires a combination of biological and engineering knowledge. Although engineering aspects are alluded to within this report, it should be noted that the primary focus of the consultants at EnviRoss CC is ecological.

Engineering discussion points are included that are based on a general knowledge and experience gained through similar projects and ongoing interaction with engineers.

All drawings and engineering concepts that are contained within this report are not considered final until they have been reviewed by suitably-qualified engineers and EnviRoss CC cannot be held responsible for the structural integrity of engineering features or the risks associated with development of features that are not structurally sound.

4.Importance of Lows Creek to Fish & Habitat

Low's Creek is a is regarded as one of the headwater streams of the Crocodile River. It's confluence with the Kaap River falls within the quaternary catchment of X23H, which then later confluences with the Crocodile River within the quaternary catchment of X24C. It is a seasonal to semi-permanent stream that would provide valuable breeding and refuge habitat for fish species found within the river reach, some of which are regarded as obligatory migratory species (those species that the ability to migrate and located suitable seasonal breeding habitat is important to their survivability).

From the habitat accounts provided by the extract of the aquatic specialist survey (Deacon, 2020), Low's Creek does indeed offer suitable habitat and is regarded as an important stretch of river contributing to maintenance of the overall ecological health of the fish species within the system.

A species of provincial conservational significance, namely *Opsaridium peringueyi* (Southern barred minnow), listed as Vulnerable within Mpumalanga, is known from the system.

Although this species was not observed during the aquatic specialist survey (Deacon, 2020), Low's Creek does provide for suitable breeding habitat for this species. Dietary preferences of this species are indicated as aquatic invertebrate species from the Chironomidae and Simuliidae families in particular (Skelton, 1996). The habitat within the Low's Creek is conducive to supporting these prey species as well.

5.Target Fish Species

A specialist aquatic ecological survey has been undertaken by Dr Andrew Deacon during November 2020 as part of the requirements for the ecological authorization process associated with the proposed development. An extract of the report detailing those sections relevant to the aquatic habitat features associated with the river reach and the fish species that were surveyed during that period was provided by the Client.

It is not feasible to sample all of the fish species present within a particular river reach during a single sampling survey, and therefore the expected fish species list as per the DWS FROC (Fish Frequency of Occurrence) for various reference sites throughout South Africa is used to allow for the understanding of the fish diversity within the reach.

The FROC data is then used to populate the Ecostatus FRAI (Fish Response Assessment Index) (DWS, 2007), which provides an outline of the migrational importance of each species (Table 1).

The species data indicates that the river reach associated with the proposed dam does indeed support fish species that require migrational freedom to complete a certain stage within their life cycle, and that these species make up the majority of the species community structure.

Table 1: A reference list of expected fish species applicable to the river reach, together with an importance rating of providing migrational freedom (*taken from* Deacon, 2020).

Fish Species	Migration potential
Migration critical (4-5):	
Longfin eel *(Anguilla mossambica)*	5: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Largescale yellowfish *(Labeobarbus marequensis)*	5: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Orangefin barb *(Enteromius eutaenia)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal. Migrate into floodplains & seasonal rivers confirmed.
Longbeard barb *(Enteromius unitaeniatus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal. Migrate into floodplains & seasonal rivers confirmed.
Beira barb *(Enteromius radiatus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal). Swim upstream into seasonal rivers confirmed/shoals of adults.
Three-spot barb *(Enteromius trimaculatus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal). Swim upstream into seasonal rivers confirmed/shoals of adults.
Bowstripe barb *(Enteromius viviparus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Southern barred minnow *(Opsaridium peringueyi)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Red-eye labeo *(Labeo cylindricus)*	Juveniles and adults: 4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Leaden labeo *(Labeo molybdinus)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal). Strong swimmers, migrate upstream [including seasonal rivers]
Rednose labeo *(Labeo rosae)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Silver robber *(Micralestes acutidens)*	4: Migration critical for survival of species (large scale migrations undertaken for reproduction, avoidance, feeding and dispersal).
Migration moderately important (3):	
Bulldog *(Marcusenius macrolepidotus)*	3: Migration moderately important for survival of species (uncertain)

Fish Species	Migration potential
Migration not important (1-2):	
Sharptooth catfish *(Clarias gariepinus)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).
Sawfin suckermouth (*Chiloglanis paratus)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).
Shortspine suckermouth (*Chiloglanis pretoriae)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).
Lowveld suckermouth (*Chiloglanis swierstrai)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal).
Oreochromis mossambicus	2: Migration not important for survival of species (migration mostly undertaken for dispersal). Juvenile: 1: Migration not important for survival of species (migration mostly undertaken for dispersal).
Redbreast tilapia *(Tilapia rendalli)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal). Juvenile: 1: Migration not important for survival of species (migration mostly undertaken for dispersal).
Banded tilapia *(Tilapia sparrmanii)*	2: Migration not important for survival of species (migration mostly undertaken for dispersal). Juvenile: 1: Migration not important for survival of species (migration mostly undertaken for dispersal).
Southern mouthbrooder *(Pseudocrenilabrus philander)*	1: Migration not important for survival of species (migration mostly undertaken for dispersal).

Table 2 presents the fish species that were sampled during the fish surveys as well as the flow-depth classes (habitat types) that they were associated with. Many of these species are regarded as having migratory requirements and therefore require freedom of movement into river reaches that provide suitable breeding and feeding areas.

Table 2: Fish species sampled during the fish survey and the corresponding flow-depth classes where observed (Deacon, 2020).

SPECIES SAMPLED	SLOW DEEP	SLOW SHALLOW	FAST DEEP	FAST SHALLOW
Largescale yellowfish *(Labeobarbus marequensis)*				3
Orangefin barb *(Enteromius eutaenia)*				4
Longbeard barb *(Enteromius unitaeniatus)*				5
Beira barb *(Enteromius radiatus)*		1		
Three-spot barb *(Enteromius trimaculatus)*	1	3		1
Bowstripe barb *(Enteromius viviparus)*				6
Silver robber *(Micralestes acutidens)*		1		3
Sharptooth catfish (*Clarias gariepinus*)	1	1		
Mozambique tilapia *(Oreochromis mossambicus)*	2	3		
Banded tilapia *(Tilapia sparrmanii)*		1		
Southern mouthbrooder *(Pseudocrenilabrus philander)*		3		

It should be noted that this list of species is regarded as a once-off “grab sample” and not necessarily regarded as a comprehensive potential list of fish that utilise the river reach associated with the site, or the purpose of this survey, the fish species are grouped into migratory functional groups according to swimming abilities. These data are then used to guide the design criteria and to set the hydraulic parameters of any fishway or fish pass structures to be developed. A fishway has to provide hydraulic conditions that fall within the limits of the swimming abilities of the target fish species.

6.Fish Passage Options for the Site

6.1. Formal fishway option

Formal fishway structures, such as a vertical slot, pool and weir, or similar are formal concrete structures that provide a mechanism to divide the overall change in water levels induced by the dam structure (approx 10 m) into smaller steps and level changes by placing baffles strategically within the fishway in order to provide for suitable hydraulic conditions that do not inhibit upstream migrations. Formal structures do present some advantages, in that their placement (in particular the fish entrance (outflow) can be accurately placed for maximum ecological benefit.

Site conditions that offer suitable foundation material (i.e., bedrock) is generally required for a base for a formal structure. It should be noted, however, that the dam infrastructure site has similar requirements, so this is generally not a limiting factor to the application of a formal structure. One aspect that has to be considered is that a formal fishway structure needs to be integrated into the dam structure design and retrospective fishpass placement within an existing design strategy is relatively difficult.

Another limiting feature is that the dam structure at Louw's Creek, although inducing a relatively high change in water levels (approximately 10 m), it is considered a relatively small development feature due to the steep riparian zones. A formal fishway structure would seek to provide for a change in water level between consecutive pools of no more than between 0.150 and 0.180 m, which would induce maximum water velocities of 1.716 and 1.879 m/s, respectively.

In order to dissipate the turbulences within each pool sufficiently, the length of each pool would be required to be at least 1.950 m in length and 0.900 m wide. In order to gain a height difference of approximately 10 m, at least 67 pools would be required, making for a fishway structure that is approximately 135 m long. This is considered to be completely unpractical for the site in terms of space availability as well as the cost of the structure in relation to the scale of the proposed development.

6.2. Informal fishway option: Natural rock-ramp/bypass channel fishway

Based on the above, an informal bypass channel is considered to be far more suitable for the site. The proposal for the implementation of a natural bypass/rock-ramp type of fish passes are usually the preferred design over formal fishway structures but are very often limited in application due to unsuitable site conditions.

Factors such as channel profiling, slope and substrate type (foundation material availability/suitability), accessibility to the site for construction equipment and availability of materials are all aspects to be considered during the design process. Rock-ramp type of fishways aim to have a gradient of between 1:15 and 1:25 (Thorncraft & Harris, 2000).

The steeper slope of 1:15 is more unforgiving and so requires hydraulically sheltered resting areas and strategic rock placement that promotes diversity of hydraulic conditions, including less turbulent sections. The steeper the fishway gradient, the more technical and cumbersome the design becomes, which usually induces a greater level of maintenance as well).

A slope of 1:15-1:25 (or higher) is therefore recommended, where the channel will be more likely to have lower water velocities and therefore, lower turbulence levels. The water will also tend to pool more readily, which will reduce the incidences of supercritical flow conditions. Formal designs are thought to be of limited value for rock ramp fishways as each one is site specific and different – being completely dependent on available site conditions.

Broadly described, a rock ramp fish pass is a series of rocks and boulders of various sizes that is embedded into a stable foundation material (concrete) in such a way that the turbulence created by the natural flow path through the boulders creates pooled areas of various sizes, depths and hydraulic conditions. The actual watercourse is broadly an open parabolic-shaped channel. The aim of a rock ramp type fishway is to simulate a natural rapid-type habitat unit that would allow fish to overcome an otherwise hydraulically difficult area.

A factor that is considered for a rock ramp type fishway is that it requires a relatively large amount of water to function optimally, depending on the dimensions of the channel itself (i.e., the broader the channel, the more water flow is required to allow for sufficient water column for fish to utilise it).

Figure 1 presents a conceptual view of a rock-ramp type of fishway.
Figure 2 presents a rock-ramp fishway that has been implemented. Superficially, the water velocities seem to be high within this fishway, but upon closer examination of the hydraulic characteristics, the highly variable flow patterns and distribution of flow velocity ranges achieve a high success rate at facilitating a diversity of fish species of a variety of age classes.

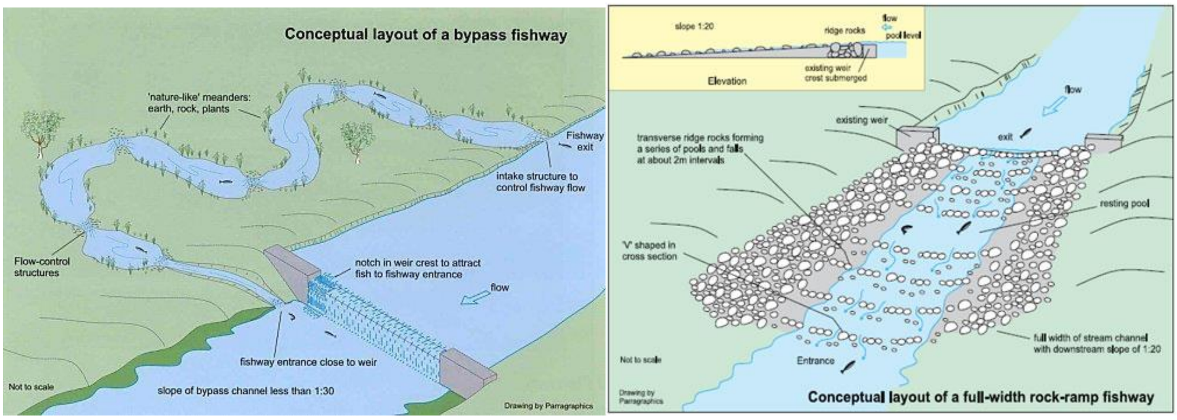

Figure 1: Conceptual view of a fish bypass structure and a typical rock ramp fish pass (from Thorncraft & Harris, 2000). Usually the rock-ramp type of channel engineering is implemented within the bypass structure as it allows for a steeper gradient to be catered for.

Figure 2: A typical rock ramp fish pass that has made use of embedded boulders to roughly shape consecutive pools. The variable hydraulic conditions are clearly seen, which is a feature that makes the rock ramp fish pass successful in enabling migration of a wide diversity of fish species and size classes.

6.3. Choice of the preferred alignment

Analysis of the site conditions through aerial imagery, detailed contour data and the placement and characteristics of the dam infrastructure has seen opportunity for two potential channel alignments that are regarded as being suitable to cater for the technical requirements of a rock-ramp type bypass channel. The alignments of the two profiles that are considered feasible are presented in Figure 3.

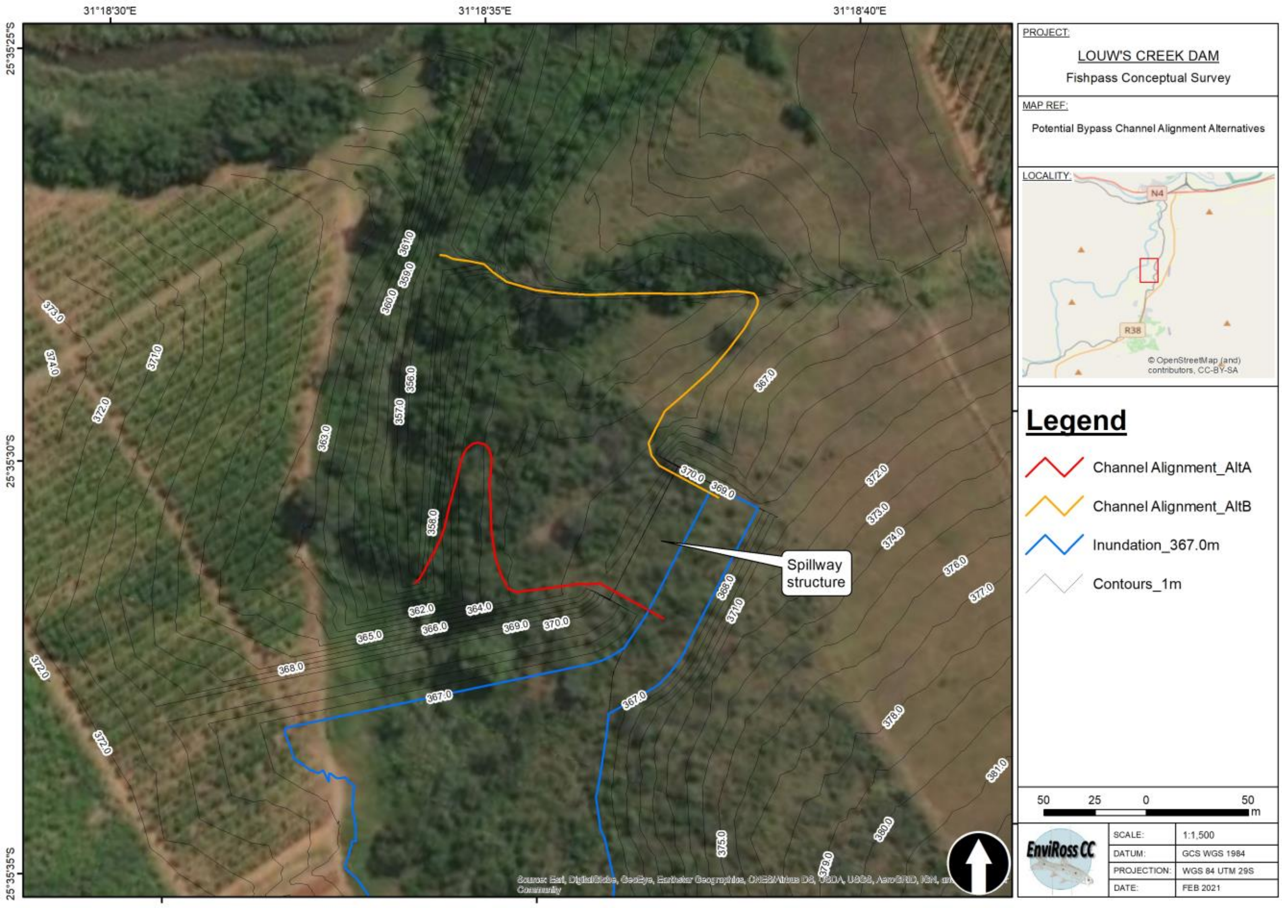

Figure 3: The two identified potential channel alignment alternatives. Both alignments are considered feasible from an ecological perspective.

The vertical profiles of Alt A and Alt B are presented in
Figure 4 and
Figure 5, respectively. These vertical profiles are representative of the present natural site topography prior to any earthworks or excavations. It is acknowledged that an impoundment structure requires extensive earthworks and therefore these profiles are subject to change. This is therefore merely an indication of the conceptual possibilities. Earthworks will be advantageous in that it would provide for the opportunity to artificially profile and landscape the channel to best suit the hydraulic conditions.

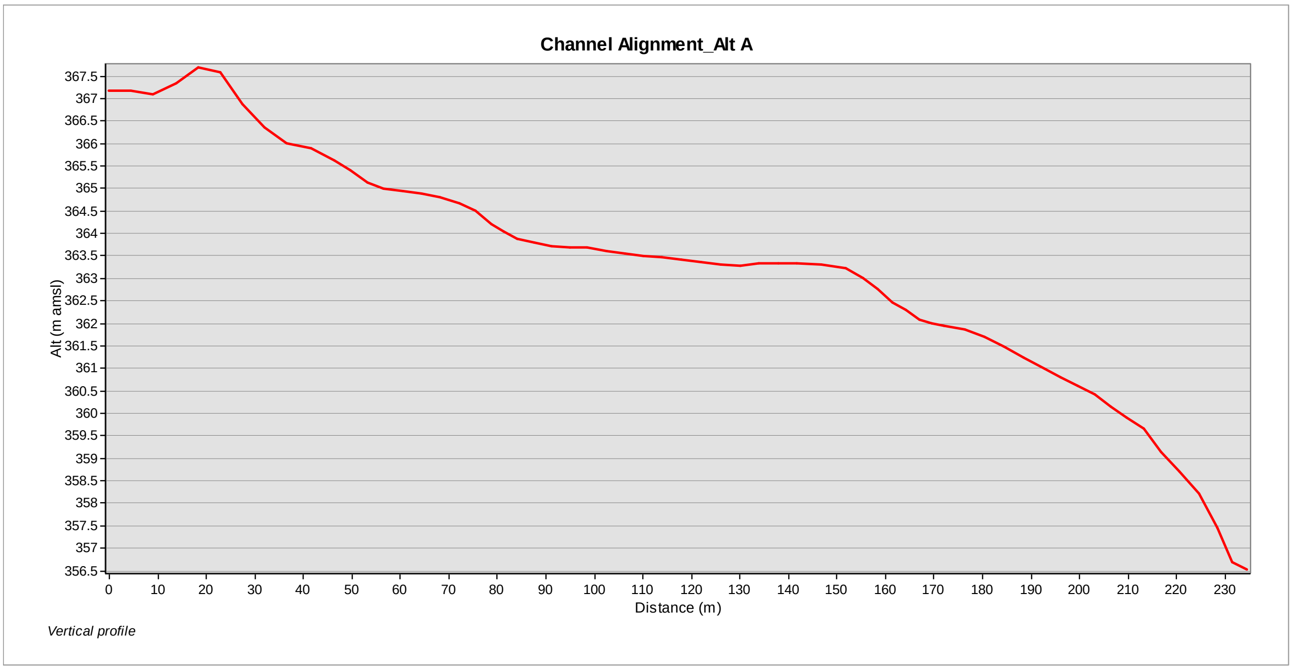

Figure 4: Vertical profile of the proposed channel alignment (Alt A).

This alignment alternative originates within the left side of the spillway section from a flow control structure and leads north and then bends back to outflow near the base of the dam structure. The entire channel measures approximately 235 m and the average of the present natural slope of the alignment (prior to any excavations being undertaken) is approximately 1:22.4. This is an acceptable slope for a rocky bypass channel, and, although it would require some landscaping and channel shaping, the natural profile of the topography allows for a reduction of the required earthworks to achieve a functional bypass channel.

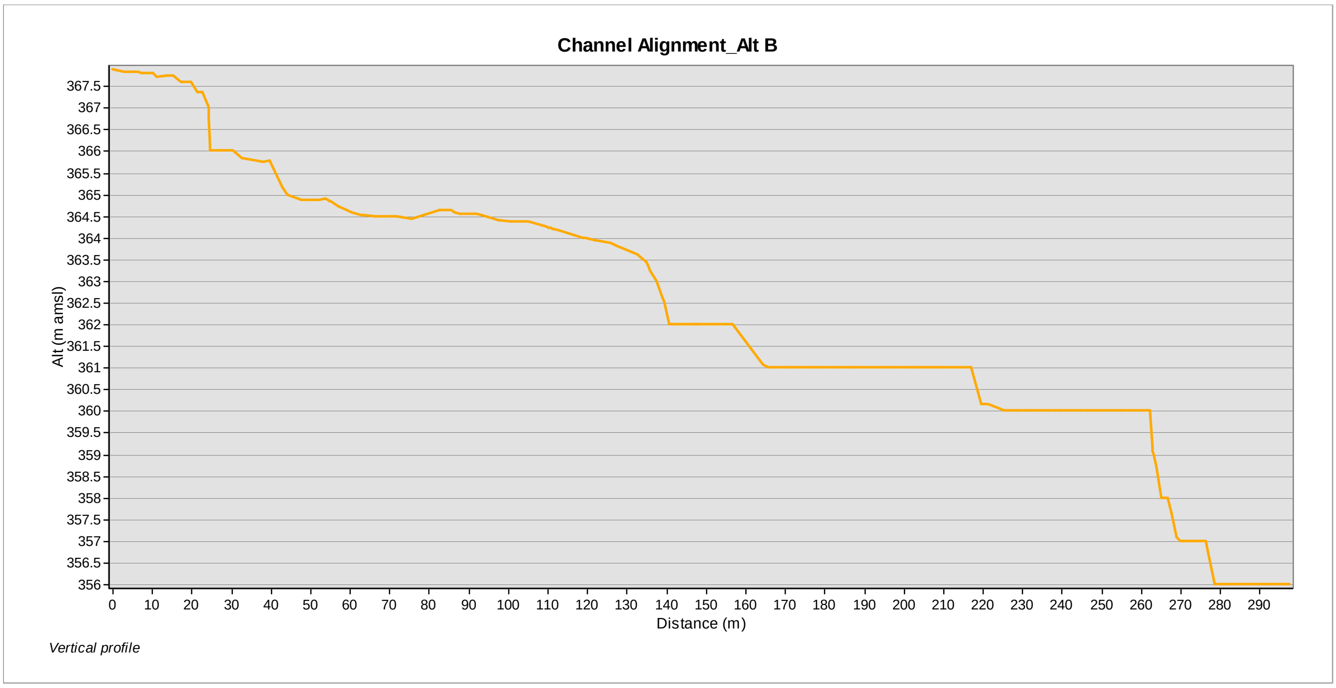

Figure 5: Vertical profile of the proposed channel alignment (Alt B).

Channel alignment alternative B originates from a control structure located at the right side of the spillway channel and leads northwards toward a nearby natural watercourse/valley bottom. This valley bottom was included as part of the vertical profiling, which can be seen from distance mark of approximately 260 m, showing a relatively steep decline only within the last 15-20 m of the confluence zone of the valley with the Low’s Creek watercourse.

This steep decline zone could be relatively easily landscaped to allow for a gentler slope. Disregarding this steep decline, the channel profile would be approximately 260 m long, with an average slope of approximately 1:23.6. This is a slope that is comparable to that of Alt A, albeit slightly better, but this alternative has the disadvantage that the fishway entrance would be located a small distance from the base of the dam wall.

Both of these alignment alternatives are considered viable from an ecological perspective. The preferred alignment will therefore largely be based on site conditions and engineering aspects.

6.3. Attraction flows

Fish that undertake upstream migrations tend to follow along the line of the greatest currents and flow volumes. It is thought that this is largely due to the largest flows representing expansive habitat availability upstream of wherever the fish may find themselves within the river reach.

Fishways and fishpass facilities therefore have to provide for sufficient attraction flows that will allow for the fish to actually located the entrance of the fishway/fish pass. This is usually problematic for infrastructure that has a large release of water volume (such as a hydropower facility) in relation to the flow volumes designated to the fishway.

This is usually a fraction of the overall volumes of the water being released, and therefore accurate placement of the fishpass entrance as well as supplementary attraction water is imperative to ecological functionality of the bypass channel. This project, being an impoundment developed for irrigation pumping, is regarded as a consumptive user of the water volume within the watercourse and therefore relatively little water (besides the designated environmental flow requirements/e-flows) will be released from the dam (which will all be directed through the fishpass channel).

There will therefore be very little competing flows that antagonistically act to reduce the attraction flow volumes toward the fishpass channel. Accurate placement of the fishway entrance is therefore not as pertinent for a project of this nature as what it would be for (for example) a hydropower development.

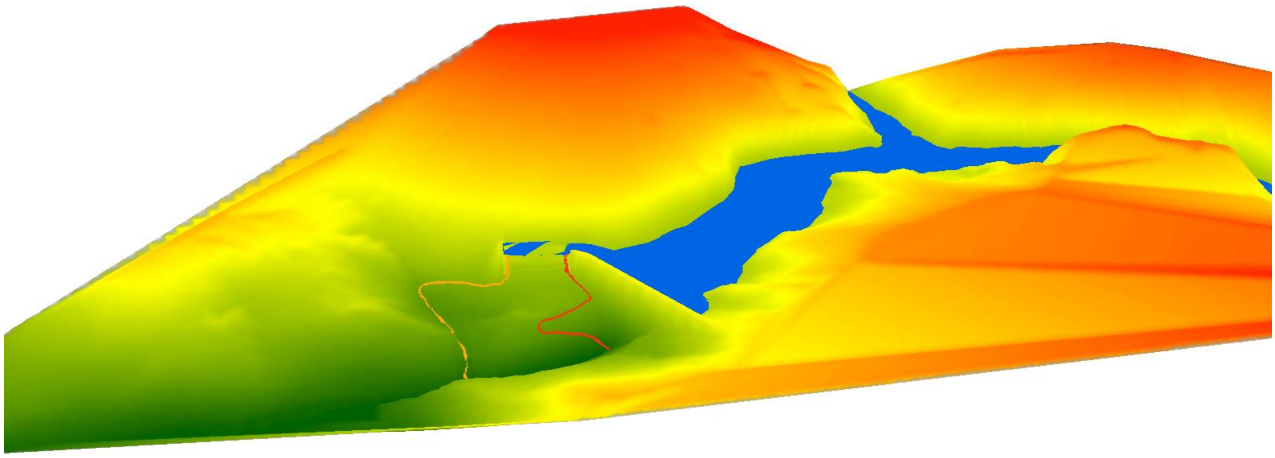

Figure 6: A 3D terrain model rendering of the location of the two fish pass channel alignment alternatives.

6.5. Design specifications and hydraulic characteristics of the fishpass channel

The approximate ecological flows (Ecological Water Requirements – EWRs) associated for the river reach associated with the proposed dam development site was designated as 31% of the Mean Annual Runoff (MAR) value.

The natural hydrograph of the Low's Creek for the reach associated with the proposed dam site was provided in tabular format. These data are provided as a surety curve, where, according to the data series averages over a prolonged period of time, a percentage surety of the flow can be ascertained. It is the norm to work withing the 70% surety limit, which further provides for greater representation of realistic flow data.

This 70% value of the MAR, together with the 31% EWR values are presented within Figure 7. This EWR volume is required to maintain the Low's Creek within a B category (Largely natural) for flow-related stressors. Provision has been made for all of the designated EWR flow volume be directed through the fishpass channel.

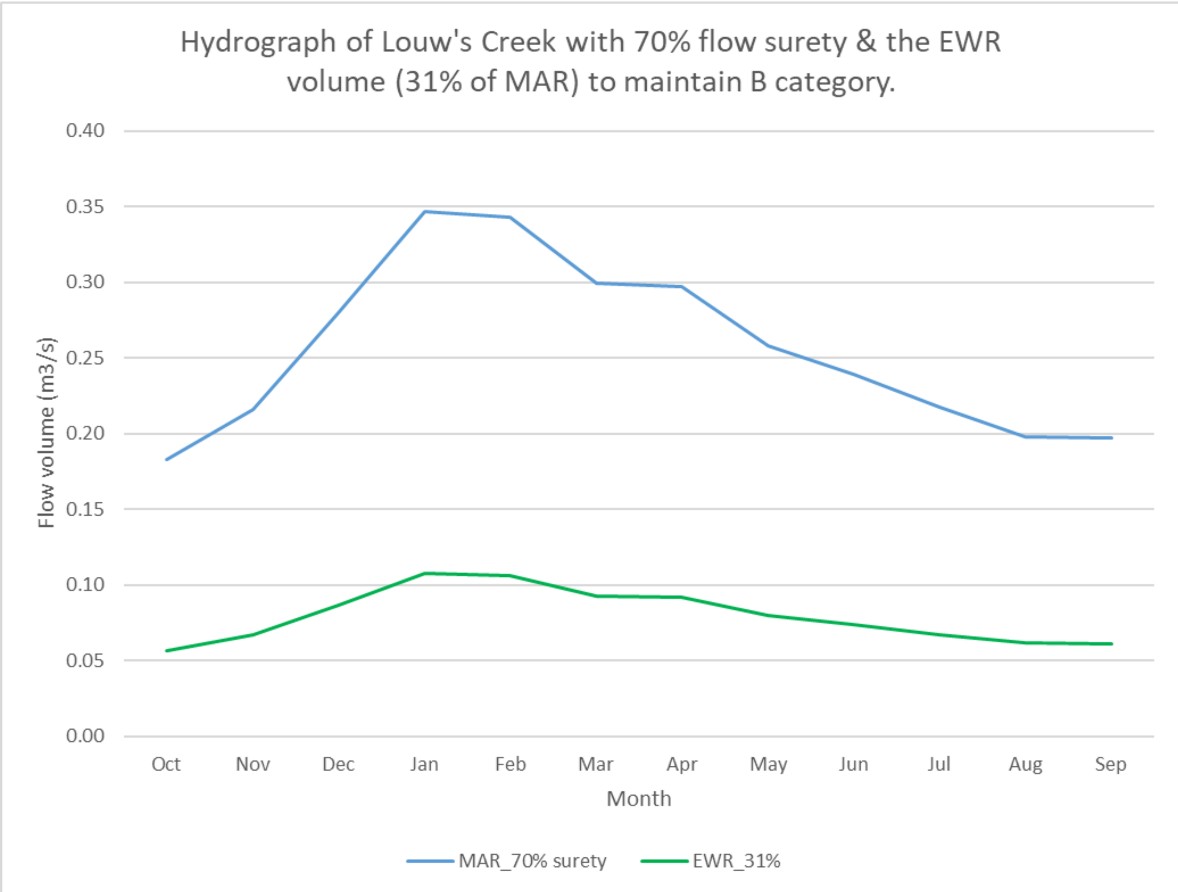

Figure 7: The hydrograph of the Low's Creek indicating the 70% surety flow values, together with the 31% EWR flow requirements.

In order to promote maximum ecological functionality of the fishway, a basic 2-stage trapezoidal channel shape is recommended as presented in
Figure 8. The basic channel shape is regarded as being important, but the dimensions should be regarded as being dynamic and adaptive to site and hydraulic conditions. A type of an adaptive construction methodology should be applied when structuring the channel as there is no formal plan nor guide for an informal fishpass due to it being dependent on the site conditions. All of the presented hydraulic modelling has been based on this channel profile, with the given dimensions.

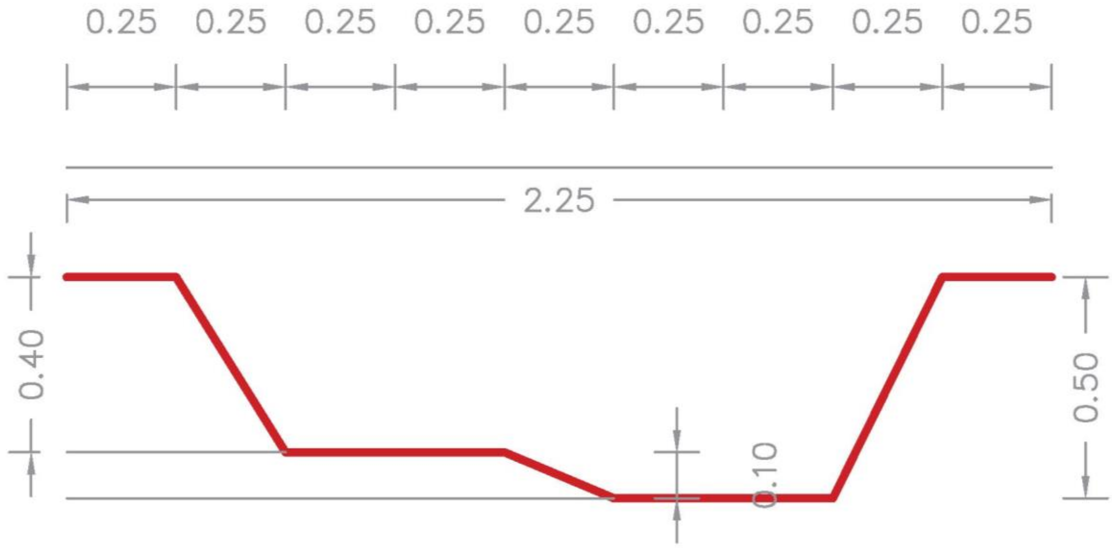

Figure 8: The stylised channel profile that would be best suited for catering for a variety of fish species and age classes. The shallower area induces greater flow resistance and therefore provides areas of lower water velocities for weaker-swimming specie. A substrate of rocks and cobbles will induce resistance to flow, slow the overall water velocity and also provide for velocity variation.

The allocated EWR flow volumes ranged between 0.057 m^3/s and 0.108 m^3/s, which are regarded as relatively small volumes. The channel profile had to be dimensioned to suit this flow volume, whilst still being able to allow for functioning of the two-stage profile.

The shallower section induces a greater resistance to flow, which slows the velocity of the water relative to the deeper section. This allows for greater variation of the velocities experienced within the channel and thus better facilitates a greater diversity of fish species and size classes (i.e., variation of swimming abilities). It is recommended that the deeper portion of the channel be located to the outside of the bend (i.e., the deeper section will be located along the right bank of the channel (as viewed downstream). This will allow for further hydraulic sheltering of the shallow sections, which will induce slower velocities within these areas.

A basic HECRAS model was applied to a stylised channel profile with a slope example of 1:22, which equates to a rise of 11 m over a distance of 260 m. A Manning's (n) flow co-efficient of 0.05 was utilised, which would be applicable to a cobble and roughened substrate. This would allow for flow resistance and a relatively deeper hydraulic depth.

Care should be taken in order not to fill the channel with rocks that would only allow for interflow through interstitial spaces between the rocks rather than being fully submerged. Only allowing interflow between the interstitial spaces within the substrate within the channel will limit the size class of fish that would utilise the channel. A channel such as this is small enough to allow for a large degree of manipulation in order to allow for channel profile variation, pool creation and a further level of habitat diversity.

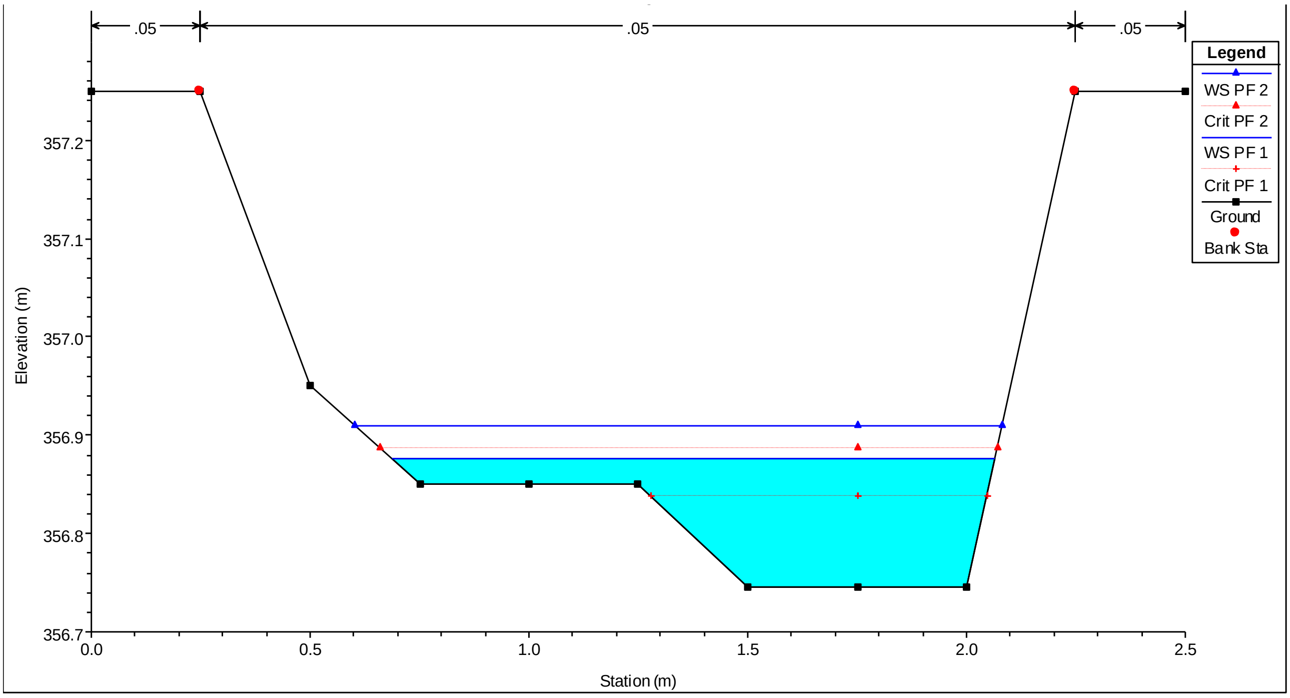

Figure 9: The hydraulic analysis of the proposed alignment as per the maximum and minimum flow rates provided as part of the EWR flow volumes (high flow and low flow volumes). The image presents hydraulic characteristics of a typical channel cross section. The blue-shaded area represents low flow conditions, whereas the blue line located above that presents the hydraulic depth of the fish pass channel under high flow conditions.

It is recommended that a control gate be fitted to this structure that will be capable of closing the water off to the channel for any modelling and ongoing maintenance. Allowing the shutoff of the water will also aid in future monitoring of the fishpass.

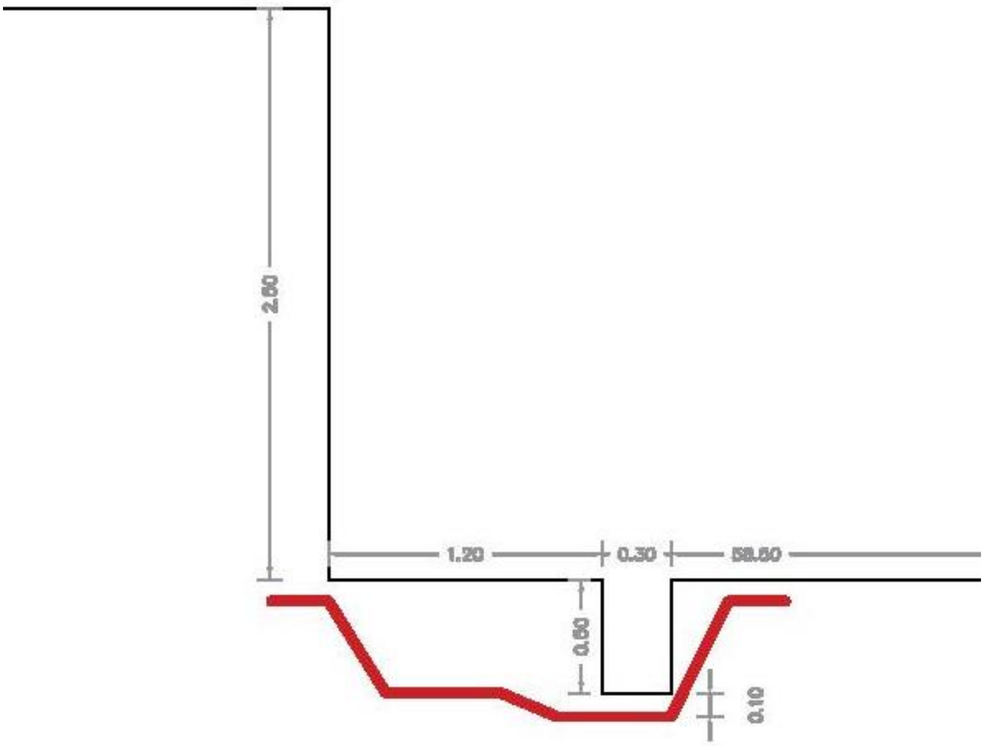

Figure 10: The dimensions of the flow control structure that is located at the inflow of the fish pass channel.

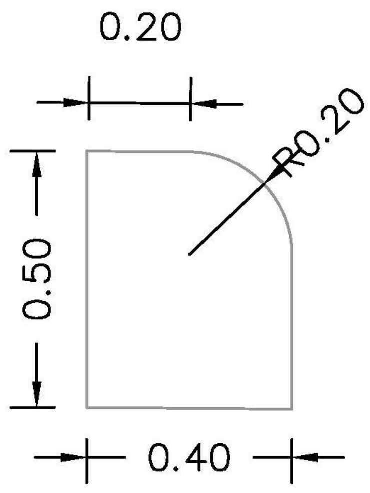

Figure 11: The dimensions of the baffle that will control the flow into the fish bypass channel. The crest of this baffle is set at 366.745 m amsl, allowing for a hydraulic depth of 0.255 m under high flow conditions and 0.165 m under low flow conditions. This will then suit the allocated EWR flow volumes.

7. Downstream Migrations

As the spillway of the dam is expected to periodically spill over, downstream migrations will occur passively with little injuries to fish being expected to occur.

8.Proposed Monitoring Plan

As fishway development tends to remain a novel concept within the African context, monitoring data that is able to determine the level of fishway ecological functioning are lacking. This is especially true for bypass channels, which requires a dynamic and adaptive approach to design and construction.

It is therefore recommended that the final stages of the fish pass construction be inspected by a suitably qualified fish biologist (specialist) prior to it being signed off. It is also recommended that the fish pass be monitored biennially for at least two years post construction in order to gain data for two high flow and two low flow seasons. An informed management decision can then be taken following that period according to the results of the surveys.

It is recommended that some sort of shutoff structure be fitted to the inflow of the fish pass channel. This will aid in future maintenance. The construction of the fish pass will require follow-up rock placement or modifications in order for it to function optimally. Being able to stop the flow of water into the channel will aid in any required construction processes. Being able to shut off the flow of water will also aid in monitoring of the fish pass channel as it will provide more favourable conditions for fish biologists to gain entry to within the channel for surveying purposes.

9.Conclusions & Recommendations

Following an analysis of the migratory requirements of the fish species associated with the river reach associated with the proposed dam site, the following salient conclusions could be reached:

- The river reach associated with the proposed Low's Creek dam development potentially supports a diversity of fish species and is considered to offer habitat that is pertinent to supporting the freshwater fish within the region;
- Obligatory migratory fish (those that will suffer detrimental impacts if migratory freedom is lost to them) were included within the fish species and therefore the need for mitigating for habitat fragmentation was clear, with the implementation of a type of fishway or fish pass facility being regarded as the most feasible option for mitigation;
- A fishway channel that simulates a natural bypass channel and rock-ramp type of fishway has been proposed for the site as site conditions and the nature of the development tends to suit this style. Two alternative alignments were explored, with both of them being regarded as suitable for the purpose;
- Given that the design criteria and the alignment route are taken into consideration, it is believed that the proposed fishway channel will adequately cater for the migratory requirements of the target fish species;
- It is recommended that once the basic channel has been excavated, that the channel be surveyed and the profile modelled in order to offer an optimal design with modifications presented in areas that are shown to not function adequately. Physical and engineering limitations are unknown at this stage, and the unearthing of different foundation materials may require an adaptive approach to the channel profile;
- A basic monitoring plan should be implemented that will allow for the gauging of the success of the fishpass channel;
- The drawing and diagrams provided within the report are also presented as an AutoCAD model for the perusal of the design engineers.

10. References

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APPENDIX 4.5.5:
YIELD ANALYSIS OF THE PROPOSED LOWS CREEK DAM

Yield Analysis of the proposed Low's Creek Dam

November 2020

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

DWS	Department of Water and Sanitation
DWA	Department of Water Affairs
EWR	Ecological Water Requirement
Ha	Hectare
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MAE	Mean Annual Evaporation
m^3/annum	Cubic metres per annum

1.INTRODUCTION

IWR Water Resources were appointed to carry out a Yield Analysis of a proposed dam on the Low's Creek River, referred to in this report as the Low's Creek Dam. The dam site that has been identified is on the lower reaches of the Low's Creek River immediately upstream of the confluence with the Kaap River. See Figure 1.1.

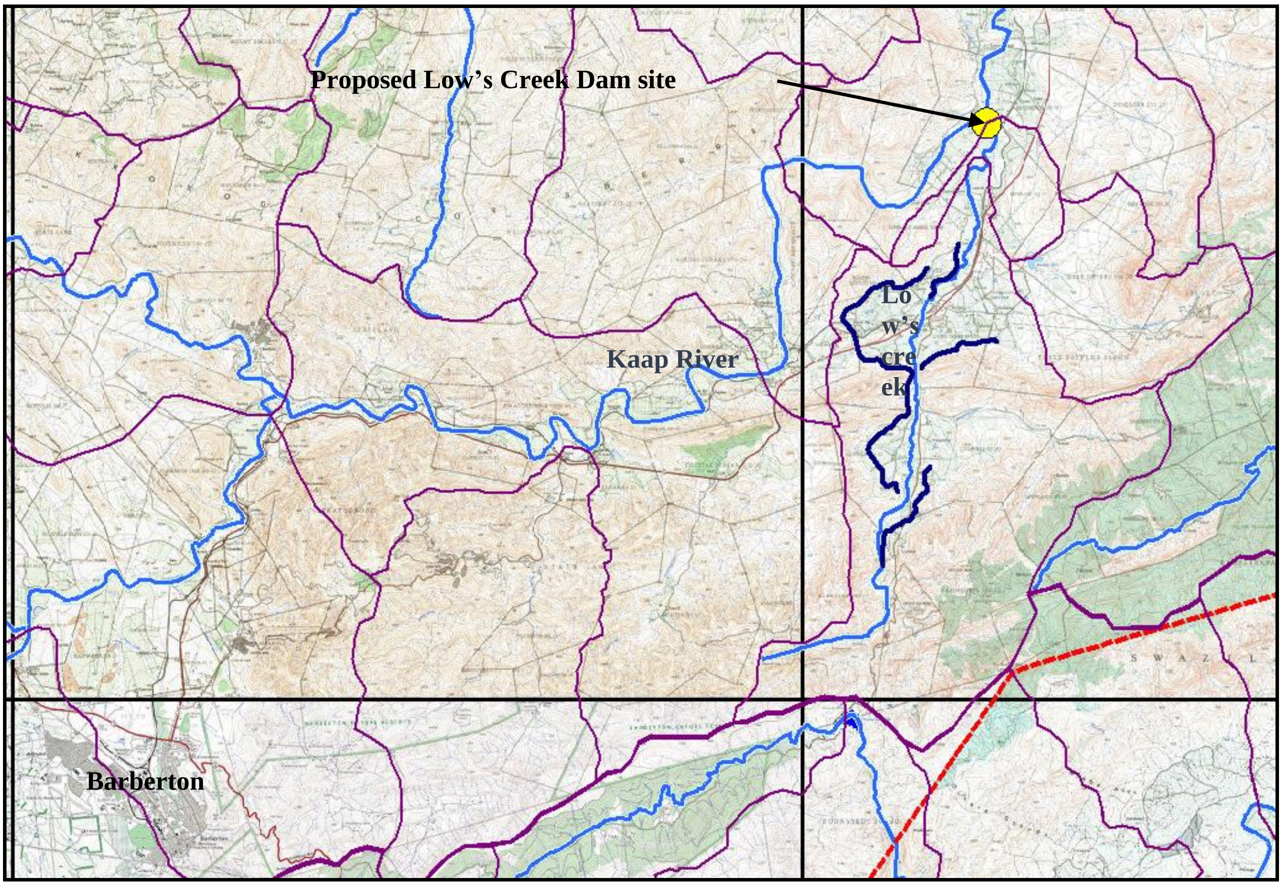

Figure 0.1: Location of the proposed Low's Creek Dam

This analysis of the water resources was carried out with a water resources model and conducting what is generally referred to as a Yield Analysis. A Yield Analysis determines how much water can be abstracted from a dam (or river) on a sustainable basis. For irrigation use this would be done assuming an assurance of supply, typically 70%, which means that the farmer should obtain all the water he requires 70% of the time with shortages being experienced the remainder 30% of the time.

2.HYDROLOGICAL AND CATCHMENT INFORMATION

The proposed Low's Creek Dam is located in the X23H quaternary catchment on the Low's Creek, a tributary of the Kaap River. As part of the Inkomati Water Availability Assessment Study (DWA, 2008), quaternary catchments were further subdivided into quinary catchments with X23H quaternary catchment being sub-divided into X23A-1, X23H-2, X23H-3, X23H-4 and X23H-5. The catchment of the proposed Low's Creek Dam occupies the X23H-2, X23H-3 and X23H-4 quinary catchments. See Figure 2.1.

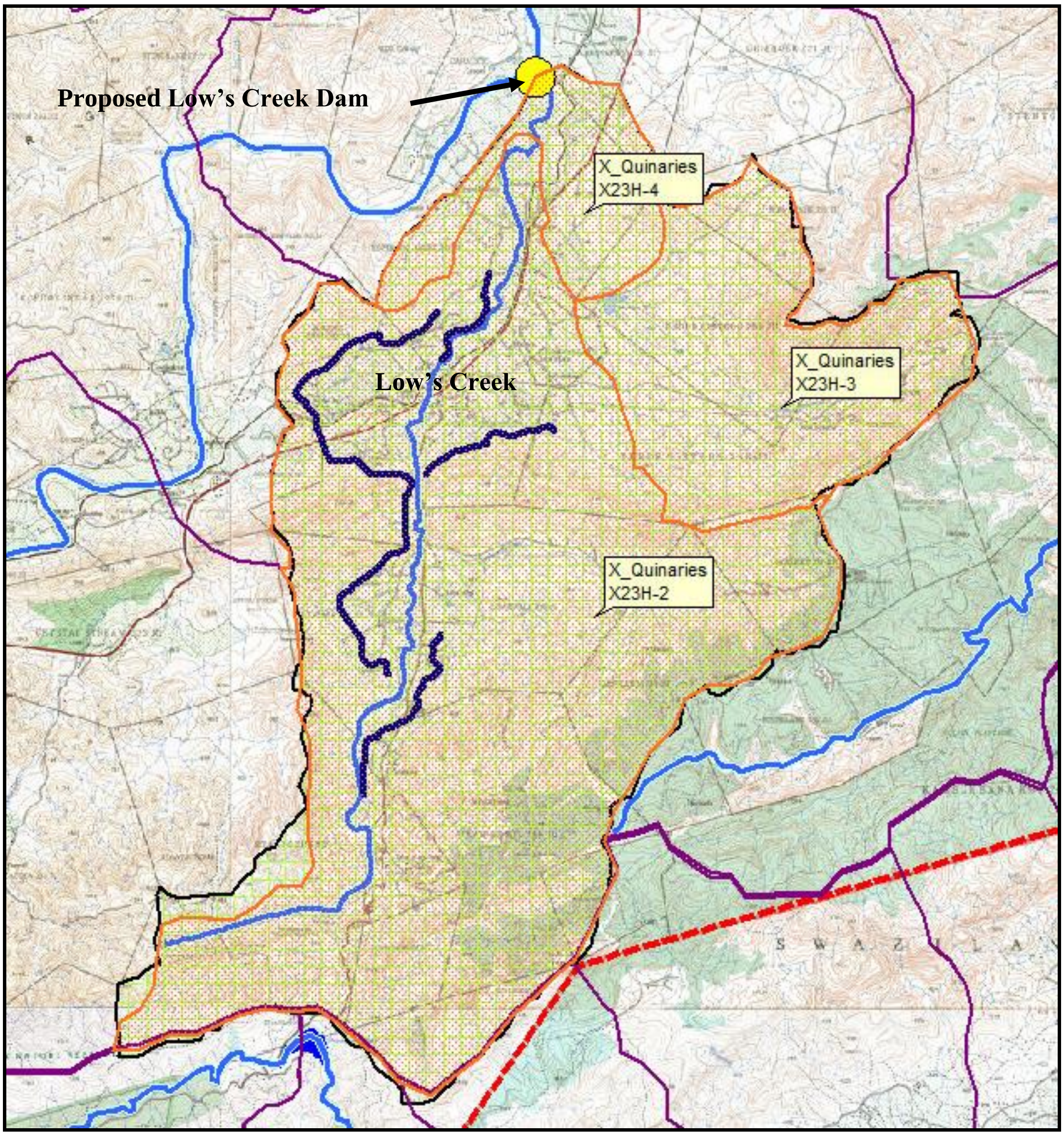

Figure 2.1: Location of the proposed Low's Creek Dam within the within the X23H-2, X23H-3 and X23H-4 quinary catchment

The hydrological information for the Kaap River catchment is readily available at quinary catchment scale from the Inkomati Water Availability Assessment Study (DWA, 2008), and more recently from the update of the Crocodile Hydrology (IUCMA, 2019). See Table 2.1.

Table 2.1: Summary of climate and hydrology information for the Low's Creekcatchment

Catchment	Area (km^2)	Mean Annual Evaporation (mm)	Mean Annual Precipitation (mm)	Natural Mean Annual Runoff (million m^3/annum)
X23H-2	110.2	1 461	926	12.4
X23H-3	30.0	1 466	1 027	4.2
X23H-4	11.0	1 527	700	0.5
Total	**151.2**			**17.1**

The time series of the Natural Runoff from the catchment of the proposed Low's Creek Dam is shown in Figure 2.2. Note the extreme variability of the flow which is typical of the runoff from catchments on the South African eastern escarpment.

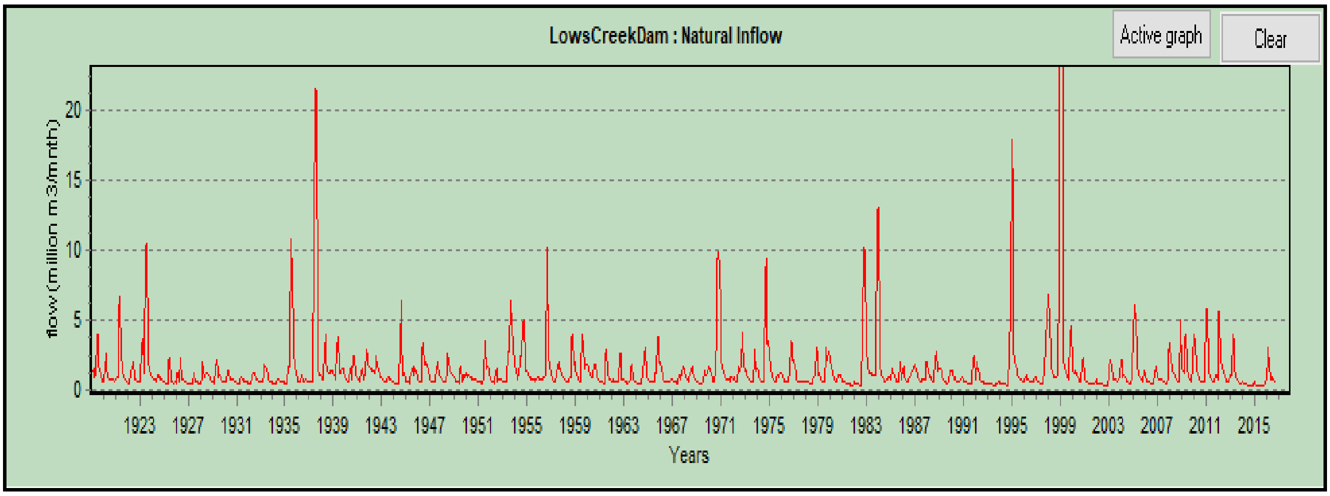

Figure 0.2: Time series of Natural flow from the catchment of the proposed Low's Creek Dam

3.WATER RESOURCES ANALYSIS

a. Methodology

A water resources analysis or Yield Analysis is required to assess how much water can be abstracted from a river or dam on a sustainable basis. The term *sustainable* has different connotations to different users and is defined for the purpose of this evaluation as follows:

- The amount of water that can be abstracted at the specified level of assurance. Irrigation use within the Kaap River catchment is typically in the order of 70%, and even lower in the lower Kaap.
- The EWR must be met as a priority over other water users.

The Water Resources Modelling Platform (Mallory et al, 2013) was used for this analysis. This is a time series simulation model which operates at a monthly time step. The model simulates river flow, reservoir storage and water use at a monthly time step over the period 1920 to 2016.

b. Water-use in the catchment

In order to determine the availability of water in a river or dam, it is essential to have a good understanding of how much water is being used upstream of the point of abstraction. The following water uses have been identified in the catchment area and is described in the following sections:

- Irrigation
- Mining
- Domestic use

- Streamflow reduction (SFR) due to commercial afforestation

Table 3.1 summarises the upstream water use and its impact on the streamflow.

Table 0.1: Summary of water use in the Low's Creek River

Type of water use	Allocation (million m^3/annum)	Water use (million m^3/annum)	Impact on streamflow (million m^3/annum)
Irrigation	8.16	~ 5.4	~0.2
Mining	0.3	0.0	0.0
Domestic use	0.0	0.66	0.0
SFR	0.58	0.58	0.58
Total	**9.04**	**6.64**	**0.78**

I. Irrigation

While there is a lot of irrigation within the catchment of the proposed Low's Creek Dam, most of this water is sourced from the Shiyalongubu Dam (on a tributary of the Lomati River), and not from the Low's Creek River. There is a small allocation of 187 680 m^3/annum from the Manders Dam located on the Revolver Creek, a tributary of the Low's Creek. While there are a few pumps installed on the Low's Creek River for emergency use, the actual direct abstraction from the river is negligible (M Le Roux, per comm 2020). See Figure 3.1.

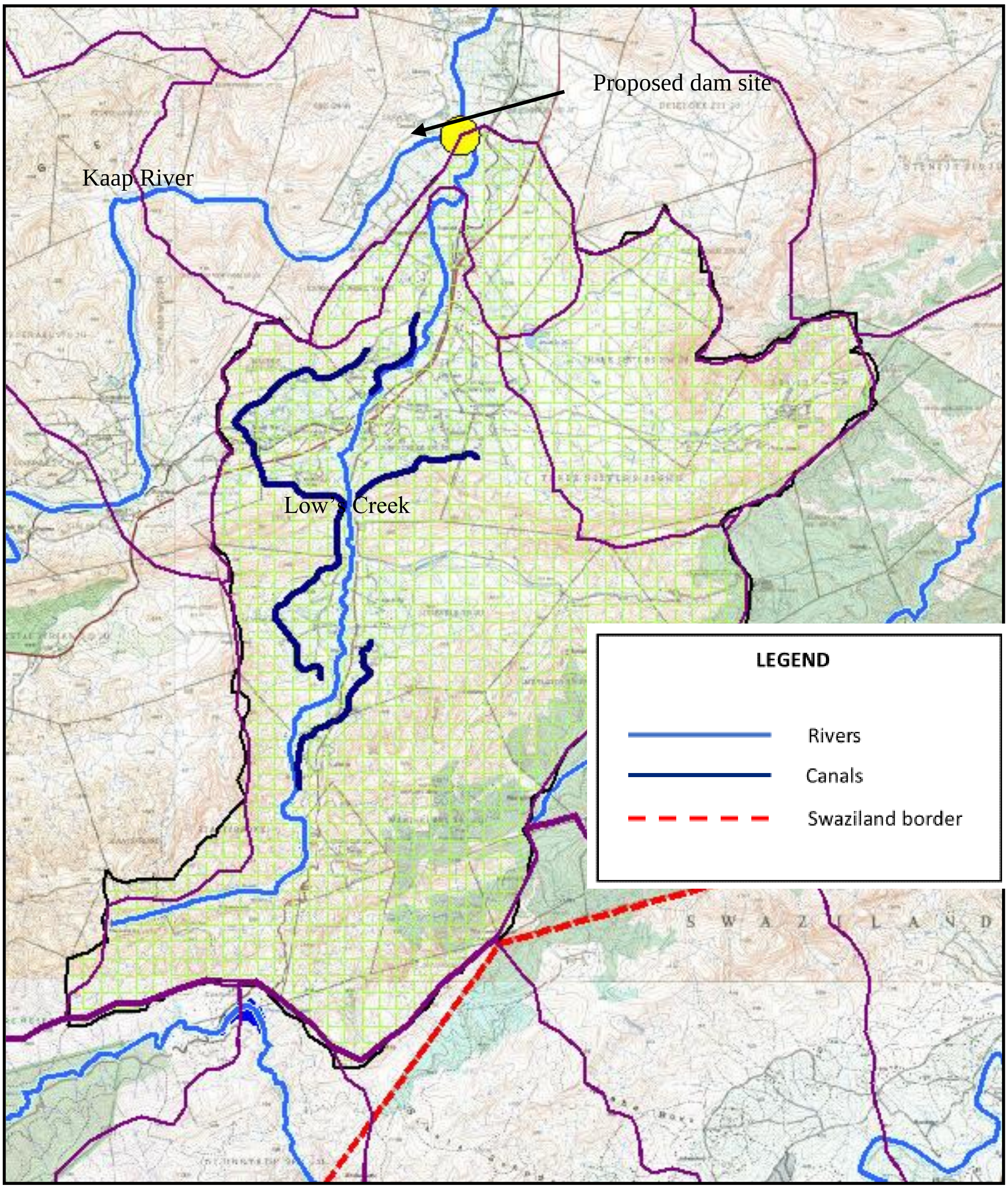

Figure 0.1: Water distribution within the Low's Creek catchment

ii.Mining

The Barbrook mine's water is sourced from groundwater within the mine and probably has minimal impact on the streamflow of the Low's Creek. The mine is currently not operational.

iii. Streamflow reduction

The area of commercial forestry is however significant. See Figure 3.2. The estimated streamflow reduction due to this forestry is 576 216 m^3/annum based on and estimated area of 13.0 km^{2}., 73% of which is Eucalyptus and the remainder is Pine.

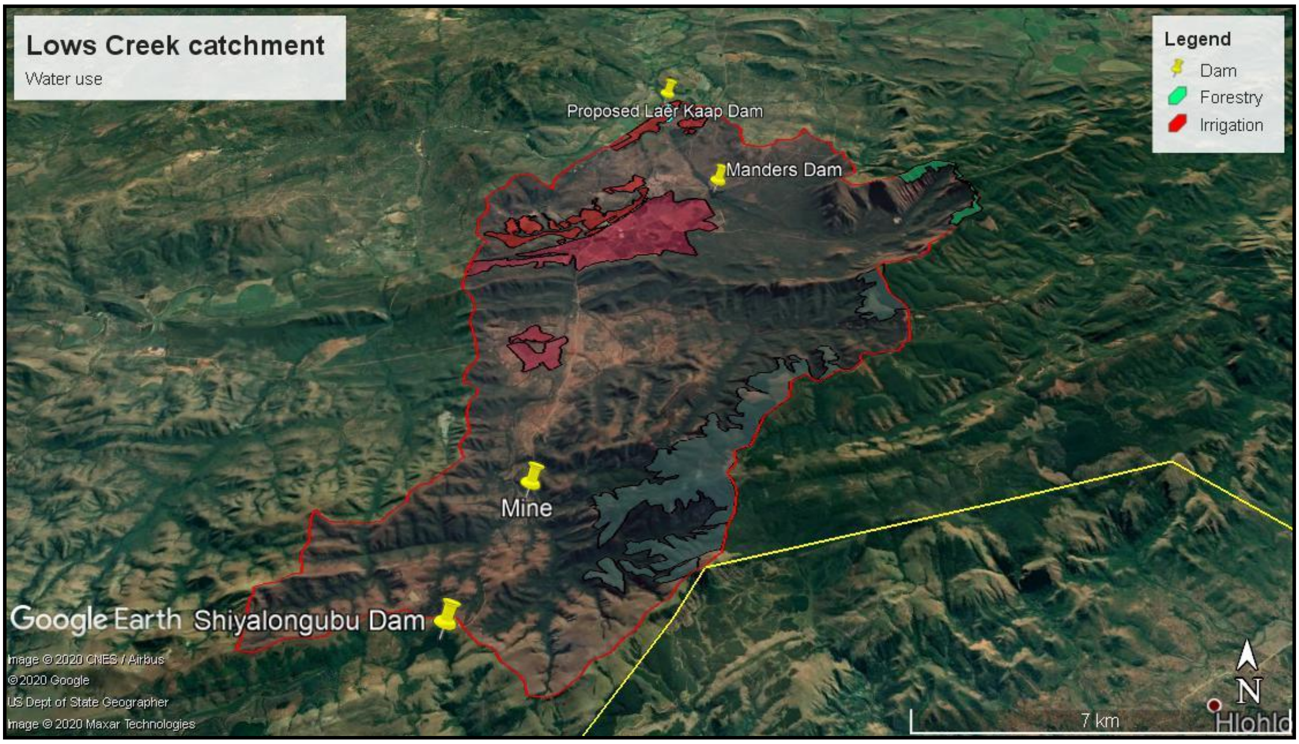

Figure 0.2: Low's Creek catchment showing existing water users

iv. Domestic use

The villages near the proposed dam site are supplied out of the Low's Creek canal using a 110ha irrigation allocation. However, the Low's Creek Irrigation Board report that these communities are unlawfully abstracting water more from the canal than is allocated to them. Since the water in the canal is sourced from the Shiylongubu Dam, this practice, while unlawful, does not affect the flow in the Low's Creek.

Ecological water requirements

The Ecological Water Requirements (EWR) of the Kaap River have been determined (DWA, 2010) and published in the Government Gazette. While there is no specific EWR for the Low's Creek, it can be estimated with the aid of the Hughes Desktop model (Hughes and Hannart, 2002). In consultation with Dr Andrew Deacon, the EWR was estimated for B category river. The rule curve for this EWR is attached Appendix B. The rule curve expresses the EWR as a function of the natural flow from which a time series EWR can be derived. See Figure 3.3.

Note that this EWR is a preliminary estimate and the yield of the dam, together with operating rules to meet the EWR, will need to be updated once Dr Deacon has completed his work.

For completeness the EWR is summarized in Table 3.2.

Table 0.2: Summary of the EWR

Natural flow (million m^3 /annum)	EWR Category	EWR	
		(million m^3 /annum)	% of the MAR
17.1	B	5.34	31%

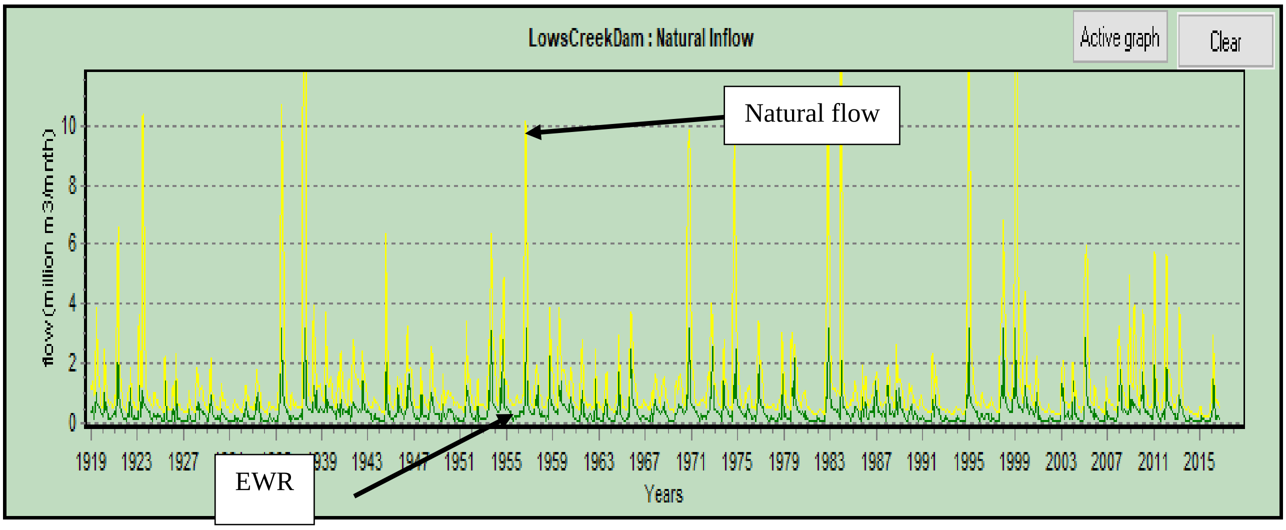

Figure 0.3: Time series of the Ecological Water Requirements compared to natural flow

Results

The yield of any dam depends not only on the inflow into the dam, but also the size of the dam. While the dam designers have indicated a preferred full supply capacity of 195 000 m^3, a range of dam sizes was analysed in order to assess whether a smaller (or larger) dam could be better in terms of the cost versus yield. Table 3.3 lists the yield for a range of full supply capacities while Figure 3.4 shows this graphically.

Table 0.3: Yield of the Low's Creek Dam

Full supply capacity (m^3)	Yield at 70% assurance (million m^3/annum)
100 000	2.70
150 000	3.00
195 000	3.20
250 000	3.42
300 000	3.61

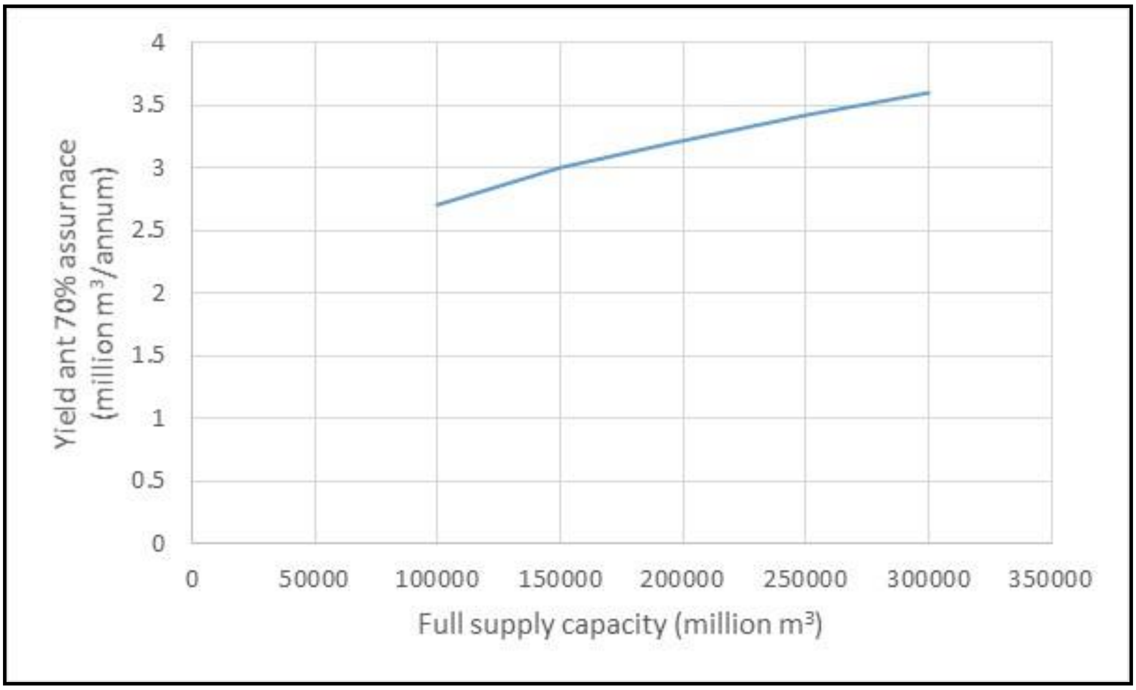

Figure 0.4: Yield of the Low's Creek Dam

4.IMPACT ASSESSMENT/LOW FLOW ANALYSIS

a. Impact on the Lows Creek River

In order to assess the impact of the dam on the river ecology, the ecologist will require a flow time series of the flow before and after the construction of the dam. An analysis of how the low flow changes and whether or not the EWR is met is required. The results of this analysis are shown in Figures 4.1 which expresses the change in flow regime as a duration curve.

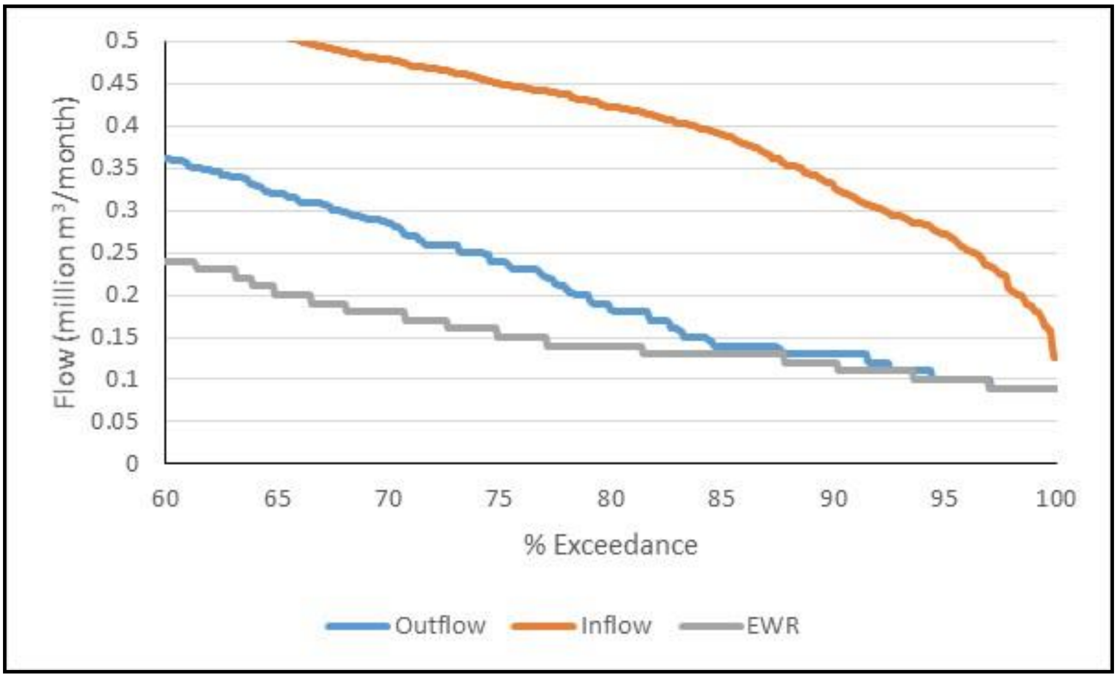

Figure 0.1: Inflow, outflow and EWR expressed as duration curves

The duration curves show that after the construction of the dam and abstraction of up to 3.2 million m^3/annum, the low flow in the river downstream of the dam will be significantly lower. However, the B category EWR will still be met.

b. Impact on the Kaap River

The construction of the Low's Creek Dam and abstraction from the dam for irrigation will reduce the flow from the Low's Creek River into the Kaap River and this could have a negative impact on the irrigators in the lower reaches of the Kaap River (downstream of the confluence of the Lows creek). The ecological water requirements of the Kaap River also need to be taken into account and the impact of the proposed Low's Creek Dam on these requirements assessed.

There are significant irrigation requirements in the lower Kaap River, estimated to be 7.2 million m^3/annum. These irrigators receive their water at an unacceptably low assurance due to excessive and uncontrolled upstream use. See Figure 4.2 which shows the supply to irrigators in the lower Kaap as a duration curve.

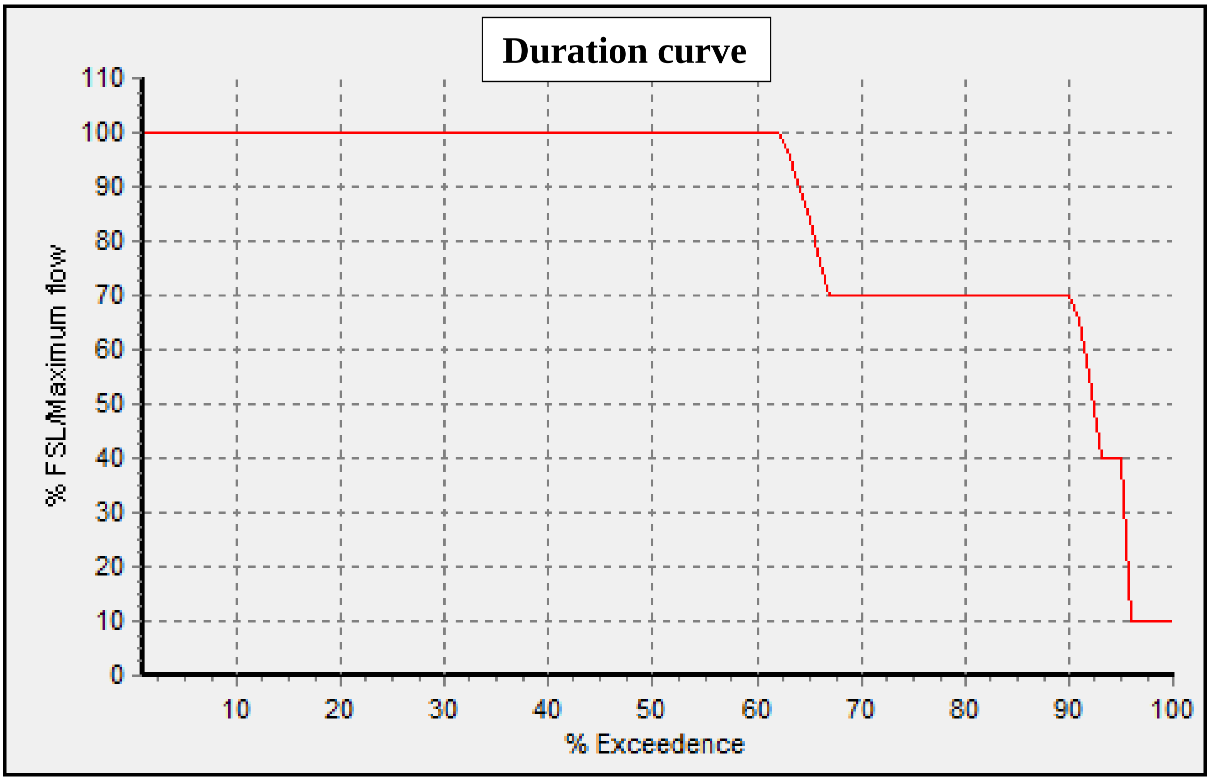

Figure 0.2: Assurance of supply of irrigators in the lower Kaap River

Assuming only the EWR is released from the Low's Creek Dam, the impact on the downstream irrigators is shown in Figure 4.3.

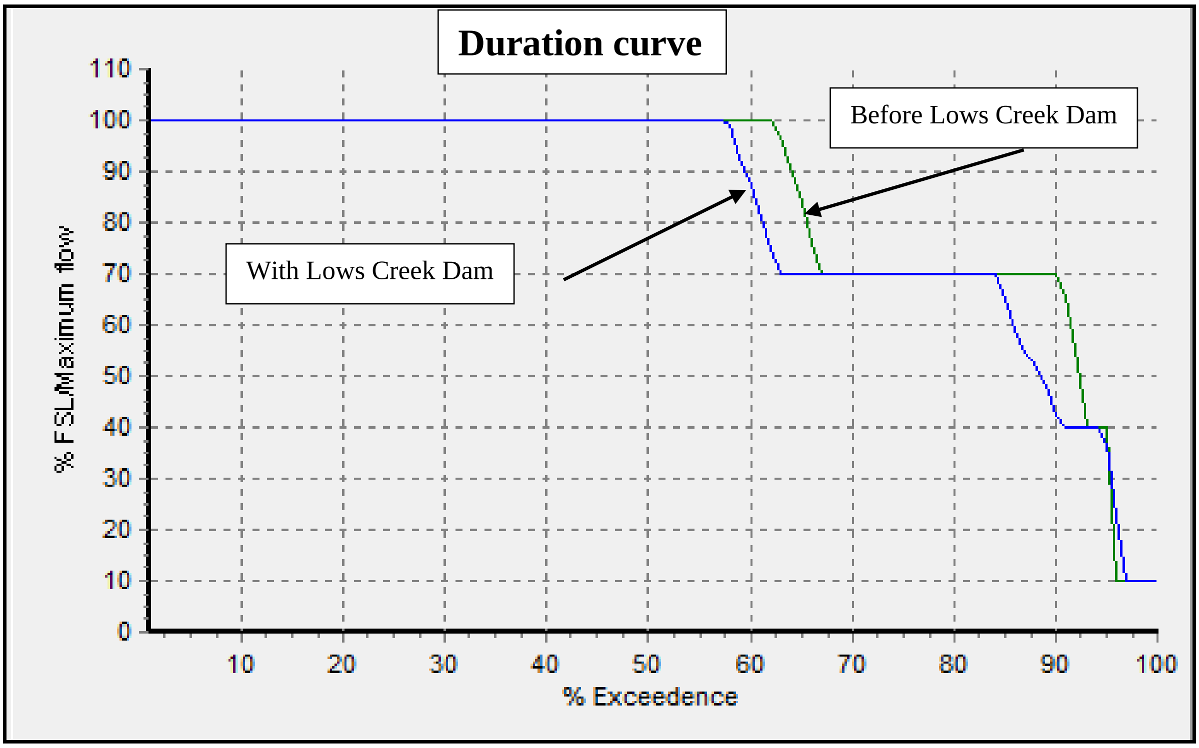

Figure 0.3: Impact of Lows Creek Dam on downstream irrigators

It can be concluded that the Low's Creek Dam will further reduce the assurance of supply of downstream users by about 5 percentage points (from 63% to 58%).

c. Proposed mitigation measures

An analysis of the irrigation water requirements versus supply shows that the irrigation requirements are largely met during the summer, but shortages occur in winter. As a mitigation measure, water can be released from the Low's Creek Dam in the months of May through to the end of October. In order to maintain the assurance of supply at its current level, a release of approximately 1 million m^3/annum will be required. Figure 4.4 shows the pattern of this release.

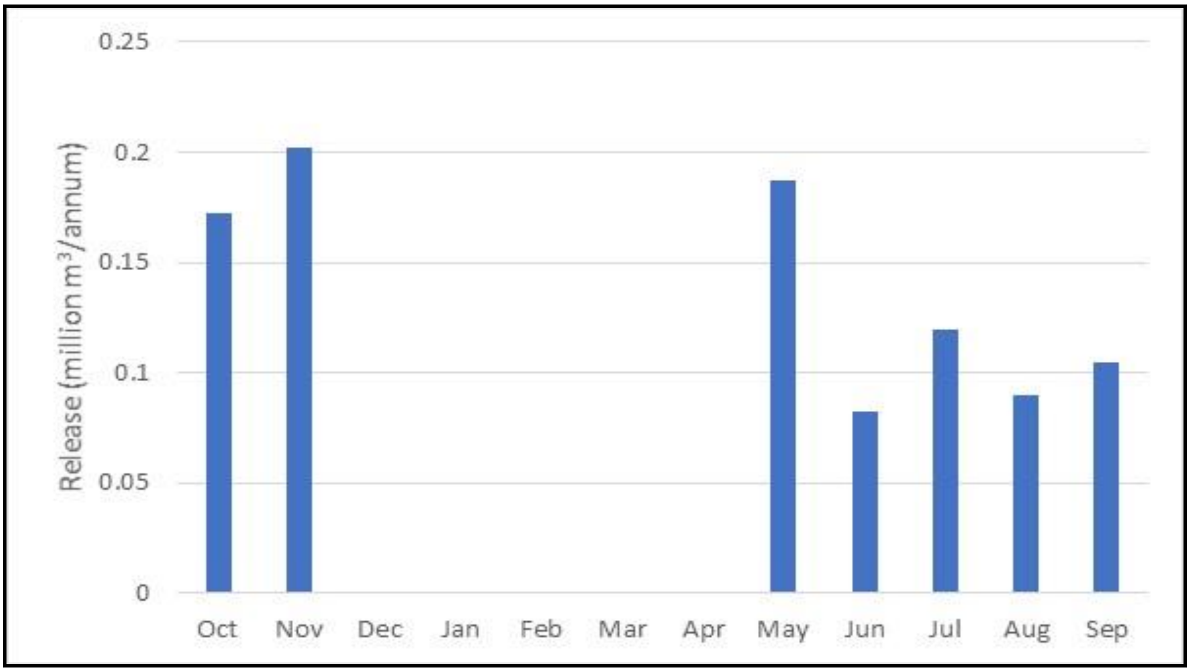

Figure 0.4: Release from Lows Creek Dam to compensate downstream irrigators

This reduces the yield of the dam to 2.2 million m^3/annum assuming the preferred full supply capacity of 195 000 m^3.

d. Ecological Water Requirements of the Kaap River

The EWR of the Kaap River was determined by DWS in 2009 (DWS, 2009). However, the EWR site is located upstream of the confluence of the Low's Creek River with the result that any development on the Low's Creek River will not influence the flow at the EWR site. Figure 4.5 show the EWR at site 7 as a time series while Figure 4.6 shows the EWR as a duration curve from which it can be concluded that the EWR at Site 7 is substantially met.

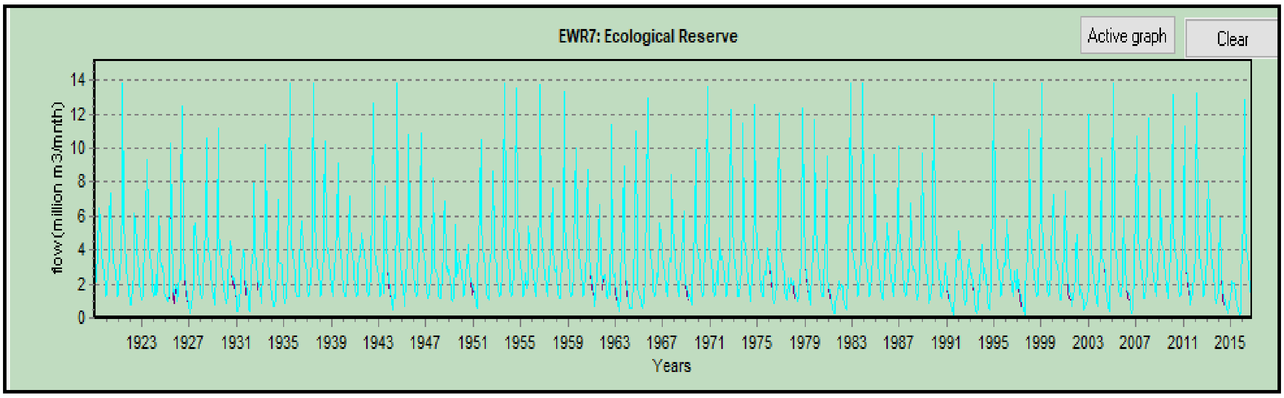

Figure 0.5: EWR Site 7 (Time series)

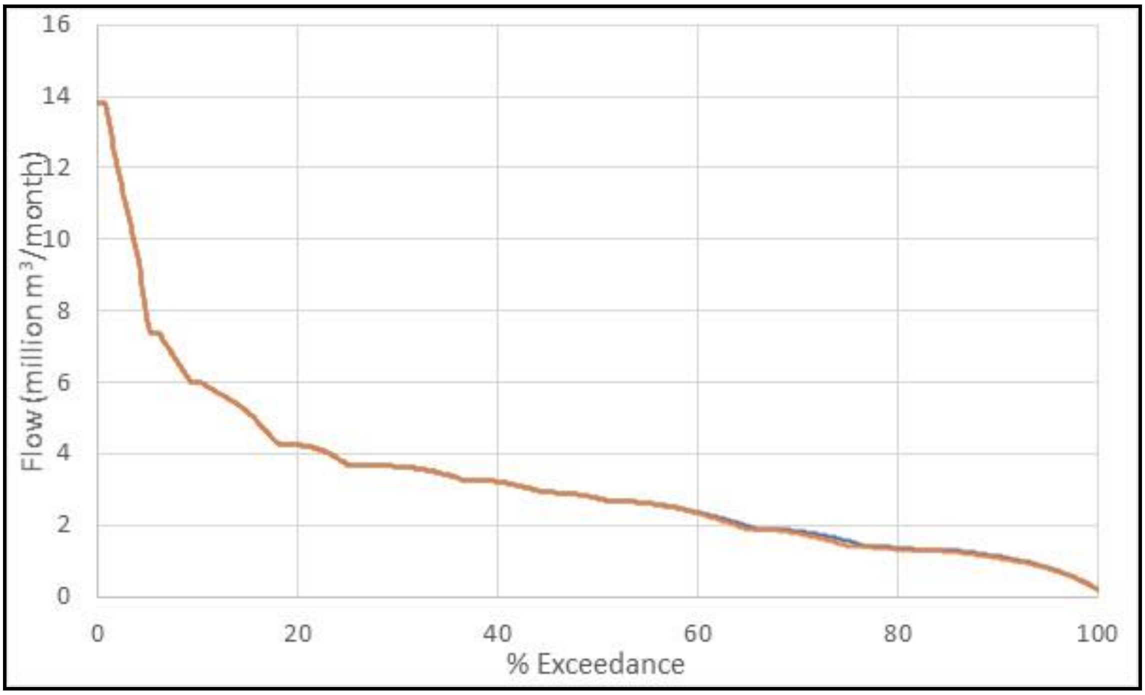

Figure 0.6: EWR Site 7 (Duration Curve)

While the EWR is substantially met at Site 7, the principle of ecological flow requirements is that it is a continuum which needs to be me along the entire river reach and not only at a particular point in the river. Extrapolating the EWR to the lower end of the Kaap River, downstream of the confluence with the Low's Creek River results in periodic failure of the EWR as indicated in Figure 4.7.and 4.8.

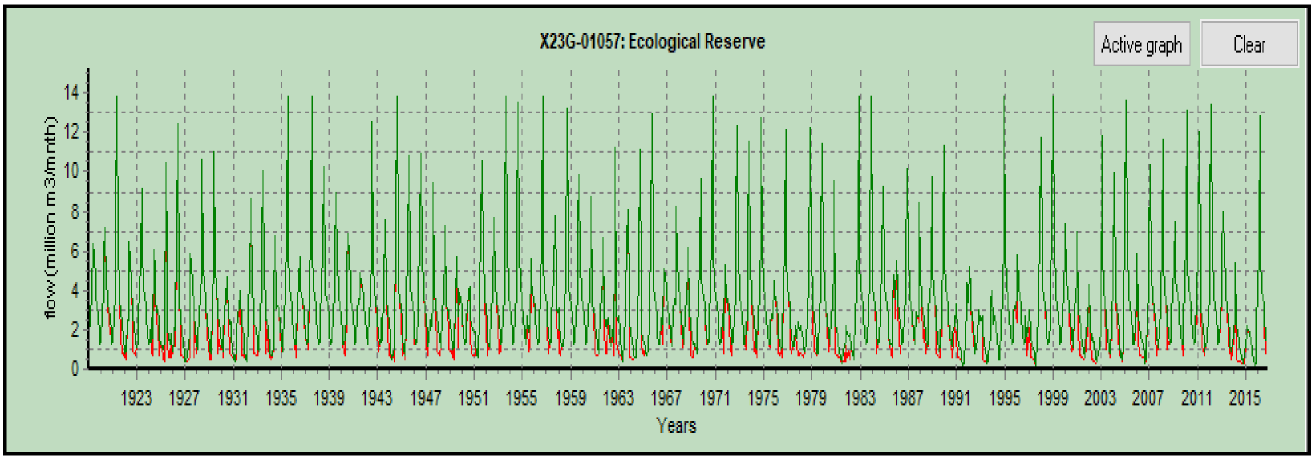

Figure 0.7: EWR at the lower end of the Kaap River

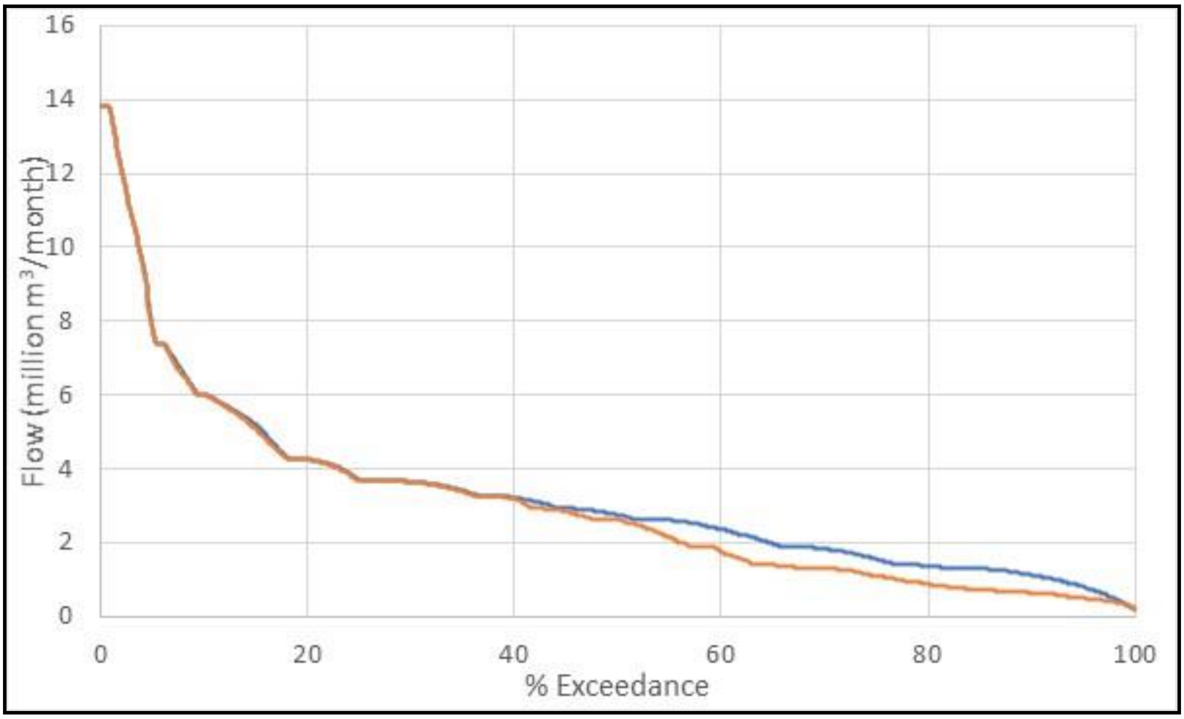

Figure 0.8: EWR at the lower end of the Kaap River (duration curve)

The failure of the EWR at the lower end of the Kaap River is an issue that needs to be addressed by restricting abstraction of all water users in the system. It is not a problem that can be solved by the proposed Low's Creek Dam, but the release of a category B EWR from the dam and a compensation release of 1.0 million m /annum will ensure that lack of compliance with the EWR is not exacerbated.

5.SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

IWR Water Resources were appointed to carry out a Yield Analysis of a proposed dam on the Low's Creek River, referred to in this report as the Low's Creek Dam. The dam site that has been identified is on the lower reaches of the Low's Creek River immediately upstream of the confluence with the Kaap River.

While there is a significant amount of irrigation within the Low's Creek catchment, the water for this irrigation is supplied from the Shiyalongubu Dam, located on a tributary of the Lomati River. The only developments which reduces the runoff from the Low's Creek catchment is forestry which reduces the runoff by about 5% of the natural runoff. There is also a small area of irrigation on the Revolver Creek supplied out of the Manders Dam which will reduce the runoff into the proposed dam.

The yield of the dam was assessed over a range of full supply capacities. At the preferred full supply capacity of 195 000 m^3, the yield is 3.2 million m^3/annum at 70% assurance. However, the low flow downstream of the dam will decrease significantly due to this development. In order to compensate downstream irrigators a release of a B category EWR as well as an additional 1.0 million m^3/annum is recommended. This decreases the yield of the dam to 2.2 million m^3/annum. The latter release should take place over the months May to the end of October.

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Mallory, S.J.L, Desai, A.Y., Odendaal, P. (2013) Water Resources Modelling Platform (Version 3.4) – User's Guide, www.waterresources.co.za

APPENDIX A: ECOLOGICAL WATER REQUIREMENTS

Summary of IFR rule curves for: Lows Creek Dam
Total Runoff: Runoff: RREGIO
Regional Type: Lowveld
EMC = B

Data are given in m^3/s mean monthly flow

Month	% Points									
	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.154	0.147	0.132	0.109	0.081	0.058	0.043	0.036	0.033	0.033
Nov	0.203	0.195	0.177	0.147	0.110	0.075	0.052	0.041	0.038	0.038
Dec	0.479	0.395	0.316	0.236	0.138	0.091	0.063	0.051	0.050	0.050
Jan	0.336	0.296	0.253	0.200	0.131	0.087	0.059	0.048	0.048	0.048
Feb	1.298	1.048	0.822	0.600	0.327	0.208	0.137	0.108	0.104	0.104
Mar	0.401	0.384	0.348	0.287	0.212	0.142	0.095	0.073	0.067	0.067
Apr	0.266	0.254	0.228	0.186	0.138	0.097	0.070	0.058	0.054	0.054
May	0.229	0.217	0.192	0.154	0.113	0.080	0.060	0.050	0.047	0.047
Jun	0.228	0.217	0.195	0.160	0.120	0.086	0.064	0.052	0.047	0.046
Jul	0.196	0.185	0.164	0.133	0.099	0.071	0.054	0.045	0.041	0.040
Aug	0.170	0.162	0.145	0.120	0.091	0.066	0.049	0.041	0.037	0.036
Sep	0.151	0.144	0.128	0.104	0.077	0.056	0.043	0.037	0.035	0.034

Reserve Flows without High Flows

Oct	0.130	0.124	0.112	0.093	0.070	0.051	0.039	0.033	0.031	0.031
Nov	0.127	0.122	0.112	0.094	0.073	0.053	0.039	0.033	0.031	0.031
Dec	0.153	0.146	0.132	0.108	0.081	0.057	0.042	0.037	0.036	0.036
Jan	0.182	0.175	0.160	0.134	0.100	0.069	0.049	0.041	0.041	0.041
Feb	0.299	0.285	0.256	0.208	0.152	0.104	0.075	0.063	0.062	0.062
Mar	0.279	0.268	0.244	0.203	0.153	0.107	0.075	0.060	0.056	0.056
Apr	0.266	0.254	0.228	0.186	0.138	0.097	0.070	0.058	0.054	0.054
May	0.229	0.217	0.192	0.154	0.113	0.080	0.060	0.050	0.047	0.047
Jun	0.228	0.217	0.195	0.160	0.120	0.086	0.064	0.052	0.047	0.046
Jul	0.196	0.185	0.164	0.133	0.099	0.071	0.054	0.045	0.041	0.040
Aug	0.170	0.162	0.145	0.120	0.091	0.066	0.049	0.041	0.037	0.036
Sep	0.151	0.144	0.128	0.104	0.077	0.056	0.043	0.037	0.035	0.034

Natural Duration curves

Oct	0.347	0.273	0.220	0.209	0.202	0.190	0.183	0.161	0.153	0.108
Nov	0.984	0.532	0.440	0.359	0.278	0.239	0.216	0.197	0.162	0.123
Dec	1.378	0.982	0.668	0.553	0.426	0.332	0.280	0.235	0.202	0.127
Jan	2.053	1.191	0.803	0.642	0.534	0.448	0.347	0.302	0.228	0.149
Feb	2.720	1.517	1.000	0.628	0.550	0.438	0.343	0.285	0.256	0.136
Mar	1.777	0.963	0.728	0.609	0.463	0.399	0.299	0.261	0.220	0.153
Apr	1.161	0.806	0.617	0.544	0.478	0.390	0.297	0.255	0.220	0.147
May	0.717	0.612	0.493	0.463	0.377	0.321	0.258	0.224	0.198	0.134
Jun	0.637	0.459	0.421	0.363	0.336	0.285	0.239	0.212	0.193	0.131
Jul	0.459	0.366	0.321	0.280	0.261	0.235	0.217	0.190	0.175	0.123
Aug	0.355	0.299	0.250	0.235	0.220	0.209	0.198	0.183	0.157	0.112
Sep	0.309	0.243	0.228	0.216	0.208	0.201	0.197	0.174	0.150	0.116

APPENDIX 4.5.6:
HERITAGE IMPACT ASSESSMENT

SPECIALIST REPORT

PHASE 1 ARCHAEOLOGICAL / HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED LOUWS CREEK DAM PROJECT: CONSTRUCTION OF AN IRRIGATION DAM ON PORTIONS OF THE REMAINING EXTENT OF THE FARM ESPERADO 253JU AND PORTIONS 1 & 2 OF ESPERADO ANNEX 222JU, LOUW'S CREEK-KAAPMUIDEN AREA, MPUMALANGA PROVINCE

REPORT COMPILED FOR

RHENGU ENVIRONMENTAL SERVICES

MR. RALF KALWA

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JULY 2020

ADANSONIA HERITAGE CONSULTANTS

ASSOCIATION OF SOUTHERN AFRICAN PROFESSIONAL ARCHAEOLOGISTS

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P.O. BOX 75, PILGRIM'S REST, 1290

EXECUTIVE SUMMARY

A Phase 1 Heritage Impact Assessment (HIA) regarding archaeological and other cultural heritage resources was conducted on the footprint for the Low's Creek Dam Project development of a proposed storage dam for irrigation purposes *on portions of the remaining extent of the farm ESPERADO 253JU & portions 1 & 2 of the farm ESPERADO ANNEX 222JU*, Low's Creek in the Kaapmuiden area.

The study area is situated on topographical map 1:50 000, 2531CB, which is in the Mpumalanga Province. This area falls under the jurisdiction of the Ehlanzeni District Municipality, and Nkomazi Local Municipality.

The National Heritage Resources Act, no 25 (1999) (NHRA), protects all heritage resources, which are classified as national estate. The NHRA stipulates that any person who intends to undertake a development, is subjected to the provisions of the Act.

The applicants, Mr. Walter Giuricich and Mr. Riaan Kotze in co-operation with Rhengu Environmental Services, is requesting the development of a storage dam for irrigation purposes on the ESPERADO farms, to provide for adequate water in the agricultural activities. The proposed dam area will cover an area of approximately 6.5ha. The farms on both sides of the Low's Creek, were historically disturbed by commercial farming activities such as banana, paw paw and macadamia orchards, and both farms are adjacent to other large commercial farms in the north, south, east and west.

The proposed development is situated approximately 6km south of the N4 national road. Swaziland is situated approximately 30 km to the south. Low's Creek is situated in natural riverine (riparian) vegetation consisting of large trees and areas of dense scrub. Alien species were also observed in the study area. The farm is zoned as agricultural.

The survey revealed no archaeological or historical features or graves, and it is unlikely to find such features in the riparian zone of a river where flooding may occur. Both owners of the farms were interviewed and confirmed that they, or their farm workers, have never encountered graves or archaeological features in the study area.

It is recommended that the owners be made aware that distinct archaeological material or human remains may only be revealed during the construction operation. Due to the dense grass cover along the Low's Creek during the survey, it is recommended that when construction of the dam commences, earthmoving activities be monitored by a qualified archaeologist which will assess any finds should it be necessary. Based on the survey and the findings in this report, Adansonia Heritage Consultants state that there are no compelling reasons which may prevent the proposed development to continue.

Disclaimer: Although all possible care is taken to identify all sites of cultural significance during the investigation, it is possible that hidden or sub-surface sites could be overlooked during the study. Christine Rowe trading as Adansonia Heritage Consultants will not be held liable for such oversights or for costs incurred by the client as a result.

………………………..

CHRISTINE ROWE

JULY 2020

CONTENTS

PHASE 1 ARCHAEOLOGICAL / HERITAGE IMPACT ASSESSMENT FOR THE PROPOSED LOWS CREEK DAM PROJECT: CONSTRUCTION OF AN IRRIGATION DAM ON PORTIONS OF THE REMAINING EXTENT OF THE FARM ESPERADO 253JU AND PORTIONS 1 & 2 OF ESPERADO ANNEX 222JU, LOW'S CREEK-KAAPMUIDEN AREA, MPUMALANGA PROVINCE

A. BACKGROUND INFORMATION TO THE PROJECT

The applicants, Mr. Walter Giuricich and Mr. Riaan Kotze in co-operation with Rhengu Environmental Services, is requesting the development of a storage dam for irrigation purposes on the ESPERADO farms, to provide for adequate water in the extensive agricultural activities on both farms. There were three options for possible dam sites, but only one proved to be feasible, and will be discussed in this report. The area for the dam site will approximately be 6.5ha in size. The study area is situated on portions of the remaining extent of the farm ESPERADO 253JU & portions 1 & 2 of ESPERADO ANNEX 222JU, in the Low's Creek area. [1] The farms on both sides of the Low's Creek, were historically disturbed by commercial farming activities such as banana, paw paw and macadamia orchards, and both farms are adjacent to other large commercial farms in the north, south, east and west (see map 6: Google image).

Adansonia Heritage Consultants were appointed by *RHENGU ENVIRONMENTAL SERVICES,* to conduct a Phase 1 heritage impact assessment (HIA) on archaeological and other heritage resources on the study area. A literature study, relevant to the study area as well as a foot survey was done, to determine that no archaeological or heritage resources will be impacted upon (see map 4: Topographical Map: 2531CB (1984).

The aims of this report are to source all relevant information on archaeological and heritage resources in the study area, and to advise the client on sensitive heritage areas as well as where it is viable for the development to take place in terms of the specifications as set out in the National Heritage Resources Act no., 25 of 1999 (NHRA). Recommendations for maximum conservation measures for any heritage resources will also be made. The study area is indicated in maps 1 - 6, and Appendix 1 & 2.

- This study forms part of an EIA, Consultant: *RHENGU ENVIRONMENTAL SERVICES*., P.O. Box 1046, Malelane, 1320, Cell: 0824147088 / Fax: 0866858003 / e-mail: rhengu@mweb.co.za
- Type of development: Construction of the Low's Creek Dam for irrigation purposes. The dam will be in the extent of 6.5ha and located *on portions of the remaining extent of the farm ESPERADO 253JU & portions 1 & 2 of the farm ESPERADO ANNEX 222JU*, in the Low's Creek / Kaapmuiden area, Mpumalanga Province.
- The study areas are partly natural and disturbed land and zoned as agricultural – no

[1] BID, Rhengu Environmental Services, p.4.

rezoning will take place.

- Location of Province, Magisterial district / Local Authority and Property (farms): The area falls within the Mpumalanga Province under the jurisdiction of the Ehlanzeni District Municipality and Nkomazi Local Municipality.
- Landowners (two farms): Mr. Walter Giuricich (Cell: 0829676757 / e-mail: walter@ivorymacs.co.za) and Mr. Riaan Kotze (Cell: 0829482257 / e-mail: hak.riaan@gmail.com).

Terms of reference: As specified by section 38 (3) of the NHRA, the following information is provided in this report.

a) The identification and mapping of heritage resources where applicable;
b) Assessment of the significance of the heritage resources;
c) Alternatives given to affected heritage resources by the development;
d) Plans for measures of mitigation.

Legal requirements:

The legal context of the report is grounded in the National Heritage Resources Act no. 25, 1999, as well as the National Environmental Management Act (1998) (NEMA) (as amended):

- In terms of Government Notice R546, a basic Environmental Impact Assessment is required in terms of listed activities.

- **Section 38 of the NHRA**

This report constitutes a heritage impact assessment investigation linked to the environmental impact assessment required for the development. The proposed development is a listed activity in terms of Section 38 (1) of the NHRA. Section 38 (2) of the NHRA requires the submission of a HIA report for authorisation purposes to the responsible heritage resources agency, (SAHRA). Heritage conservation and management in South Africa is governed by the NHRA and falls under the overall jurisdiction of the South African Heritage Resources Agency (SAHRA) and its provincial offices and counterparts.

Section 38 of the NHRA requires a Heritage Impact Assessment (HIA) to be conducted by an independent heritage management consultant, for the following development categories:

- Any development or other activity which will change the character of a site:
  - exceeding 5000m² in extent;
  - the rezoning of a site exceeding 10 000m² in extent;

In addition, the new EIA regulation promulgated in terms of NEMA (as amended), determines that any environmental report will include cultural (heritage) issues.

The end purpose of this report is to alert *RHENGU ENVIRONMENTAL SERVICES*, as well as the clients, interested and affected parties about existing heritage resources that may be affected by the proposed development, and to recommend mitigation measures aimed at reducing the risks of any adverse impacts on these heritage resources. Such measures could include the recording of any heritage buildings or structures older than 60 years prior to demolition, in terms of section 34 of the NHRA and also other sections of this act dealing with archaeological sites, buildings and graves.

The NHRA section 2 (xvi) states that a “heritage resource” means any place or object of cultural significance, and in section 2 (vi) that “cultural significance” means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance.

Apart from a heritage report assisting a client to make informed development decisions, it also serves to provide the relevant heritage resources authority with the necessary data to perform their statutory duties under the NHRA. After evaluating the heritage scoping report, the heritage resources authority will decide on the status of the resource, whether the development may proceed as proposed or whether mitigation is acceptable, and whether the heritage resource require formal protection such as a Grade I, II or III, with relevant parties having to comply with all aspects pertaining to such a grading.

- **Section 35 of the NHRA**

Section 35 (4) of the NHRA stipulates that no person may, without a permit issued by SAHRA, destroy, damage, excavate, alter or remove from its original position, or collect, any archaeological material or object. This section may apply to any significant archaeological sites that may be discovered. In the case of such chance finds, the heritage practitioner will assist in investigating the extent and significance of the finds and consult with an archaeologist about further action. This may entail removal of material after documenting the find or mapping of larger sections before destruction. No archaeological material was found during the survey.

- **Section 36 of the NHRA**

Section 36 of the NHRA stipulates that no person may, without a permit issued by SAHRA, destroy, damage, alter, exhume or remove from its original position or otherwise disturb any grave or burial ground older than 60 years, which is situated outside a formal cemetery administered by a local authority. It is possible that chance burials might be discovered during development of the road infrastructure or agricultural activities. No graves were identified during the survey and both owners who were interviewed, confirmed this.

- **Section 34 of the NHRA**

Section 34 of the NHRA stipulates that no person may alter, damage, destroy, relocate etc., any building or structure older than 60 years, without a permit issued by SAHRA or a provincial heritage resources authority. This section does not apply since no structure older than 60 years was identified in the study area during the survey.

- **Section 37 of the NHRA**

This section deals with public monuments and memorials but does not apply in this report.

- **NEMA**

The regulations in terms of Chapter 5 of the National Environmental Management Act, (107/1998 / as amended), provides for an assessment of development impacts on the cultural (heritage) and social environment and for specialist studies in this regard.

B BACKGROUND TO ARCHAEOLOGY AND HISTORY OF THE STUDY AREA

- **Literature review, museum databases & previous relevant impact assessments**

Very little contemporary research has been done on prehistoric African settlements in the study area. No Early or Later Stone or Iron Age sites were recorded by Bergh.[2] The SAHRA database was consulted and a few Specialists AIA reports revealed no significant archaeological (Stone Age or Iron Age) sites.

STONE AGE

- The Stone Age is the period in human history when people produced stone tools. The Stone Age in South Africa can be divided in three periods:
- Early Stone Age (ESA): +- 2 million – 150 000 years ago;
- Middle Stone Age (MSA): +- 150 000 – 30 000 years ago;
- Later Stone Age (LSA): +- 40 000 – 1850AD.

IRON AGE

- The Iron Age is the period in time when humans manufactured metal artifacts. According to Van der Ryst & Meyer, [3] it can be divided in two separate phases, namely:
- Early Iron Age (EIA) +- 200 – 1000 AD;
- Late Iron Age (LIA) +- 1000 – 1850 AD.

Archaeological surveys by heritage practitioners in the immediate and wider area revealed mainly burial sites and historic features (see below).

In order to place the areas in and around Kaapmuiden / Low's Creek to Nelspruit and north towards Bushbuckridge in an archaeological context, primary and secondary sources were consulted. Ethnographical and linguistic studies by early researchers such as Ziervogel and Van Warmelo shed light on the cultural groups living in the area since ca 1600. Historic and academic sources by Küsel, Meyer, Voight, Bergh, De Jongh, Evers, Myburgh, Thackeray and Van der Ryst were consulted, as well as historic sources by Makhura and Webb.

Primary sources were consulted from the Pilgrim's Rest Museum Archives for a background on the pre-history and history of the study area. The author was involved in a *Desktop Study for Proposed Eskom Powerlines, Hazyview – Dwarsloop* in 2008, *Inspection of Umbhaba Stone-walled settlement, Hazyview,* in 2001, as well as a *Phase 1 Archaeological and Heritage Impact Assessment for 132Kv Powerlines from Kiepersol substation (Hazyview), to the Nwarele substation (Dwarsloop (2002),* as well as a *Phase 1 Archaeological and Heritage Impact Assessment for a proposed traffic training academy, Calcutta, Mkhuhlu, Bushbuckridge* (2013*).* The SAHRA database for archaeological and historical impact assessments was consulted and

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[2] J.S. Bergh, *Geskiedenis Atlas van Suid-Afrika Die Vier Noordelike Provinsies*, pp. 4-7.
[3] Van der Ryst, M.M, & Meyer, A, Die Ystertydperk in *Geskiedenis Atlas van Suid-Afrika Die Vier Noordelike Provinsies,* pp. 96 – 98.

revealed a few reports for the Komatipoort region, which are listed below. One report for Bushbuckridge (F. Roodt), and one for Acornhoek (JP Celliers) revealed no archaeological sites of significance. Two reports by Dr. J. Van Schalkwyk (NCHM) revealed only historical sites close to the Komatipoort – Mozambique border.[4] Reports by Birkholz and Van Vollenhoven for the Nelspruit area revealed historical / recent structures and graves but no archaeological features.

Very little contemporary research has been done on prehistoric African settlements in the study area. Later Stone Age sites in the Kruger National Park date to the last 2500 years and are associated with pottery and microlith stone tools.[5] The only professionally excavated Early Iron Age site in the immediate area, besides those in the Kruger National Park, is the Plaston site towards the west, dating ca 900 AD.[6] No other archaeological excavations have been conducted to date within the study area, which have been confirmed by academic institutions and specialists in the field.[7] [8] A stone walled settlement with terracing was recorded by C. van Wyk (Rowe) close to Hazyview,[9] as well as several others further west and north-west,[10] outside of the study area. Research has been done by the Pilgrim's Rest Museum on San rock art as well as rock art made by Bantu speakers in the Escarpment area, but none have been recorded to date in the Low's Creek area.[11]

Several early ethnographical and linguistic studies by early researchers such as D. Ziervogel and N.J. Van Warmelo, revealed that the study area was inhabited by mainly Swazi groups from before the 18th century.[12] [13] However, when concentrating on ethnographical history, it is important to include a slightly wider geographical area in order for it to make sense.

The whole district is divided in two, with the Drakensberg Escarpment in the west, and the Low Veld (in which the study area is situated) towards the east. Today, we found that the boundaries of groups are intersected and overlapping.[14] Languages such as Zulu, Xhosa, Swazi, Nhlanganu, Nkuna, sePedi, hiPau and seRôka, are commonly spoken throughout this area.[15]

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[4] National Cultural History Museum, 2002., Archaeological Survey of a section of the Secunda-Mozambique Gas Pipeline, Barberton District, Mpumalanga & J. Van Schalkwyk, 2008., HIA Report: Proposed new Lebombo Port of Entry and Upgrade of Komatipoort Railway Station, Mpumalanga (SA) & Mozambique.
[5] J.S. Bergh (red)., *Geskiedenis Atlas van Suid Afrika: Die vier Noordelike Provinsies,* p. 95.
[6] M.M. Van der Ryst., Die Ystertydperk, *in J.S. Bergh (red)., Geskiedenis Atlas van Suid Afrika: Die vier Noordelike Provinsies.* p. 97.
[7] Personal information: Dr. J. Pistorius, Pretoria, 2008-04-17.
[8] Personal information: Dr. MS. Schoeman, University of Pretoria, 2008-03-27.
[9] C. Van Wyk, *Inspection of Umbhaba Stone-walled settlement, Hazyview,* pp. 1-2.
[10] PRMA: Information file 9/2.
[11] PRMA: Information file 9/2.
[12] N.J. Van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa.* pp. 90-92 & 111.
[13] H. S. Webb, The Native Inhabitants of the Southern Lowveld, *in Lowveld Regional Development Association, The South-Eastern Transvaal Lowveld.* p. 16.
[14] N.J. van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa*, p. 51.
[15] M. De Jongh (ed)., *Swatini,* p. 21.

The Swazi under Mswati II (1845), commenced on a career of largescale raids on the prosperous tribal lands to the north of Swaziland. His regiments such as the *Nyatsi* and the *Malelane* brought terror to African homes as far afield as Mozambique.[16] During their northern expansion they forced the local inhabitants out of Swaziland, or absorbed them.[17] There is evidence of resistance, but the Eastern Sotho groups who lived in the northern parts of Swaziland, moved mainly northwards.[18] This appears to have taken place towards the end of the 18th century,[19] when these groups fled from Swaziland to areas such as Nelspruit, Bushbuckridge, Klaserie, Blyde River and Komatipoort.[20]

Mswati II built a line of military outposts from west to east of the upper Komati River and the Mlambongwane (Kaap River). At each outpost he stationed regiments to watch and stop the BaPedi returning to their old haunts.[21] Shaka in the course of his military actions, came into conflict with Zwide Mkhatshwa (1819). Nonwithstanding Zwide's numerical superiority, Shaka defeated him. The remnants of Zwide's tribe fled into the Eastern Transvaal where they settled. They ultimately found a new kingdom in Gaza land, which extended from just north of the current Maputo, up the east coast as far as the Zambezi river.[22] Soshangane was a very powerful chief of the Gaza people, even though he was under the rule of Zwide. Soshangane decided to leave and was given full passage through Swaziland. He passed on his way through the Komati gorge, today known as Komatipoort, taking with him a great booty of cattle and women. Meanwhile more Shangane arrived and by 1896 some 2000 refugees settled between Bushbuckridge and Acornhoek where they are still living today. With the establishment of the Sabie Game Reserve (later known as the Kruger National Park), the BakaNgomane, their Shangaan protégés and Swazis who lived within its borders, were evicted in 1902, and went westward into Klaserie and Bushbuckridge areas, or south of the Crocodile River and established themselves in the Tenbosch and Coal Mine (Strijdom Block) areas (east of the current study area), west and south of Komatipoort. The Swazi of Khandzalive moved to Mjejane or Emjejane, the current name for Hectorspruit.[23] (See also: Map 1: 1935 Map of Van Warmelo).

Several circular stone-walled complexes and terraces as well as graves have been recorded in the vicinities of Hazyview[24], Bushbuckridge, Graskop and Sabie. Clay potsherds and upper as well as

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[16] Bornman H., *The Pioneers of the Lowveld* p 11.
[17] A.C. Myburgh, *The Tribes of Barberton District*, p. 10.
[18] N.J. Van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa.* p. 111.
[19] H. S. Webb, The Native Inhabitants of the Southern Lowveld, *in Lowveld Regional Development Association, The South-Eastern Transvaal Lowveld.* p. 14
[20] *Ibid.,* p. 16.
[21] Bornman H., *The Pioneers of the Lowveld* p. 12.
[22] Bornman, H., *The Pioneers of the Lowveld*, p.17.
[23] Bornman, H., *The Pioneers of the Lowveld*, p.19.
[24] PRMA: Information file 9/2.

lower grinding stones, are scattered at most of the sites.[25] Many of these occur in caves as a result of the Swazi attacks on the smaller groups.

The only early trade route mentioned, which crossed this section, was a footpath used by the African groups from Delagoa Bay towards Bushbuckridge (Magashulaskraal as it was previously named), along the Sabie river, up the Escarpment, and further north to the Soutpansberg.[26] There is however, no physical evidence left of this early route.

Van Warmelo based his 1935 survey of *Bantu Tribes of South Africa* on the number of taxpayers in an area. The survey does not include the extended households of each taxpayer, so it was impossible to indicate how many people were actually living in one area.[27]

The author was involved in desktop studies and surveys in the **wider area**, such as:

- *Study for the Proposed Eskom Powerlines, Hazyview – Dwarsloop* (2008);
- *Inspection of Umbhaba Stone-walled settlement, Hazyview,* (2001);
- a *Phase 1 Archaeological and Heritage Impact Assessment for 132Kv Powerlines from Kiepersol substation (Hazyview), to the Nwarele substation Dwarsloop (2002);*
- a *Phase 1 Archaeological and Heritage Impact Assessment for a proposed traffic training academy, Calcutta, Mkhuhlu, Bushbuckridge* (2013*);*
- *Phase 1 Archaeological and Heritage Impact Assessment for the proposed Nkambeni cemetery in Numbi, Hazyview (2013);* no features of significance were identified;
- *Phase 1 Archaeological and Heritage Impact Assessment for a Development on the farm Agricultural Holding no 56 JU, White River (2013)* was done in the wider area;
- *Phase 1 Archaeological and Heritage Impact Assessment for proposed agricultural development on the farm SIERAAD, Komatipoort area, (2013)* revealed one possible Late Stone Age borer which was identified in a soil sample, one meter below the surface*;*
- *Phase 1 AIA / HIA for proposed debushing of natural land for agricultural use: Portion 10 of the farm Thankerton 175JU, Hectorspruit, Mpumalanga Province (2013);* revealed some Later Stone Age artifacts which were all out of context and a burial site*.*
- *Phase 1 AIA / HIA for proposed debushing of natural as well as disturbed land for agricultural use: Portion 2 of the farm Herculina 155JU, Hectorspruit area, Mpumalanga Province*; no significant archaeological or historical features were identified.
- Letter of recommendation for the exemption from a Phase 1 AIA / HIA *for the proposed new position for the Gutshwa substation, Gutshwa (near White River) (2016);*
- Recommendation: Archaeological Material discovered on a building site at stand no 134 (Lugedlane Development), Mjejane Game Reserve, Lodwichs Lust 163JU, Hectorspruit

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[25] D. Ziervogel, *The Eastern Sotho, A Tribal, Historical and Linguistic Survey,* p. 3.
[26] L. Changuion & J.S. Bergh, Swart gemeenskappe voor die koms van die blankes, *in J.S. Bergh (red)., Geskiedenis Atlas van Suid Afrika: Die vier Noordelike Provinsies.* p. 104.
[27] N.J. van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa*, p.9.

(2016);

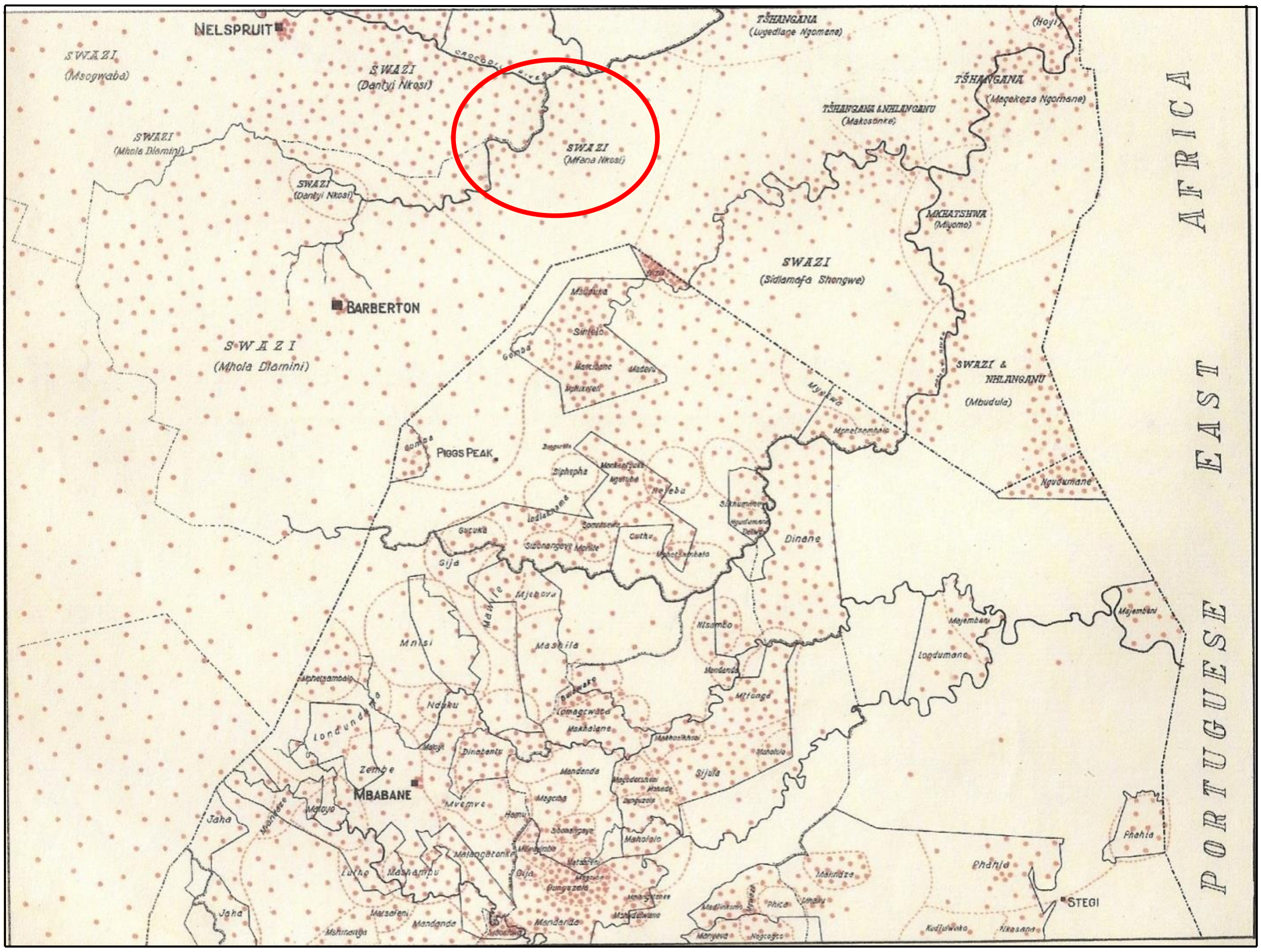
- Report on Grave site found at the Lugedlane Development site, Mjejane Game Reserve, Lodwichs Lust 163JU, Hectorspruit (2016).
- Phase 1 AIA / HIA for a *proposed agricultural development on the farm Krokodilspruit 248JT, White River, Mpumalanga Province* – some archaeological features as well as graves were observed.
- *Phase 1 AIA / HIA for proposed establishment of macadamia plantation on portion 1 of the farm PEEBLES 31JU,* White River, Mpumalanga Province;

The author was involved in desktop studies and surveys in the **immediate area,** such as:

- *Phase 1 AIA / HIA for proposed Residential Township, Tekwane Extension 2, Portion 7 of Tekwane 537JU, Kanyamazane, Mpumalanga Province (2014);* the entire area was transformed agricultural lands which revealed a few upper grinders*;*
- *Phase 1 AIA / HIA for proposed Reservoir, Bulk sewer and bulk water pipelines, Portion 7 of Tekwane 537JU, Kanyamazane, Mpumalanga Province (2014);* mostly disturbed residential areas which revealed no features of significance*;*
- Report on Grave site found at *portion 7 of the farm Tekwane 537 JU, in way of amended Bulk Sewer Pipeline, Kanyamazane, Mpumalanga Province (2017)* – Large graveyard identified.
- Phase 1 AIA / HIA *for the proposed construction of a 0.75ML/D water treatment plant and bulk line on government land at Makoko Village (near White River) Kabokweni, Mpumalanga Province (2017) residential township,*
- *Letter of recommendation for the exemption from a phase 1 AIA & HIA investigation: Proposed construction of a bridge on the D233 road in Louieville, Nkomazi local Municipality, Mpumalanga*, (April 2018). – no archaeological sites were observed.
- Phase 1 AIA / HIA for the *proposed 2ha development of the Msogwaba Youth Development Centre on a portion of the farm Nyamasaan 647JU, Msogwaba, Mpumalanga province* - no significant archaeological sites were observed (2018).
- DESKTOP *Heritage Impact Assessment for the proposed Tekwane Hub residential development on Portion 9 of the farm Tekwane 573JU, Mbombela, City of Mbombela, Mpumalanga* (2019).
- DESKTOP *HIA for the proposed construction of a gravity outfall sewer line through a wetland, UMP Township & Portion 74 of the farm Friedenheim 282JU, Mbombela, City of Mbombela, Mpumalanga* (2020).

The SAHRA database for archaeological and historical impact assessments was consulted and revealed other recent Archaeological Impact Assessment reports in the wider and immediate areas:

- National Cultural History Museum, J. Van Schalkwyk: Archaeological survey of a section of the Secunda- Mozambique Gas pipeline, Barberton District, Mpumalanga (2002), revealed one historic structure.
- J. Van Schalkwyk: *Proposed new Lebombo Port of Entry and upgrade of Komatipoort railway station between Mpumalanga (SA) and Mozambique (2008)* – Some historic buildings were identified but no archaeological remains;
- A. Van Vollenhoven: *Report on a cultural Heritage Impact Assessment for the proposed Kangwane Antracite Mine, Komatipoort (2012)* – An archaeological site with Middle and Late Stone Age tools were identified as well as some Iron Age artifacts and decorated pottery. Mitigation measures were recommended by exclusion from the development or a Phase 2 study;
- JP Celliers: *Report on Phase 1 Archaeological Impact assessment on erven at Komatipoort 182 JU Extension 4, Komatipoort (2012)* – Revealed two pieces of undecorated sherds of pottery which was of low significance. It was recommended that any earthmoving activities be monitored by a qualified archaeologist.
- A. Van Vollenhoven: *Archaeological Impact Assessment for Border site at Komatipoort (2012)* – Revealed historic remains linked to the Steinaeker's Horse regiment during the South African War.
- A. Van Vollenhoven: *A Report on a basic assessment relating to cultural heritage resources for the proposed ESKOM Tekwane North line and substations, Mupumalanga Province (2013)* – revealed historic remains of low significance and a cemetery.
- P. Birkholz: *HIA for the proposed development of the Karino Interchange located east of Mbombela, Mpumalanga Province (2017)* – Historical buildings and structures were revealed but no archaeological sites of features were identified.
- A. Van Vollenhoven: HIA for Aurecon, 15 June 2012, *Basic Assessment for the Environmental Impact Assessment for the Friedenheim Office Complex, Nelspruit, Mpumalanga*. – revealed no graves or archaeological sites. Recent buildings were observed.



MAP 1: Van Warmelo: 1935: The study area is indicated by the red oval.

Tsonga groups: The Nhlanganu and Tšhangana

The Nhlanganu and Tšhangana (also generally known as the Shangaan-Tsonga)[28] form part of the larger Tsonga group of which the original group occupied the whole of Mozambique (Portuguese East Africa), and it has been recorded that by 1554, they were already living around the Delagoa Bay area (Maputo).[29] They fled from the onslaughts of the Zulu (Nguni) nation from the Natal area, and great numbers of emigrants sought safety in the “Transvaal” as recently as the 19th century, especially in the greater Pilgrim's Rest district (including the study area that we are concerned with). The Tsonga also moved west from Mozambique into the “Transvaal”. They have never formed large powerful tribes but were mostly always subdivided into loosely knit units and absorbed under the protection of whichever chief would give them land.[30] They were originally of Nguni origin.[31] The term “Shangaan” is commonly employed to refer to all members of the Tsonga division.[32]

[28] M. De Jongh (ed)., *Swatini,* p. 24.

[29] N.J. Van Warmelo, Grouping and Ethnic History, *in Schapera I., The Bantu-Speaking Tribes of South Africa. An Ethnographical survey,* p. 55.

[30] N.J. Van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa*, pp. 90-91.

[31] N.J. Van Warmelo, Grouping and Ethnic History, *in Schapera I., The Bantu-Speaking Tribes of South Africa. An Ethnographical survey,* p. 55.

[32] N.J. Van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa*, p. 92

The **Nhlanganu** occupied the Low Veld area in their efforts to escape the Zulu raids during 1835-1840. They lived side by side with the Tšhangana, and the differences between the two are inconsiderable. They have mixed extensively with other tribes.[33]

The **Tšhangana** are also of Nguni origin who fled in the same way as the Nhlanganu and settled in the "Transvaal" a little later than the former. Most of the Tsonga were subjects to *Soshangane,* who came from Zululand.[34] The downfall of *Ngungunyana* (son of *Soshangane*) saw his son seeking sanctuary in the "Transvaal", and the latter became known as *Thulamahashi,*[35] the name that is still used for the area east of Busbuckridge.

The historical background of the study area confirmed that it was occupied since the 17th century by the Tsonga groups (Nhlanganu and Tšhangana). These groups have intermarried extensively or were absorbed by other groups in time.[36]

Swazi

The Swazi people descend from the southern Bantu (Nguni) who migrated from central Africa in the 15th and 16th centuries.[37] The differences between the Swazi and the Natal Nguni were probably never great, their culture as far as is known from the comparatively little research being carried out, does not show striking differences. Their language is a 'Tekeza' variation of Zulu, but through having escaped being drawn into the mainstream of the Zulus of the *Shaka* period, they became independent and their claim to be grouped apart as a culture is now well founded.[38]

[33] *Ibid.,*. pp. 91-92.
[34] N.J. Van Warmelo, Grouping and Ethnic History, *in Schapera I., The Bantu-Speaking Tribes of South Africa. An Ethnographical survey,* p. 57.
[35] N.J. Van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa*, p. 92.
[36] M. De Jongh (ed).*, Swatini,* p. 40.
[37] Internet access: http://en.wikipedia.org/wiki/Swaziland p.1.
[38] N.J. Van Warmelo, *A Preliminary Survey of the Bantu Tribes of South Africa*, p. 83.

C. DESCRIPTION OF THE AREA TO BE AFFECTED BY THE PROPOSED DEVELOPMENT

The proposed project will involve the following:

The applicants wish to develop an irrigation storage dam in the Low's Creek near the confluence with the Kaap River (figs. 5 – 6). It is proposed to construct the dam *on portions of the remaining extent of the farm ESPERADO 253JU and portions 1 & 2 of the farm ESPERADO ANNEX 222 JU.* The dimensions of the proposed dam are as follows:

- Wall Height 11.4m;
- Wall Length 245m;
- Cover an area of 6.5 ha;
- Storage capacity of 193 000 cubic meters;
- Maximum full supply water depth will be 8m;
- Additional infrastructure: pump house & pipelines.[39]

The development of this storage facility will allow the applicants / farmers to manage the water supply to the orchards in a sustainable manner reducing the risk of poor supply versus demand especially during the dry seasons.[40] The proposed dam development will cover the current riparian zone which consists of natural as well as alien vegetation in a section of the Low's Creek (see map 2), as well as some of the existing road infrastructure and historically disturbed agricultural lands (see google map 6 of the study area).

Large areas surrounding the *ESPERADO* farms have been historically disturbed by commercial sugar cane, banana, paw paw and other fruit farms (see map 6 & 4 topo map & study area). Most of the land surrounding the riparian zone of the Low's Creek and Kaap Rivers, has historically been disturbed with agricultural fields (see Appendix 2).

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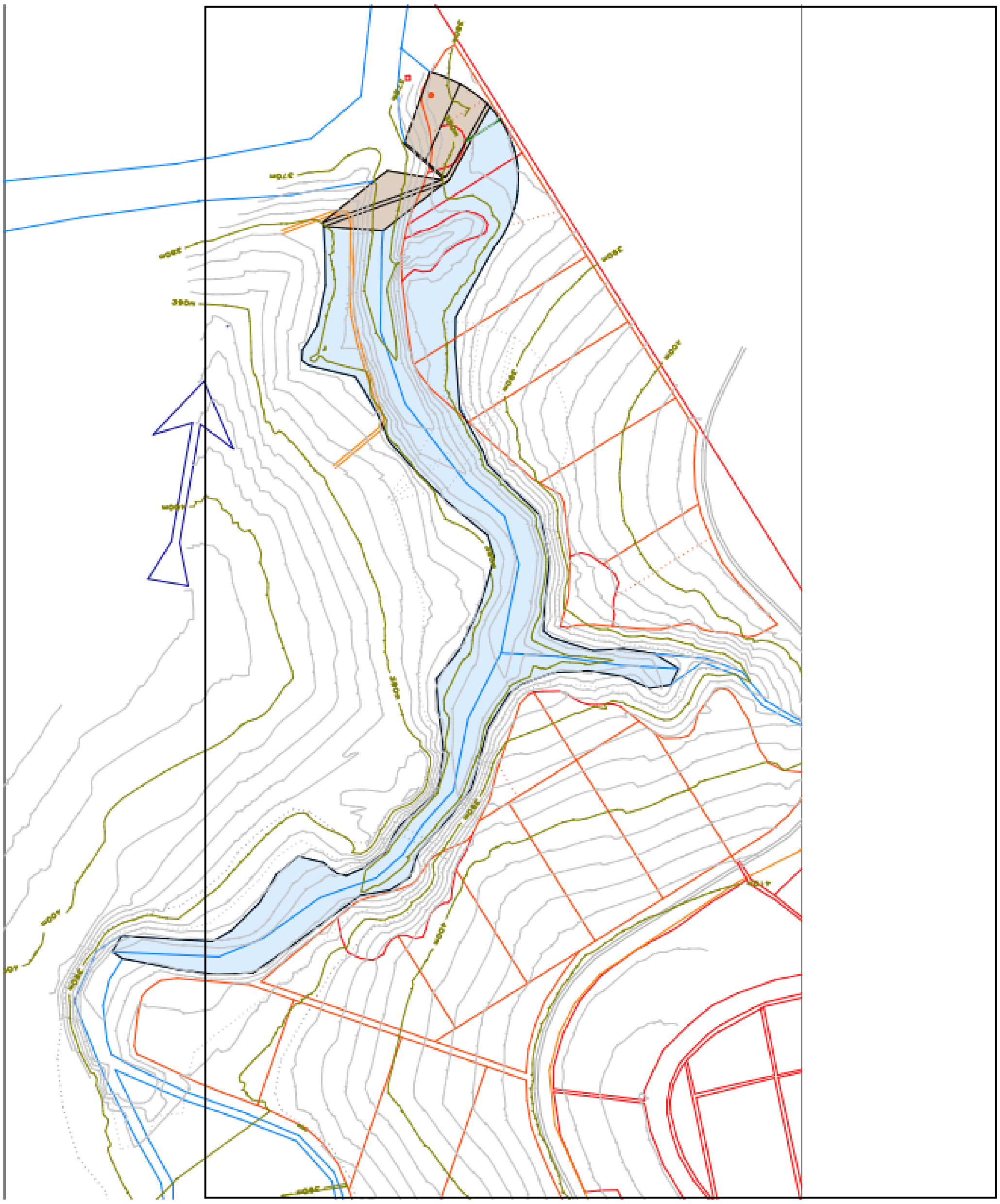
[39] BID, Rhengu Environmental Services, p.4.

[40] BID, Rhengu Environmental Services, p.4.



MAP 2: Proposed layout of the Louw's Creek Dam construction (Map provided by Rhengu Environmental Services).

Sections along the Low's Creek are partly natural and partly covered with invasive vegetation. Disturbances such as a quarry site (fig. 19), a donga (fig. 18) and a cleared area (fig. 16), also occur. These were all investigated for any remains of archaeological or historical nature, but nothing was observed.

The general study area consists of the mountainous bushveld of eastern Mpumalanga. The landscape is characterized by wooded hills and slopes, intersected by large perennial rivers and smaller streams. The general geology of the area consists of granite and gneiss, mostly of the Nelspruit suite, forming hills with large boulders. Soils are shallow, comprised of Glenrosa or Mispah soil types. [41]

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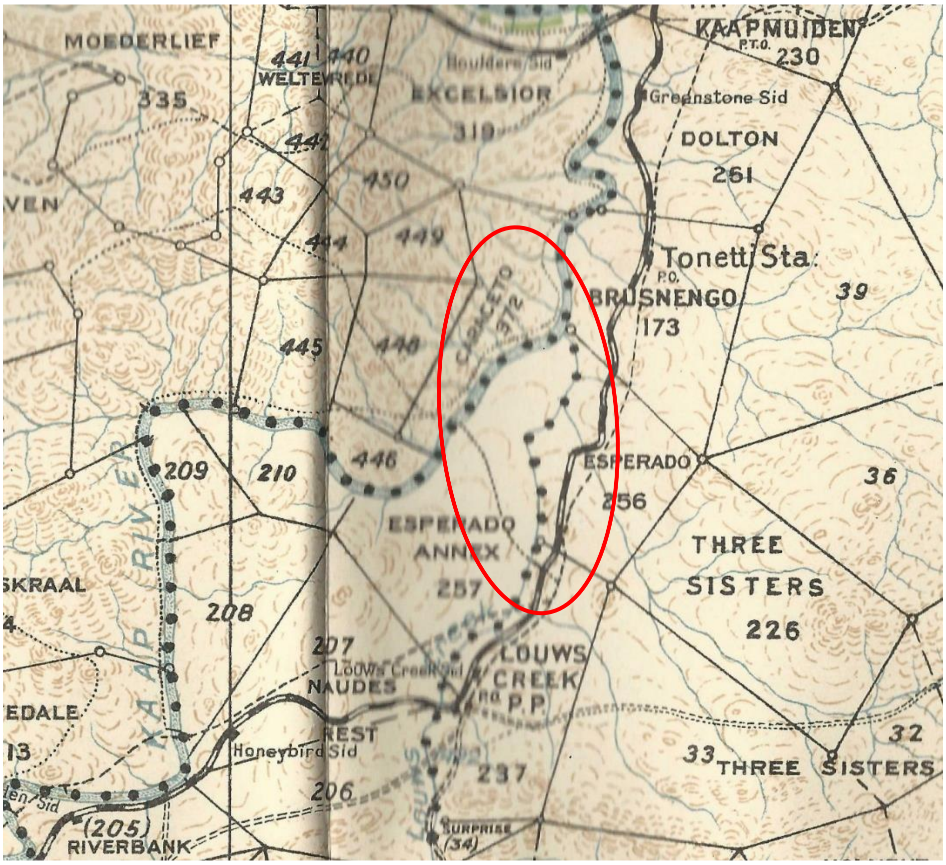
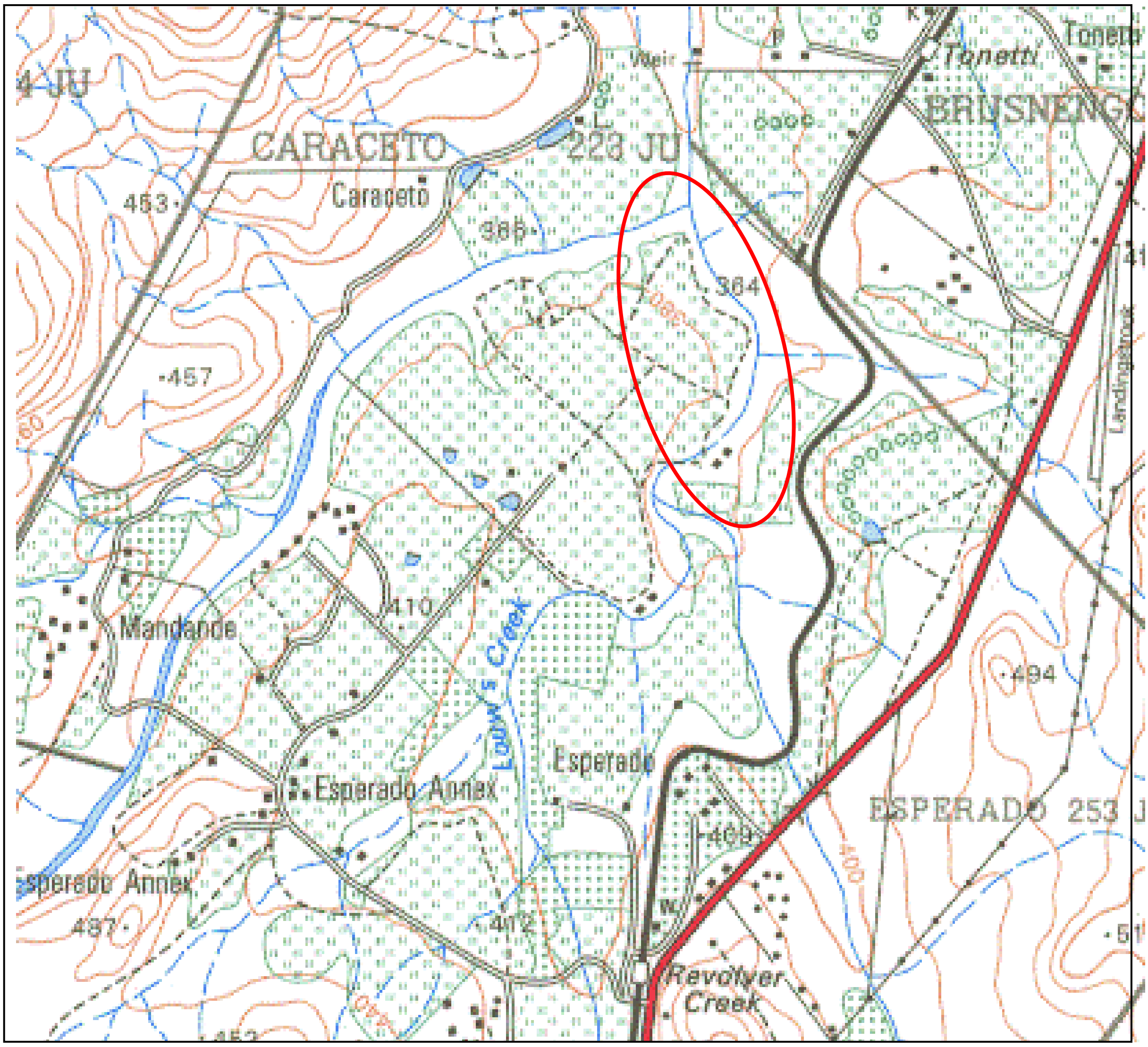
[41] Nelspruit area: Friedenheim Housing project, AEB, p. 2. Access: 2020-02-25.



MAP 3: The 1926 topographical map does not indicate any black settlements within or near the study area.

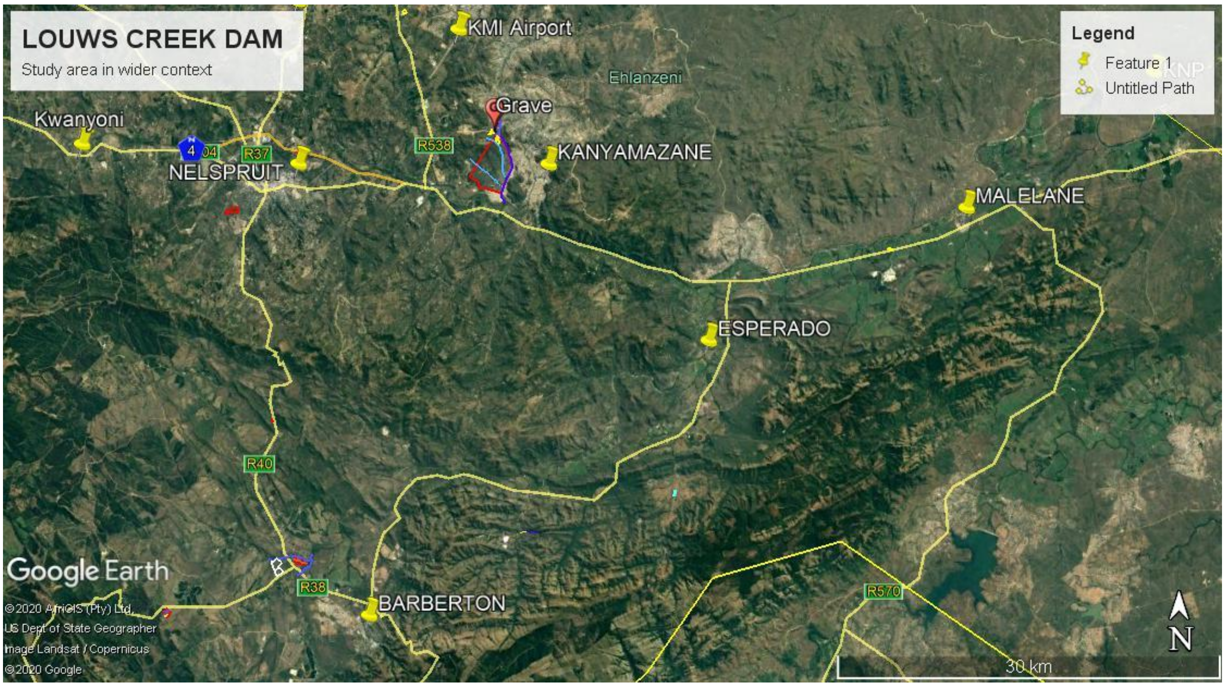


MAP 4: 1984 Topographical map: The study area is within red oval. No black settlements were recorded in the immediate area. Extensive cultivated lands are visible.

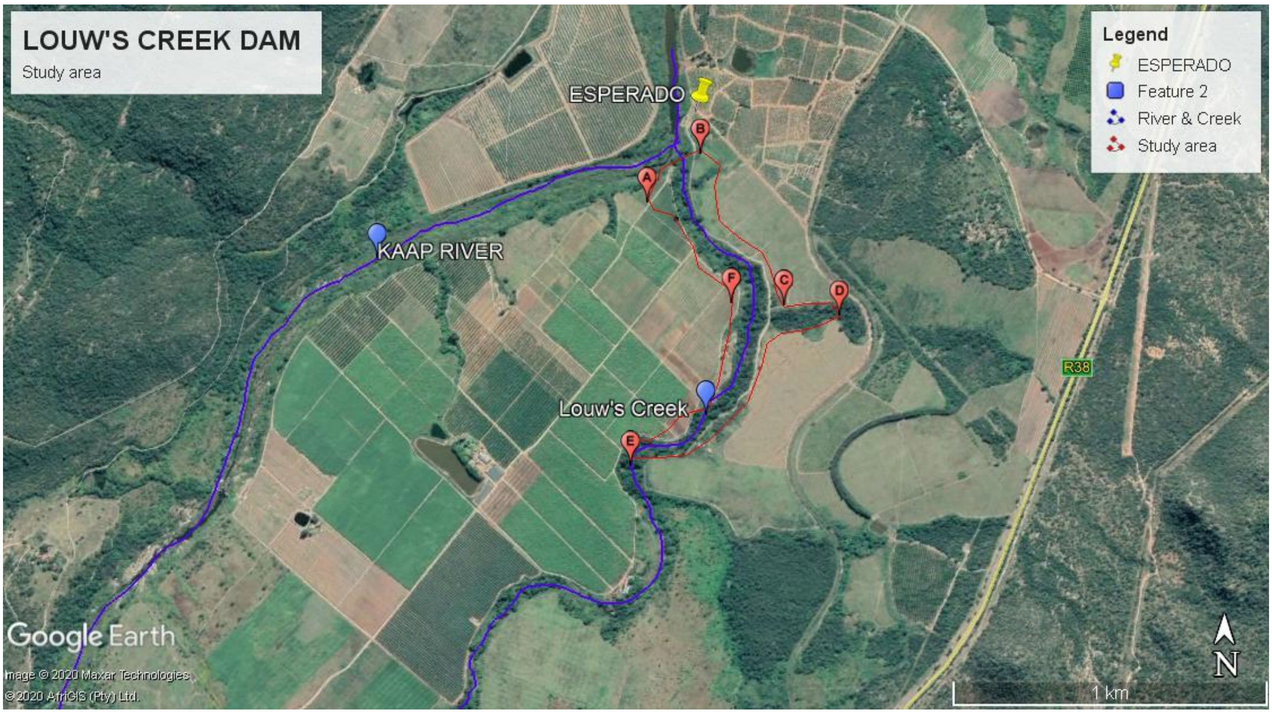
The *ESPERADO* farms are indicated on the 1984 (1: 50000) topographical map 2531CB (map 4). This map shows the extent of farming operations in the area, and on the property in the past.

D. LOCALITY

The proposed project site is located on portions of the remaining extent of the *farm ESPERADO 253JU and portions 1 & 2 of the farm ESPERADO ANNEX 222 JU* (see map 5). The study area is approximately 6 km south of the N4 near Kaapmuiden, turning towards Barberton on the R38 road. It is approximately 30km north of Swaziland. The site falls under the Nkomazi Local Municipal jurisdiction, which in turn falls within Ehlanzeni District Municipality, in the Mpumalanga Province (see maps 3 - 6). Large areas surrounding the *ESPERADO* farms have historically been disturbed by commercial agricultural farms.



MAP 5: The wider area surrounding *ESPERADO*.



MAP 6: The study area is indicated by the red line. Please note the historically disturbed farmlands in the surrounding area (see figs. 3 & 4).

- **Description of methodology:**

The 1984 topographical map, (2531CB, map 4), as well as the 1926 topographical map (map 3), and Google images of the site (maps 5 & 6**)**, indicate the study area of the proposed development. These were intensively studied to assess the current and historically disturbed areas and infrastructure. The historic Google Images show extensive agricultural disturbances on portions of the remaining extent of the *farm ESPERADO 253JU and portions 1 & 2 of the farm ESPERADO ANNEX 222 JU,* in the past. In order to reach a comprehensive conclusion regarding the cultural heritage resources in the study area, the following methods were used:

- The desktop study consists mainly of archival sources studied on distribution patterns of early African groups who settled in the area since the 17th century, and which have been observed in past and present ethnographical research and studies.
- Literary sources, books and government publications, which were available on the subject, have been consulted, in order to establish relevant information.
- Several specialists currently working in the field of anthropology and archaeology have also been consulted on the subject.

-Literary sources: A list of books and government publications about prehistory and history of the area were cited, and revealed some information;

-The archaeological database of SAHRA as well as the National Cultural History Museum were consulted. Heritage Impact Assessment reports of specialists who worked in the area were studied and are quoted in section B.

- The *portions of the remaining extent* of the *farm ESPERADO 253JU and portions 1 & 2 of the farm ESPERADO ANNEX 222 JU*, are primarily commercial farming concerns with small sections of natural vegetation along the Low's Creek, Kaap River and drainage lines.
- A site visit with interested and affected parties was held on 17 July 2020.
- The fieldwork and survey were conducted extensively on foot and with a vehicle. Existing roads and small paths were mainly used to access areas (See Appendix 1: Tracks & Paths).
- The terrain next to the Low's Creek was typical of riparian vegetation. Visibility directly next to the river was restricted due to a dense vegetation cover. However, the visibility in the open cultivated areas on the banks of the Creek & River was excellent (see Appendix 2).
- The relevant data was located with a GPS instrument (Garmin Etrex) datum WGS 84 and plotted. Co-ordinates were within 4-6 meters of identified sites.
- Evaluation of the resources which might be impacted upon by the footprint, was done within the framework provided by the National Heritage Resources Act, no. 25 (1999);
- Personal communication with relevant stakeholders on the specific study areas were held during the site visit with the owners. [42] [43] The owners are familiar with the properties and confirmed that they have never encountered any graves or archaeological features on the

[42] Personal information: Mr. Walter Giuricich, Owner or ESPERADO, 2020-07-17.

[43] Personal information: Mr. Riaan Kotze, Owner of ESPERADO ANNEX, 2020-07-17.

properties. Ecologist Dr. A. Deacon [44] and environmental practitioner Mr. R. Kalwa [45] were also consulted during the research.

- GPS co-ordinates were used to locate the site and for possible heritage features within the study area (Co-ordinates provided by RHENGU Environmental Services)**:** (See Map 6 for perimeters of the sites).

GPS CO-ORDINATES			
Location	**South**	**East**	**Elevation**
A	S 25° 35' 27.85"	E 31° 18' 27.18"	372m
B	S 25° 35' 22.44"	E 31° 18' 33.71"	372m
C	S 25° 35' 39.18"	E 31° 18' 43.95"	372m
D	S 25° 35' 40.34"	E 31° 18' 50.65"	383m
E	S 25° 35' 56.96"	E 31° 18' 25.24"	376m
F	S 25° 35' 38.96"	E 31° 18' 37.53"	376m

E. DESCRIPTION OF IDENTIFIED SITES

The applicant is requesting to establish a dam *on portions of the remaining extent* of the *farm ESPERADO 253JU and portions 1 & 2 of the farm ESPERADO ANNEX 222 JU.* The footprint of the study area will include the construction of a dam wall near the confluence of the Kaap River and the Low's Creek. The footprint of the dam will cover an area of approximately 6.5ha in the Low's Creek and will cover partly natural riparian vegetation as well as historically disturbed agricultural lands and access roads (see map 6).

The dimensions of the proposed dam are as follows:

- Wall Height 11.4m;
- Wall Length 245m;
- Cover an area of 6.5 ha;
- Storage capacity of 193 000 cubic meters;
- Maximum full supply water depth will be 8m;
- Additional infrastructure: pump house & pipelines.[46]

The study area falls within Kaapmuiden / Low's Creek area which has historically been known for commercial agricultural farming. Large sections on the adjacent properties are already cultivated with bananas, paw paw, sugarcane and macadamias (see map 6). The area consists of the riparian zone within the Low's Creek, and mainly flat agricultural sections. One small rocky outcrop is located towards the south of the proposed study area. Modern topographical maps also clearly show extensive historical farming activities in the surrounding areas (map 4 - 1984). The 1926

[44] Personal information: Dr. A Deacon, 2020-07-21.
[45] Personal information: Mr. R. Kalwa, e-mail access: 2020-07-17.
[46] BID, Rhengu Environmental Services, p. 4.

topographical map (map 3) does not indicate any historic settlements directly in the study area. The 1935 map by Van Warmelo indicated the groups living in the area as mainly of Swazi decent (map 1).

The study area is indicated in maps 2 - 6. The terrain was fairly even although the natural sections along the Low's Creek, was dense and visibility was restricted (see figs. 5 - 26). Sections were however accessible by existing paths and roads and was surveyed on foot and per vehicle. All disturbed sections on the farm (quarry, donga and excavated cleared areas, as well as cleared agricultural lands) were investigated for possible signs of an archaeological or historical nature. No archaeological material or deposits, graves, historical features or structures were observed, and the disturbed areas were all sterile (fig. 16 – 19 & map 6).

The farm owners were interviewed to find out if they were aware of any archaeological, historical features or graves. The confirmed that they, or their farm workers had no knowledge of any burial sites or other heritage related features on the property. [47] [48]

The terrain was mostly even but the vegetation cover was dense in sections. Paths and roads made some sections more accessible for the survey. The area next to the riparian zone was mostly disturbed with access roads and agricultural lands. The visibility in these sections were excellent (Appendix 1 & 2).
No archaeological sites of significance, stone walls or historic structures or graves were identified, and was confirmed by the applicants.

[47] Personal information: Mr. W. Giuricich, Owner ESPERADO, 2020-07-17.
[48] Personal information: Ms. R. Kotze, Owner ESPERADO ANNEX: 2020-07-17.

F. DISCUSSION ON THE FOOTPRINT OF THE PROPOSED DEVELOPMENT

ACT	***COMPONENT***	***IMPLICATION***	***RELEVANCE***	***COMPLIANCE***
NHRA	S 34	Impact on buildings and structures older than 60 years	None present	None
NHRA	S35	Impacts on archaeological heritage resources	None present	None
NHRA	S36	Impact on graves	None present	None
NHRA	S37	Impact on public monuments	None present	None
NHRA	S38	Developments requiring an HIA	Development is a listed activity	HIA done
NEMA	EIA regulations	Activities requiring an EIA	Development is subject to an EIA	HIA is part of EIA

- **Summarised identification and cultural significance assessment of affected heritage resources: General issues of site and context:**

Context		
Urban environmental context	No	NA
Rural environmental context	No	NA
Natural environmental context	No	NA
Formal protection (NHRA)		
(S. 28) Is the property part of a protected area?	No	NA
(S. 31) Is the property part of a heritage area?	No	NA

Other		
Is the property near to or visible from any protected heritage sites	No	NA
Is the property part of a conservation area of special areas in terms of the Zoning scheme?	No	NA
Does the site form part of a historical settlement or townscape?	No	NA
Does the site form part of a rural cultural landscape?	No	NA
Does the site form part of a natural landscape of cultural significance?	No	NA
Is the site adjacent to a scenic route?	No	NA
Is the property within or adjacent to any other area which has special environmental or heritage protection?	No	NA
Does the general context or any adjoining properties have cultural significance?	No	NA

Property features and characteristics		
Have there been any previous development impacts on the property?	Yes	Historically disturbed agricultural land
Are there any significant landscape features on the property?	No	NA
Does the property have any rocky outcrops on it?	Yes	Very small outcrop
Does the property have any fresh water sources (springs, streams, rivers) on or alongside it?	Yes	Low's Creek, drainage lines & Kaap River

Heritage resources on the property		
Formal protection (NHRA)		
National heritage sites (S. 27)	No	NA
Provincial heritage sites (S. 27)	No	NA
Provincial protection (S. 29)	No	NA
Place listed in heritage register (S. 30)	No	NA
General protection (NHRA)		
Structures older than 60 years (S. 34)	No	NA
Archaeological site or material (S. 35)	No	NA
Graves or burial grounds (S. 36)	No	NA
Public monuments or memorials (S. 37)	No	NA
Other		

Heritage resources on the property		
Any heritage resource identified in a heritage survey (author / date / grading)	No	NA
Any other heritage resources (describe)	No	NA

NHRA S (3)2 Heritage resourcecategory	***ELEMENTS***	***INDICATORS OF HERITAGE SIGNIFICANCE***										***RISK***
		Historical	Rare	Scientific	Typical	Technological	Aesthetic	Person/ community	Landmark	Material condition	Sustainability	
Buildings / structures of cultural significance	No	No	No	No	No	No	No	No	No	No	No	NA
Areas attached to oral traditions / intangible heritage	No	No	No	No	No	No	No	No	No	No	No	NA
Historical settlement/ townscapes	No	-	-	-	-	-	-	-	-	-	-	NA
Landscape of cultural significance	No	-	-	-	-	-	-	-	-	-	-	NA
Archaeological sites	No	-	-	-	-	-	-	-	-	-	-	NA
Grave / burial grounds	No	-	-	-	-	-	-	-	-	-	-	NA

NHRA	***ELEMENTS***	***INDICATORS OF HERITAGE SIGNIFICANCE***										***RISK***
Areas of significance related to labour history	No	-	-	-	-	-	-	-	-	-	-	NA
Movable objects	No	-	-	-	-	-	-	-	-	-	-	NA

- **Summarised recommended impact management interventions**

NHRA S (3)2 Heritage resource category	***SITE***	***IMPACT SIGNIFICANCE Cultural significance rating***		***Impact management***	***Motivation***
		Cultural significance	***Impact significance***		
Buildings / structures of cultural significance	No	No	None	-	NA

NHRA S (3)2 Heritage resource	SITE	IMPACT SIGNIFICANCE Cultural significance rating		Impact management	Motivation
Areas attached to oral traditions / intangible heritage	No	None	None	-	NA
Historical settlement/ townscape	No	None	None	-	NA
Landscape of cultural significance	No	None	None	-	NA
Archaeological sites	No	None	None	-	NA
Grave / burial grounds	No	No	None	-	NA

NHRA S (3)2 Heritage resources	SITE	IMPACT SIGNIFICANCE Cultural significance rating		Impact management	Motivation
Areas of significance related to labour history	No	None	None	-	NA
Movable objects	No	None	None	-	NA

ACT	COMPONENT	IMPLICATION	RELEVANCE	COMPLIANCE
NHRA	S 34	Impact on buildings and structures older than 60 years	None present	None
NHRA	S35	Impacts on archaeological heritage resources	None present	None
NHRA	S36	Impact on graves	None present	None
NHRA	S37	Impact on public monuments	None present	None
NHRA	S38	Developments requiring an HIA	Development is a listed activity	Full HIA
NEMA	EIA regulations	Activities requiring an EIA	Development is subject to an EIA	HIA is part of EIA

G. STATEMENT OF SIGNIFICANCE & EVALUATION OF HERITAGE RESOURCES

Section 38 of the NHRA, rates all heritage resources into National, Provincial or Local significance, and proposals in terms of the above is made for all identified heritage features.

- **Evaluation methods**

Site significance is important to establish the measure of mitigation and / or management of the resources. Sites are evaluated as *HIGH (National importance), MEDIUM (Provincial importance) or LOW, (local importance),* as specified in the NHRA. It is explained as follows:

- **National Heritage Resources Act**

The National Heritage Resources Act no. 25, 1999 (NHRA) aims to promote good management of the national estate, and to enable and encourage communities to conserve their legacy so that it may be bequeathed to future generations. Heritage is unique and it cannot be renewed and contributes to redressing past inequities.[49] It promotes previously neglected research areas.
All archaeological and other cultural heritage resources are evaluated according to the NHRA, section 3(3). A place or object is considered to be part of the national estate if it has cultural significance or other special value in terms of:
(a) its importance in the community, or pattern of South Africa's history.
(c) its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
(g) its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
(h) its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa.[50]

- **The significance and evaluation of the archaeological and cultural heritage features in the study area**

The farms in the study area (*portions of the remaining extent of the farm ESPERADO 253JU and portions 1 & 2 of the farm ESPERADO ANNEX 222 JU*), are operated as commercial concerns with the cultivation of, banana, paw paw, and macadamias. The only areas which are currently not under development, are areas directly along the Low's Creek and Kaap River. No archaeological sites of significance, stone walls or historic structures or graves were identified during the survey, and the applicants, who were interviewed, had no knowledge of any such features on the farm. [51] [52]

It is not believed that any archaeological or historical features will be impacted upon by the proposed footprint of the dam development.

[49] National Heritage Resources Act, no. 25 of 1999. p. 2.
[50] National Heritage Resources Act, no. 25 of 1999. pp. 12-14
[51] Personal information: Mr. W. Giuricich, Owner of ESPERADO, 2020-07-17.
[52] Personal information: Mr. R. Kotze, Owner of ESPERADO ANNEX, 2020-07-17.

H. RECOMMENDATIONS & CONCLUSION

Archaeological material or graves are not always visible during a field survey and therefore some significant material may only be revealed during construction activities of the proposed dam development.

It is recommended that the owner be made aware that distinct archaeological material or human remains may only be revealed during further de-bushing or construction activities. Based on the survey and the findings in this report, Adansonia Heritage Consultants state that there are no compelling reasons which may prevent the proposed dam development to continue, but it is recommended that earthmoving activities be monitored by a qualified archaeologist and that an assessment be done should any archaeological material be found.

Adansonia Heritage Consultants cannot be held responsible for any archaeological material or graves which were not located during the survey.

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APPENDIX 1:

TRACKS & PATHS USED DURING THE SURVEY

APPENDIX 2: ESPERADO PHOTOGRAPHIC DOCUMENTATION

Fig. 1: A general view of the Louws Creek (yellow dashes), from the south-east, facing north-west.

Fig. 2: A general view of the Low's Creek (yellow dashes) and Kaap River (white dashes). The proposed dam wall will be located where the two lines cross.

Fig. 3: A general view from the western side, facing east. The Low's Creek is in the middle (arrows). Cultivated land visible on eastern side.

Fig. 4: A general view from the eastern side, facing west. The arrows indicate the Low's Creek. Cultivated land on the western side.

Eastern & western side where the proposed dam wall will be constructed:

Fig. 5: The section on the western side between the Low's Creek and the Kaap River. Recent pump house structures are visible (farm ESPERADO ANNEX).

Fig. 6: The section on the eastern side where the recent pump house is for the ESPERADO farm is.

Survey on the eastern side:

Fig. 7: A view from the east (facing west), of the Low's Creek (yellow) and the Kaap River (white), with cultivated lands visible in the direct vicinity.

Fig. 8: The confluence of the Low's Creek and the Kaap River is visible. The image was taken from the eastern side, facing south-west. Please note the cleared areas along the riverbank.

Fig. 9: The riparian zone along the Low's Creek in the north-eastern section. Please note alien invader species, in front of the large Fig tree.

Fig. 10: The Low's Creek is visible just behind the fence. The areas to the east are cleared for agriculture (orchards).

Fig. 11: The Low's Creek (middle section) on the eastern side. Vegetation was dense.

Fig. 12: The banks along the Low's Creek in the southern section is steep and forms a deep cutting.

Fig. 13: The southern section which is steep consists of a small rocky outcrop. The cultivated lands to the west are clearly visible.

Fig. 14: A small rocky outcrop to the south of the study area.

Fig. 15: View of the south end of the study area. The Louw's Creek is to the right, behind the fence.

Open areas, Quarry / Donga

Fig. 16: The sections to the east of the Low's Creek is de-bushed and prepared for establishing orchards.

Fig. 17: An area in the eastern section of the study area (Creek) was scraped clear. Large bamboo (other side of the Creek), and other invader species are also visible. This area was investigated for any signs of archaeological material, but none was observed.

Fig. 18: A donga, east of the Low's Creek was investigated for any signs of archeological material, but none was observed.

Fig. 19: A quarry on the western side was investigated for any signs of archaeological material, but none was observed.

Survey on the western side:

Fig. 20: The north-western corner where the dam wall will be situated. Please note the large powerlines and pump station (farm ESPERADO ANNEX).

Fig. 21: A view towards the south (from the north-western corner), show the Low's Creek towards the left, and an access road and macadamia fields to the right.

Fig. 22: A view towards the north (taken from the south). The Louw's Creek is on the right, with the access road and macadamia fields to the left.

Fig. 23: Visibility in the riparian zone of the Low's Creek was restricted. View of the middle section on the western side.

Fig. 24: A view towards the north, at the middle section of the study area (Low's Creek is towards the right hand).

Fig. 25: A small rocky outcrop is visible towards the southern end of the study area which forms a deep cutting towards the Creek. (Low's Creek is where the large trees are visible).

Fig. 26: The south end of the study area. The Creek is below where the large trees are.

APPENDIX 5:
ENIRONMENTAL MANAGEMENT PROGRAMME

LOWS CREEK DAM PROJECT: DEVELOPMENT OF AN INSTREAM STORAGE DAM FOR IRRIGATION PURPOSES ON PORTIONS OF REMAINING EXTENT OF ESPERADO 253 JU AND PORTIONS 1 AND 2 OF ESPERADO ANNEX 222 JU LOWS CREEK-KAAPMUIDEN AREA, MPUMALANGA.
PROJECT REFERENCE: 1/3/1/16/1E-294

1. ENVIRONMENTAL MANAGEMENT PROGRAMME (EMPr): DEVELOPMENT ACTIVITIES

1.1. The environmental management programme will address the development phase of the proposed activity. This will include the site establishment, the installation of services (irrigation, water meters), the construction of the dam and pump house.

1.2. The EMPr will primarily be used by the applicant/construction teams under the guidance of the ECO. For this purpose the EMPr must serve a number of functions. These are:

- Instructions and conditions included in the EMPr must be written in a clear, down to earth language.
- All aspects of the EMPr must be practical and unambiguous.
- Instructions and conditions must be concise and to the point.
- Aspects of the EMPr must reflect the recommendations and mitigation measures listed in the Environmental Impact Assessment Report/s.
- Aspects of the EMPr must reflect the recommendations and mitigation measures listed in the Specialist Studies and the comments by Interested and Affected Parties/Government Departments.
- The EMPr must be used to monitor compliance to the conditions stipulated in the Authorisation of the Project as issued by DARDLEA.
- Aspects of the EMPr can be referred to in an Operational Management Programme (OMPr) during future Environmental Audit Assessments.
- The EMPr must ensure the protection of the natural environment and cover all aspects of rehabilitation/sustainable reparation of the impacted sites.
- The EMPr will guide the process from initiation until sign off the project.
- **Note:** The EMPr will remain a dynamic document which can be updated with the approval by DARDLEA.

1.3. The implementation of the EMPr will be guided by an Environmental Control Officer (ECO).

- The applicant/developer is responsible for the appointment of the ECO.
- The name and contact details of the ECO must be submitted to DARDLEA once the project commences.
- All Interested and Affected Parties (I&AP's) must be informed of the name and contact details of the ECO.

1.4. Monitoring and Auditing

The Environmental Control Officer (ECO) will ensure that all the **conditions** as set out in the **Environmental Authorisation (EA**) **and any other requirements as issued by DARDLEA or any other applicable Department, e.g. DWS/IUCMA**, are met and implemented as stipulated.

The ECO must submit to DARDLEA, an **audit report** on the activities of the development. Quarterly audit reports will be made available to I&AP's on request. The frequency of submission will be determined by DARDLEA.

The role of the ECO and independent audit teams are well defined within the framework of Integrated Environmental Management (IEM). The developer, together with the ECO will ensure **compliance** in terms of this process**.**

1.5. Initial Role-players: Contact Details:

1. Developer/Applicant/Representative: Walter Giuricich	Cell: 082 967 6757
2. ECO: To be appointed	Cell: To be confirmed.
3. EAP: Ralf Kalwa	Cell: 082 414 7088

2. DEVELOPMENT PHASE: ENVIRONMENTAL MANAGEMENT PROGRAMME

This programme must be read in conjunction with the **Contract Documents** for the project. This environmental management programme will address the development/preparation phase of the proposed development as described in Environmental Impact Assessment Report.

KEY ISSUES: EMPr

This programme is designed for the entire development period and includes the rehabilitation of areas where development/storage activities took place.
The Contractor/Applicant together with the Environmental Control Officer (ECO) will be responsible to ensure that all construction workers, sub-contractors, suppliers and relevant personnel associated with the development:

- Understand the contents of the Environmental Management Programme (EMPr).
- Ensure that all the construction personnel are fully aware of all environmental issues relating to the development activities.
- Adhere to all the precautionary and mitigating measures described in the EMPr.
- Ensure that all the construction personnel understand the implications and stipulations of the Environmental Rules and Regulations described in the Development Contract.
- The ECO shall instruct the Applicant/Developer to suspend the works if the Contractor and/or any Sub-Contractors do not comply with the contents of the EMPr.
- The ECO will submit audit reports to DARDLEA, the Contractor and the Developer.
- The EMPr describes the responsibilities of all the staff during the development phase.
- The ECO will oversee the operations and ensure compliance with the EMPr.

Non-Compliance: The Contractor/Applicant is deemed NOT to have complied with the EMPr, the Environmental Authorisation and the EIA if:

- Within the boundaries of the site, site extensions and haul/access roads there is evidence of contravention of the Specifications of the EMPr;
- Environmental damage ensues due to negligence;
- The Contractor fails to comply with corrective or other instructions issued by the ECO within a specific time;
- The Contractor fails to respond adequately to complaints from the public;

Prior to construction: The Contractor/Applicant, in liaison with the ECO will submit a final layout plan of the development site indicating all of the following: storage areas, hazardous substances storage area (if applicable), different stockpile areas, material stores, waste disposal areas, on site offices, workshops, ablutions, access roads, no go areas etc. This construction site layout plan must be submitted to DARDLEA and the ECO prior to site establishment. Once the layout is approved by the ECO the Contractor will be required to sign acceptance of the EMPr and commence with the development. **Note:** Contractor = Farmer/Installation of Irrigation Systems (pump houses, valve chambers)/Dam Construction etc.

2. DEVELOPMENT PHASE: ENVIRONMENTAL MANAGEMENT PROGRAMME: The ECO will monitor compliance of this EMPr		
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
1. Site Establishment and Logistics.	**1. Site Office and Logistics**: Establish a site office for the development. The Farmer's Office/Maintenance Shed can serve this purpose. The following procedures and equipment must be made available at the office: • Copies of the EIA and the EMPr. • Copy of the Environmental Authorisation. • Copies of the Development/Site Layout Plan. (Dam Footprint Layout). • A Complaints Register. • A Corrective Actions and Site Instruction Register. • An Emergency/Evacuation Procedure. • A Monitoring- and Audit Register. • Emergency Contact Numbers including but not limited to telephone contact details for medical doctors; hospitals; emergency helicopters; emergency fire management; the ECO and Project/Site Manager. • Fire Extinguishers. • First Aid Kit. • A register of all applicable Standard Operational Procedures and Method Statements (e.g., handling of hazardous materials) of materials and equipment that are used and stored on site.	**Contractor**
	2. Final Walk Inspection (Pre-Construction): A final walk through the site with the ECO to point out the presence sensitive areas, e.g., Special Plants/Habitat/Drainage Line, or any other aspect which requires protection has to be undertaken prior to site establishment.	
	• All staff must be trained to respect the importance of rare/conservation significant plants and artefacts. This is specifically applicable to the no go areas around the drainage lines, rocky outcrops and buffer areas.	
	• Special features (rocky outcrops; large indigenous trees; rivers; wetland; etc.) must be indicated on the final dam layout map and demarcated on site prior to construction. Damage to such features must be rehabilitated to the satisfaction of the ECO and the developer.	
	• All drainage lines must be demarcated to ensure that all machinery is kept out of these zones.	
	• **Timing**: All development should take place in the period April-October.	
	3. Demarcation: Demarcate the boundaries of the total development site for management purposes using steel droppers/standards spaced at regular intervals with a combination of nylon rope/barrier tape between the droppers. **This will be required in the vicinity of the Lows Creek riparian zones and sites with special plants of concern.**	

	• The Contractor shall maintain the demarcation line and ensure that materials used for construction on site do not blow on or move outside the site or pose a threat to any neighbours or adjoining property owners.	
	• Where applicable, structures must be located in such a manner as to reduce visual intrusion and minimal disturbance to neighbouring properties. Make use of coloured netting or corrugated cladding to hide unsightly features.	
	• Construction activities are restricted within these boundaries, thus all construction equipment, materials and personnel will remain within this demarcated area at all times.	
	• Ensure that access to the site including related infra-structure and machinery is restricted to authorised personnel only.	
	4. Site Control: Limit the construction/development site to existing infrastructure and or to disturbed areas.	
	• Ensure that only approved workers and Sub-Contractors are accommodated and allowed access to the site. • Ensure that all applicable Covid 19 restrictions and safety measures are adhered to.	
	5. Site Facilities: The construction site and storage areas must be safeguarded against fire. • Ensure that the Contractors Site is fully functional in terms of water- and sewerage supply (temporary toilets) prior to the contractors coming on site.	
	• Contractor to be held responsible for providing construction-, drinking- and washing water for all the activities on site.	
	6. Access Routes and Control: No temporary access routes and haul roads are required for this activity. • No vehicle movement outside demarcated areas/routes/existing roads is permitted without authorisation from the ECO.	
	• Dust control measures, i.e., dampening access routes with water, must be implemented where necessary.	
	• Damage to any existing roads as a result of construction activities will be repaired to the satisfaction of the ECO and the Developer.	

	<u>7. Storage- and Material Laydown Areas</u>: The need for laydown/storage areas will be minimal however irrigation piping, pumps, cement, re-inforcing etc. will require a site when these materials are delivered and until these items are installed/used.	
	• All equipment, materials; pipelines etc. must be stored at the farm maintenance centre.	
	<u>8. Site Closure</u>: Once the development period is completed the following conditions will apply:	
	• The Contractor shall ensure that all temporary structures/facilities, equipment, materials and waste used for construction activities are removed after completion of development.	
	• The contractor shall clear and clean the construction site to the satisfaction of the ECO and the developer upon completion of the development.	
	• Remove all components of demarcation when the development phase is completed.	
	• Rehabilitate disturbed areas. This will include but not be limited to: • Break up any hardened soil surfaces allowing seeds and rainwater an opportunity to penetrate the soil surface. • Brush pack/landscape bare areas and reduce the potential run off of water. • Shape/level off any unnatural areas to fit in with the surrounding landscape.	
	<u>Site Closure</u>: Should the site be closed for a period of more than one week, a report on compliance will be lodged with the ECO, and the following will be confirmed: • Stores will be left at as low a volume as practically possible with no leaks. • The store area will be secure and locked. • Fire extinguishers will be serviced and accessible. • The area will be secure from accidental damages. • Emergency- and contact numbers will be available and prominently displayed. • Toilets will be empty and secured. • Refuse bins will be empty and secured. • Access to the site must be limited to authorised personnel only. • Security staff will patrol and guard the site.	

ACTIVITY	MANAGEMENT/MITIGATION ACTION	RESPONSIBLE PERSON
2. Site Biodiversity Management. (The ECO must be consulted at all times during this process).	**<u>1. Vegetation Management</u>**: Vegetation clearing/removal must be undertaken in a judicious and responsible manner. • The dam basin is largely inundated with alien - invader plants. Exceptions may occur and the ECO is requested to conduct a final walk through the demarcated footprint to ensure that no protected trees or plants of special concern will be affected. • Six weeks prior to the vegetation being cleared all Protected Tree Species (where applicable in the dam basin) must be clearly marked by the ECO and DAFF/MTPA Permits must be obtained to ensure permitted removals and translocations.	**Contractor and ECO where applicable.**
	• **<u>Vegetation Clearing</u>:** During the clearing of vegetation in the project area most vertebrates will move away from the project site. During this activity the project team may encounter slow moving reptiles and smaller mammals. These animals should be allowed to move away unharmed or be assisted and relocated to the upper and lower reaches of the riparian zone.	
	• **<u>Riparian Corridor</u>:** All drainage lines and riparian zones (outside of the dam basin) as identified by the Project Ecologist will be kept intact. All riparian zones will act as a corridor for migrating fauna.	
	<u>2. Alien Invader Plants</u>: Control of alien invasive species will be undertaken on the development footprint in line with the requirements of the Conservation of Agricultural Resources Act. The ECO will identify plants (where applicable) which require removal and management.	
	• Alien invasive plant material will be preferentially removed through mechanical means (e.g., chainsaw, hand-pulling of smaller specimens).	
	• Chemical control is only required as a last resort or as a support mechanism to control coppicing and sprouting.	
	• All exotic plants must be identified and earmarked for removal. The ECO will assist with identifications (where applicable).	
	• A number of workers must be used to remove the vegetation i.e., 4/6 workers. ECO to monitor.	
	• If during the establishment period, any noxious or excessive weed growth occurs, such vegetation will be removed by the contractor.	
	<u>3. Fauna and Flora Management</u>: Collection of firewood/seeds/fruit/plants/animals or any biological material (where applicable) is strictly prohibited.	
	• No animals including snakes should be killed or injured by workers during the construction- and or the operational phases of the project.	
	• No poaching will be allowed on site.	

	• The Contractor is not allowed to deface, paint or mark and/or damage natural features/vegetation on the site. **4. Topsoil Protection**: Topsoil will have to be removed/moved from all areas where pipelines are to be installed. • Topsoil to be handled twice only; once to strip and stockpile (in low heaps of 1m) in the Right of Way (ROW) next to the trench and secondly to replace along the contour, level, shape and scarify. • The topsoil must be replaced as soon as possible. • Topsoil may not be compacted, nor should any object be stored or stockpiled upon it. • No vehicle traffic will be allowed on the topsoil. • The Contractor shall prevent pollution incidents on the topsoil. ECO to monitor.	
	5. Biodiversity Protection: **See Appendix 4.5.3.: Summary of Impact Mitigation on Biodiversity Components**: **ECO to monitor and control**: • **Impact 1: The dam basin – clearing vegetation, manipulating soil layers, construction of coffer dam walls (operating and rehabilitation) and the dam wall:** • **Mitigation:** Levelling, shaping and landscaping of the site should follow natural drainage patterns as far as possible i.e., drainage towards the river. This must ensure that surface water flow velocities and run-off are minimised allowing for a gradual drainage into the river. • Clearing for the dam site should take place during the dry period, i.e., winter. However, as unpredicted high rainfall can occur during any month of the year, all measures should be taken to prevent exposed soils from being washed into the downstream tributary and or the main stream. ECO to monitor and advise. • The remaining peripheral riparian woodland in the dam basin should be left intact in order to maintain the denser riparian corridor which is utilised by the riparian animals.	**Contractor and ECO where applicable.**

	• **<u>Impact 2: Removing or inundating the riparian zone in the dam basin and affecting the link in the up- and down-stream riparian corridor:</u>** • **<u>Mitigation</u>:** Very little mitigation is possible when the riparian zone is submerged during the filling of the proposed dam. The following aspects must however be implemented to enhance riparian recovery: • **<u>Buffer Zone:</u>** Create a buffer zone around the full, high-water mark and replant some of the key riparian tree species from the basin onto the dam margin border. Currently there are intact riparian zones upstream and downstream of the proposed dam basin along the riverbanks of the Low's Creek. Usually, a riparian buffer would have been recommended for these riparian vegetation zones, however as the land has historically been developed right up to the edge of the riparian zone (up to the fence around the riparian area), no additional natural buffer is currently feasible. • Therefore, existing riparian zones upstream and downstream of the dam basin should be protected and excluded from any further development in order to maintain the integrity of these intact sections of the riparian corridor. In order to re-establish the link between the riparian corridors upstream and downstream of the dam basin, a riparian buffer should be established along the **<u>new marginal zone</u>** around the dam. • As the new marginal zone will either be covered with current orchards, or the original terrestrial vegetation, it is proposed that a buffer of 25m wide around the high-level mark of the dam should be established as a buffer for the aquatic environment. (**Why 25m?** The proposed 25 m width is representative of the current average width of the intact riparian zone upstream of the proposed dam position). • The areas adjacent to the high-level mark of the dam should thus be left intact and if possible, the new perimeter should be augmented with vegetation removed from the dam basin. • All remaining peripheral woodland in the dam basin should also be left intact in order to create some kind of new riparian zone. This buffer will hopefully represent a denser band of vegetation in time due to the increased availability of water and consequently create a denser vegetation corridor which can be utilised by riparian faunal species**.**	

- **Impact 3. River flow – downstream flows (See Appendix 4.5.5. for detail):**
- **Mitigation:** An Ecological Water Requirements (EWR) must be implemented and managed by releasing water from the dam to mimic natural flow as closely as possible.
- The Ecological Water Requirements (EWR) of the Kaap River have been determined (DWA, 2010) and published in the Government Gazette. Whilst there is no specific EWR for the Low's Creek, it can be estimated using the Hughes Desktop model (Hughes and Hannart, 2002).
- By incorporating the ecological parameters from the PES report (Deacon 2021), the EWR of the Low's Creek was estimated for a **category B river**. The rule curve for this EWR is attached in the **Appendix 4.5.5.**
- The rule curve expresses the EWR as a function of the natural flow from which a time series EWR can be determined.
- While there is a significant amount of irrigation water available within the Low's Creek catchment, the water for this irrigation is supplied from the Shiyalongubu Dam, located on a tributary of the Lomati River. The yield of the Low's Creek Dam was assessed over a range of full supply capacities. **At the preferred full supply capacity of 195 000 m^3, the yield is 3.2 million m^3/annum at 70% assurance.**
- However, the low flow downstream of the dam will decrease significantly due to this development. An analysis of the irrigation water requirements versus supply shows that the irrigation requirements are largely met during the summer, but shortages occur in winter. The Low's Creek Dam will reduce the assurance of supply of downstream users by about 5 percentage points (from 63% to 58%).
- Therefore, in order to compensate downstream irrigators, a release of a B category EWR as well as an additional **1.0 million m^3/annum** is recommended. This mitigation measure will result in water being released from the Low's Creek Dam in the months of **May through to the end of October**. This measure will decrease the yield of the dam to **2.2 million m^3/annum**.
- The construction of the dam wall should take place and be completed during the low flow period. There are times when the river naturally ceases to flow. When flow in the river resumes, measures must be taken to manage the weir or outlet structures to mimic natural variations in physical habitat upstream.

- **Impact 4. River flow – water quality:**
- **Mitigation:** Due to the size of the dam and the through flow of water, the chemistry of the water will not pose a significant threat. Nutrients and total dissolved solids will thus not reach levels that will affect the overall water quality and resultant eutrophication.
- Hazardous substances associated with construction activities will be mitigated by adhering to the best practice guidelines for these substances.
- Design the dams in accordance with the requirements of the Ecological Reserve/EWR of the river.
- In particular, a mechanism for the delivery of continual maintenance flows to the downstream system is critical. Several sluices/outlets must release water from different levels in the thermocline, thereby mixing the water being released to a more acceptable water quality and temperature.

Ecological Water Requirement per month

Month	70 Percentile million m3	m3	m3/sec	ltr/sec
Oct	0,043	43000	0,016	16,1
Nov	0,052	52000	0,020	20,1
Dec	0,063	63000	0,024	23,5
Jan	0,059	59000	0,022	22,0
Feb	0,137	137000	0,057	56,6
Mar	0,095	95000	0,035	35,5
Apr	0,07	70000	0,027	27,0
May	0,06	60000	0,022	22,4
Jun	0,064	64000	0,025	24,7
Jul	0,054	54000	0,020	20,2
Aug	0,049	49000	0,018	18,3
Sep	0,043	43000	0,017	16,6

	• **Impact 5. Erosion and Siltation:** • **Mitigation:** It is important that all work within a water resource should be completed during the **dry season**, when flows are at their lowest. This significance of the impact can be reduced to low when construction takes place during the dry season and/or when sedimentation ponds are used to settle out the suspended solids. • During vegetation **clearing** of the dam basin, bank protection (e.g., planting) will also be required to reduce sediment input. This will stabilise the problem area and maintain the present condition of the riparian wetland or secondly, attempt to reclaim the riparian wetland area that has been lost. • **Protect the Bare Areas**: Use a variety of methods, such as planting herbaceous or woody plants, placing hay bales, clay, gabions filled with rock, or if lined with a geo-textile, cover with soil, or even just pack loose rock against head-cut faces. Draft and implement a maintenance plan which optimises macrophyte/riparian plant species development. ECO to monitor and advise. • Where the dam is **constructed**, adequate erosion and sedimentation control measures must be put in place to prevent downstream impacts during both the construction- and operational phases. A stormwater management and erosion-control plan must be put in place for both the construction- and operational phases. • **Add Vegetation**: During construction, the process may include maintaining a vegetated buffer area until just prior to establishing the dam embankment (this buffer will reduce erosion and sedimentation), and/or constructing a retention swale prior to any clearing 'upstream', or any other method deemed appropriate by the Dam Designer. • Complete rehabilitation of all work areas will be required to return the site to its former condition. All areas that were cleared or disturbed during construction activities must be rehabilitated to an appropriately vegetated state. Care must be taken to ensure that these rehabilitated areas blend in with the immediate environment. • **Buffer Zone**: During the **operational** phase a buffer zone (e.g., riparian vegetation) should be established to prevent entry of additional sediment into the water course/impoundment. This will stabilise the problem areas and maintain the present condition of existing riparian woodland or attempt to reclaim the riparian area that has been lost. • **Releasing Water**: The release of bottom water with high silt loads will be detrimental to downstream fish and must be avoided. • Whenever possible, one should strive to mix the water being released from the sluices and dam overflow and/or the flow through the fish ladder when the bottom sluice is in operation. This will mix the bottom water with top layer flows and thus dilute the water. Water quality will thus improve. • These measures will prevent the degradation of the downstream river and riparian zone and ensure compliance with the Ecological Reserve, associated water use allocation, and all applicable Water Use License conditions.	

	• **<u>Impact 6. Impacts of the Dam Wall: See Appendix 4.5.4.</u>** • **<u>Mitigation</u>:** Low's Creek is a semi-permanent stream that would provide valuable breeding and refuge habitat for fish species found within the river reach. In order to mitigate for the disruption of migratory routes (aquatic environment) caused by the building of the dam, it is recommended that a **<u>fish way or fish ladder</u>** be incorporated into the dam wall. • The implementation of natural bypass or rock-ramp types of fish passes are usually the preferred design over formal fish way structures. • Broadly described, a rock ramp fish pass is a series of rocks and boulders of various sizes that is embedded into a stable foundation material (concrete) in such a way that the turbulence created by the natural flow path through the boulders creates pooled areas of various sizes, depths and hydraulic conditions, e.g., in the spillway. • In the case of the Low's Creek Dam site, a fish way channel that simulates a natural bypass channel and rock-ramp type of fish way has been proposed for the site. The site conditions and the nature of the development tends to suit this style. • A slope of 1:15-1:25 (or higher) is recommended, where the channel will be more likely to have lower water velocities and therefore, lower turbulence levels. The water will also tend to pool more readily, which will reduce the incidences of supercritical flow conditions. • Given that the design criteria and the alignment route are taken into consideration, it is believed that the proposed fish way channel will adequately cater for the migratory requirements of the target fish species. • It is recommended that once the basic channel has been excavated, that the channel be surveyed and the profile modelled in order to offer an optimal design with modifications presented in areas that are shown to not function adequately. • The overflow from the dam into the river should be close to the edge of the embankment and sculptured in such a way that most of the fish can continue to find their way up the embankment to find the fish way entrance.	

	• **Impact 7. The introduction and spread of alien vegetation**. • **Mitigation:** The control methods of alien invasive plants can broadly be classified into three categories: mechanical, chemical or biological. • Mechanical control methods involve the physical destruction or total removal of plants (e.g., felling, strip-barking; ringbarking, hand-pulling and mowing). • Chemical control of invasive alien plants includes the foliar spraying of herbicides to kill targeted plants and • Biological control or bio-control methods involves the release of natural enemies that will reduce plant health and reduce population vigour to a level comparable to that of the natural vegetation. • It is often necessary to use a combination of at least two of these methods to control or remove invasive alien plants. With repeated follow-up, mechanical and chemical control methods tend to be short-term activities suitable for smaller plant invasions that can result in the complete removal of the target species. After the implementation of the methods, it is important to evaluate the effectiveness of the methods and to monitor the cleared areas on a regular basis to identify emergent seedlings and to remove those immediately. ECO to monitor and advise.	

	• **Biodiversity Monitoring Requirements:** • **Measuring Mitigation**: Environmental performance monitoring should be designed to ensure that mitigation measures are implemented. The monitoring programme should clearly indicate the linkages between impacts, indicators to be measured, measurement methods and definition of thresholds that will signal the need for corrective actions. • **ECO:** The applicant must appoint an independent ECO that will have the responsibility of monitoring and reporting on compliance with the conditions of the Environmental Authorisation (EA), as well as monitoring and reporting on the implementation of the approved EMPr. • **Monitoring Programme**: A monitoring programme for the biodiversity associated with the project, would ideally be to record the reaction of the biota to changes in the environment due to the impacts of the project. • **Aspect 1**: **Dam buffer and riparian corridor**: It is vital to monitor the effectiveness of the maintenance plan which optimises the riparian plant species development and riparian habitat restoration (to ensure that the integrity of the wildlife corridor is retained and links between habitat types are enhanced). The restoration of the dam buffer area should be monitored throughout the duration of construction activities to ensure that the effectiveness of the final buffer zone areas are maintained, and that management measures are implemented appropriately. Regular inspections during the operational phase should also be undertaken to ensure that functions are not undermined by inappropriate activities. • **Aspect 2**: **Vegetation clearing or disturbing soil**: Establish an effective record keeping system for each area where soil is disturbed for whatever purposes. The monitoring will evaluate whether the erosion and sedimentation control techniques that are employed throughout the site preparation activities are effective in minimising erosion of exposed areas and sedimentation of site surface water. • **Aspect 3**: **Water quality**: It is recommended that the SASS5 method be implemented as part of the Biomonitoring Programme, specifically for the reaction of the sensitive species to water quality above and below the dam. During the initial survey of the water courses, five sites were surveyed. Monitoring surveys (annually) are suggested as follows: • One wet season survey at the established sites. • One dry season survey when the impacts of reduced surface water and water quality issues become evident.	**Contractor and during Operations the applicant.**

	• **<u>Aspect 4</u>**: **<u>The dam wall as a physical barrier for fish distribution</u>**: Fish way monitoring should be designed to provide data not only on the effectiveness of the fish way in terms of the internal hydraulics at various flows, but also data on the migratory behaviour and swimming ability of the aquatic biota for which it was designed. (Note: In this context the word "fish" is used for all migratory aquatic biota, including crustaceans (prawns and crabs) and eels). It is important to establish what species and size range are present downstream of the barrier weir that could potentially use the fish way. It is recommended that the FRAI methodology be implemented at sites upstream and downstream of the dam as part of the Biomonitoring Programme. • **<u>Aspect 5</u>**: **<u>Ecological water requirements for the Low's Creek and Kaap River</u>**: The low flow downstream of the dam will decrease significantly due to this development. In order to compensate downstream irrigators a release of a B category EWR as well as an additional 1.0 million m^3/annum is recommended. The release should take place over the months May to the end of October. Reserve flows have been established and these flows should be implemented and monitored by a responsible body (the Irrigation Board) to maintain the B category EWR for the river. • It is recommended that flow-gauges (incorporating data loggers, gauge plates) be installed in the river. Audit reporting and record keeping (i.e., water abstracted from the river and water released from the dam on a daily basis) by the Orchard Manager in consultation with the Irrigation Board (or their successor) is necessary. This is to ensure proper operation and maintenance. • **<u>Aspect 6</u>**: **<u>Existing riparian vegetation</u>**: The intact riparian vegetation, upstream and downstream of the dam, should be monitored to establish the impact of the dam and EWR releases on the system, as well as impacts stemming from the agricultural activities associated with the dam operation. It is suggested that a VEGRAI monitoring programme should be implemented. • **<u>Aspect 7</u>**: **<u>Exotic and alien invasive plants</u>**: To anticipate and evaluate imminent or potential risks to the project area regarding exotic- and alien invasive plants, as well as pathways of invasion, a monitoring programme should be developed in order to create effective mechanisms to manage or mitigate these. Monitor all sites disturbed by construction activities for colonisation by exotics or invasive plants and control these as they emerge. It is important to evaluate the effectiveness of control methods and to monitor the cleared areas on a regular basis to identify emergent seedlings and to remove those immediately.	

ACTIVITY	MANAGEMENT/MITIGATION ACTION	RESPONSIBLE PERSON
3. Project Specifics and Excavation Management: Trenching; Backfilling and Levelling. (Pipelines, pump house, spillway).	**<u>1. Excavation</u>**: During excavation topsoil has to be stockpiled as specified in low 1m heaps next to the trench in the Right of Way (ROW). • Excavation of soil to solid ground to be done carefully and to ensure proper drainage.	**Contractor and ECO where applicable.**
	• Remove soil/sand and debris and expose all rocky material.	
	• Excess (spoil) excavated rocky material (rock and boulders) to be used for erosion control/cladding where applicable or for purposes of landscaping.	
	<u>2. Backfilling</u>: The Contractor shall backfill according to the requirements of progressive reinstatement, i.e., reinstatement of disturbed areas to topsoil profile on an ongoing basis, immediately after selected construction activities are completed, which will allow for passive rehabilitation.	
	• All soils must be returned into the trench in the sequence in which they were excavated.	
	<u>3. Levelling</u>: Excess sand/soil (after construction) must be filled in and landscaped into natural sandbanks blending in with the topography of the surroundings.	
	• Excess stockpiled building material must be removed completely and all areas levelled.	
	• Excess sand and soil resulting from levelling activities of the work area to be stored in low heaps on the access road/or already disturbed areas.	
	• Excess topsoil to be spread evenly over the area in a manner that blends in with the natural topography.	
	• When the bulk of material stockpiles have been cleared, the disturbed areas are to be levelled and cleared of any unnatural foreign material manually using shovels and rakes.	
	<u>4. Trenching</u>: This activity is limited to the pipeline installations. • Trenching will be minimised through the use of single trenches.	
	• Planning and selection of trench routes will be indicated on the Dam Site Layout Plan.	
	• Trench routes with permitted working areas will be clearly defined and marked with painted stakes prior to excavation.	
	• All trenches must be clearly marked (Flags; coloured posts; reflective banners; lights) in order to alert people to the potential hazard thereof.	
	• All open trenches must be patrolled on a minimum of a daily basis to ensure that animals, e.g., lizards, small rodents, have not become trapped. Such animals will be removed and released. A log must be placed at strategic spots each afternoon to allow any animal that accidentally falls into the trench an opportunity to escape.	
	• Stripping and separation of topsoil will occur as stipulated in the EMPr above.	

	• Soil will be excavated and used for re-filling trenches using the **rollover method**, i.e., progressive re-instatement: This entails the following approach: • Soil from the first trench section will be stockpiled. • Soil excavated from subsequent trench lengths will be used to backfill once the pipelines have been laid on an ongoing basis. • The final trench length will be re-filled using the originally stockpiled soil.	
	• Trench lengths will be kept as short as practically possible.	
	• Trenches will be re-filled to the same level as, or slightly higher to allow for settlement of the surrounding land surface to minimise erosion. Excess soil will be stockpiled in an appropriate manner.	
	• Immediately after refilling, the disturbed areas will be stabilised.	
	• The Contractor will not pollute any eco-system as a result of construction activities. All cement mixing activities must take place on an impermeable layer, e.g., metal sheet or plastic. No mixing of cement may take place directly on the soil surface.	
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
4. Waste Management: Solid Waste.	**1. Litter and Builders Waste**: All waste to be disposed of off-site at an approved landfill site. • Contractor not to dispose of any waste and/or construction debris through burning or by burying.	**Contractor**
	• Contractor to supply tamper proof waste bins throughout the site at locations where construction workers are working.	
	• Tamper-proof refuse bins to be emptied on a daily basis. Refuse bins not to be used for any other purpose.	
	• Contractor has to designate specific areas for staff to enjoy their lunches and tea and he must provide for access to adequate refuse bins at these sites.	
	• All litter must be removed off site daily and deposited at the designated waste collection point near the Maintenance Yard.	
	• Waste includes cigarette boxes, cigarette butts, paper, plastic bags, tin, glass, wires, cable ties, and organic waste e.g., peels and bones.	
	• Under no circumstances will cigarette butts be discarded anywhere on the development site.	

ACTIVITY	MANAGEMENT/MITIGATION ACTION	RESPONSIBLE PERSON
5. Waste Management: Liquid Waste.	**<u>1. Construction Water</u>**: Construction water refers to all water affected by construction activities. • No River/Stream/Natural Drainage Line must be used for cleaning of tools and equipment. This includes the washing of clothes and bathing/recreational purposes.	**Contractor**
	• All washing of equipment to be undertaken at the designated facilities in the Farm Maintenance Site Yard.	
	• Water from any other cleaning operations in the Site Yard to be collected in a “conservancy” tank removed from site and disposed of in the agreed manner.	
	• Water and slurry to be contained to prevent the pollution of the ground surrounding the mixing and/or disposal points.	
	• No spills to be channelled into natural environment. Contractor to take reasonable precautions to prevent pollution of the ground and water resources.	
	• Contractor to ensure that no fuels (petrol/diesel), oils, lubricants and/or other chemicals are discarded onto the ground. Use drip trays in all potentially risky situations, e.g., refuelling a mobile generator.	
	<u>2. Sewerage Management</u>: Adequate temporary (e.g., Enviro-loos) ablution facilities to be put in place on sites located near to working areas. • 1 Enviro-loo per 10 workers.	
	• Toilet paper must be provided by the contractor.	
	• All toilets must be checked daily and serviced accordingly by an accredited service provider.	
	• No spillages into the surrounding environment will be allowed.	
	• The entrances to the toilets must be adequately screened from public view.	
	• Covid 19 sanitisers must be made available at all toilet facilities.	

ACTIVITY	MANAGEMENT/MITIGATION ACTION	RESPONSIBLE PERSON
6. Waste Management: Hazardous Waste (The use of hazardous materials are not envisaged during the development phase, however unforeseen events may occur which are not known to the EAP at this stage of the process. This aspect is therefore included as a precautionary measure).	**1. Hazardous Waste Process**: The EAP has not been made aware of any hazardous substances that may be used during the development construction process. To ensure that the EMPr maximises the implications of the precautionary approach the following conditions are included in the event that substances such as fuel (mobile generator); paints; varnishes; chemicals for alien plant control etc. are used at any stage of the development. • A Contractor staff member must be designated to manage this process.	**Contractor**
	• Contractor to comply to all national, regional, and local legislation with regards to the storage, transport, use and disposal of petroleum, chemicals, harmful and hazardous materials and substances.	
	• Contractor to provide the ECO with a list of all petroleum, chemical, harmful and hazardous materials and substances on site, together with all the storage, handling and disposal procedures for these materials. A register must be kept at the site office containing all the written/prescribed handling procedures.	
	• Contractor to be responsible for training and education of workers that will be working with these materials. Training to include the proper use, handling and disposal of the substances.	
	• Storage of chemicals to be safe, tamper proof and under strict control.	
	• Storage and handling of fuels, lubricants, chemicals and other hazardous substances to be protected by placing an impermeable liner, e.g., bund beneath the above ground storage containers in order to prevent accidental contamination of the soil.	
	• The contractor will ensure that there is a supply of absorbent material (or absorption blankets) readily available on site to absorb, break down and where possible control any spillages that may occur. The amount and type of absorbent material must be appropriate to the volumes of hazardous liquids on site.	
	• Any accidental chemical/fuel spills to be addressed and reported immediately to the ECO. The ECO will inform the applicable authorities and initiate a containment- and control programme as applicable.	
	• Contractor to be responsible for establishing an emergency procedure for dealing with spills/releases of fuels, chemicals, hazardous substances and medical emergencies. All spills/accidents to be recorded (in the Incident Register) and reported to the ECO. The cleanup of spills and any damage caused shall be for the Contractor's account.	

ACTIVITY	MANAGEMENT/MITIGATION ACTION	RESPONSIBLE PERSON
7. Access Roads.	**1. Existing Roads**: The farm is well serviced with all-weather farm roads to the various sections and facilities on the property. The proposed project and all deliveries will make use of these access routes.	**Contractor**
	• Adhere to the local speed limit on the farm (40km/h) at all times.	
	• Contractors to limit the number of deliveries where possible through appropriate advance planning.	
	• Contractors will be required to submit a delivery timetable to the ECO.	
	• Construction personnel should only use authorised paths and roads.	
	• Any damage caused by the construction activities to any access or public roads must be rehabilitated thoroughly upon completion of the construction.	
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
8. Construction Staff	**1. Staff Management**: The Code of Conduct for Contractors as described in the Tender Document will apply to all Construction Staff. • The EMPr will be included as a condition of the Tender Document.	**Contractor**
	• Contractor must adhere to all conditions of the Occupational Health and Safety Act. • Specifically, adherance to Covid 19 mitigation measures will apply to all staff entering the development site. This will include wearing face masks, access to sanitisers and an allowance for social distancing during lunch- and tea breaks.	
	• A Safety Plan must be submitted to the ECO prior to the commencement of construction.	
	• No contractor staff will be housed on the development site.	
	• All contractor staff will abide with the Rules and Regulations of the Project Site/Farm. This includes all aspects to gain entrance and to exit the property.	
	• All staff must use the water- and sewerage facilities judiciously and keep these facilities neat and clean.	
	• All staff must remain within the development footprint and behind the demarcated boundaries.	
	• No open fires will be allowed for cooking and or heating purposes.	
	• Staff must supply their own lunches and refreshments. No cooking will be allowed on site.	
	• Staff must respect the surrounding environment and prevent all littering and damage to fauna and flora.	
	• **Site Specifics: Induction Courses**: All staff will undergo an intensive induction course on worker safety and safety procedures for the various sections of the site.	

	• **EMPr**: The conditions of the Environmental Management Programme must be explained to all workers and staff on site.	
	• All staff on site must sign an acceptance of understanding the EMPr form prior to being allowed on site.	
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
9. Fire.	**1. Fire Management**: Contractor to take all the necessary precautions to ensure that no fires are caused as a result of activities on site. • A Contractor staff member must be designated to manage this process.	**Contractor**
	• Contractor to supply all facilities, site offices, workshop areas, storage areas, with approved fire-fighting equipment.	
	• All staff on site will be made aware of general fire prevention and control methods and the name of the responsible person to alert to the presence of a fire.	
	• The Contractor will advise the relevant authority of a fire outside of a demarcated area as soon as it starts and will not wait until he can no longer control it.	
	• All fire-fighting equipment to be maintained in good operating order.	
	• No open fires for heating or cooking are allowed on site.	
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
10. Accidents.	**1. Staff Safety**: Contractor to comply with the Occupational Health and Safety Act (OHASA) and any other labour regulations with regard to safety on site.	**Contractor**
	• Contractor to provide an Occupational Health and Safety Management Plan to the ECO for approval prior to the commencement of works in terms of the Construction Regulations.	
	• A Contractor staff member must be designated to manage this process.	
	• Fencing and barriers will be in place in accordance with the Occupational Health and Safety Act (Act No. 85 of 1993).	
	• Applicable notice boards and hazard warning notices will be put in place and secured. Night hazards, e.g., open trenches, will be suitably indicated (e.g., reflectors, lighting, and traffic signage).	
	• No unauthorised firearms or weapons of any kind will be permitted on the site.	
	• Contractor to ensure that all staff are familiar with all the emergency procedures.	
	• All staff must undergo a basic First Aid Course.	
	• Contractor to ensure that lists of all emergency telephone numbers/contact people are available and are posted at relevant locations, e.g., site office, at all times and that they are updated regularly.	

	• Contractor to be responsible for establishing an emergency procedure for dealing with medical emergencies. All incidents to be recorded (in the Incident Register) and reported to the ECO.	
	• Contractor to establish a Covid 19 isolation facility for persons suspected of infections until an ambulance has collected the patient.	
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
11. Adverse Weather Conditions and Erosion Protection.	**1. Wet Weather: Overflows and Erosion Protection**: Development on this project will preferably take place during the period April-October.	**Contractor**
	• Contractor to set up a procedure for rapidly emptying any collection points to prevent them filling with rainwater.	
	• Contractor to ensure that no sumps (where applicable) are emptied unnecessarily. Special care to be taken during rainy periods/adverse weather conditions to prevent contents from overflowing.	
	• Contractor to ensure that a procedure is established for dealing with potentially polluted rainwater. Procedures/method statements must be filed in the register in the site office.	
	• Stockpiles of fine material such as sand, topsoil, etc. to be protected from rainfall run-off and wind.	
	• During construction, Contractor to protect all areas susceptible to erosion by installing all the necessary temporary and permanent drainage works ASAP. Contractor must also prevent water scouring of the slopes, embankments (where applicable) and any other areas.	
	• Correct any cause of erosion at the onset thereof through the most appropriate mechanism. Discuss any remedial actions with the resident ECO.	
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
12. Noise, Visual and Dust Impacts.	**1. Noise Impacts**: Contractor to use the equipment that is appropriate to the task in order to minimise the extent of damage to the environment and minimise the noise levels.	**Contractor**
	• The provisions of SABS 1200A will apply to all areas within audible distance of the site.	
	• Noise levels to be kept within acceptable limits for a conservation/agricultural area, and not to be of such a nature as to detract from the experience of persons in the area.	
	• No amplified music will be allowed.	
	• Construction activities generating output levels of 85dB or more will be confined to the hours 07h00 to 17h00 Mondays to Fridays.	
	2. Dust: Dust to be controlled on site at all times.	

	• Dust emissions may occur during the clearing of vegetation and delivery of equipment and supplies on the farm roads to the project area. • Contractor must control dust emissions using a water tanker as and when the impact arises.	
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
13. Cultural Artefacts.	**<u>1. Handling of Unexpected Cultural Finds</u>**: The proposed project does not traverse, impact and or influence aspects of historical value, however the following conditions are listed in the event that an unexpected find or artefact is unearthed. • An accredited archaeologist must oversee the excavation process. • Sensitise the Contractor/labourers to be aware of the importance of cultural artefacts/fossils and implement the recommended procedure below in the event that such a discovery is made accidentally during construction. • Should any artefact, historical site or fossil be discovered during excavations for irrigation trenches as well as in future, all works must cease with immediate effect. • A buffer of 30m must be established around the find. • The find must be reported to the ECO and the Project Manager for the project. • These representatives will initiate an Action Plan in conjunction with an accredited archaeologist/palaeontologist (Contact SAHRA) to address the management and handling of the find.	**Contractor**
ACTIVITY	**MANAGEMENT/MITIGATION ACTION**	**RESPONSIBLE PERSON**
14. Site Clean Up and Closure.	**<u>1. Removal and Clearance</u>**: Contractor to ensure that all temporary structures, materials, water and waste facilities used for construction activities are removed upon completion of the project. • All signs of disturbance and contractor activity must be rehabilitated to a state as on day of site handover. • All toilets must be removed. • All left over stock and bits and pieces of materials must be removed. • All waste bags must be deposited at the waste management facility (site yard). **<u>2.Rehabilitation</u>**: • All re-seeding activities will be undertaken at the end of the dry season to ensure optimal conditions for germination and rapid vegetation establishment. • When ripping for rehabilitation the contractor will rip to refusal or a minimum of 300 mm. • The rehabilitated and seeded areas must be harrowed after spreading the topsoil and fertiliser uniformly. • All rehabilitated sites must be covered in brush to restrict run-off and prevent erosion.	**Contractor and the ECO.**

	• Inspect rehabilitated area at three monthly intervals during the first and second growing season to determine the efficacy of rehabilitation measures.	
	• Take appropriate remedial action where vegetation establishment has not been successful or erosion is evident.	
	• Only indigenous vegetation commensurate with the Lows Creek Farm landscape is to be used in any landscaping/reseeding which may be undertaken.	
	<u>3. Project Sign Off</u>: The ECO must sign off the works and the site during a Final Audit Assessment. The Final Audit Report will be submitted to DARDLEA for approval and verification.	

PROTECTION OF THE ENVIRONMENT:
DECLARATION OF UNDERSTANDING: CONTRACTOR TO SIGN:

The Contractor will not be given right of access to the Site until this form has been signed.

I / we, ____ {Contractor} record as follows:

I / we, the undersigned, do hereby declare that I / we am / are aware of the increasing requirement by society that construction activities shall be carried out with due regard to their impact on the environment.

In view of this requirement of society and a corresponding requirement by the Employer with regard to this Contract, I / we will, in addition to complying with the letter of the terms of the Contract dealing with protection of the environment, also take into consideration the spirit of such requirements and will, in selecting appropriate employees, plant, materials and methods of construction, in-so-far as I / we have the choice, include in the analysis not only the technical and economic (both financial and with regard to time) aspects but also the impact on the environment of the options.

In this regard, I / we recognise and accept the need to abide by the "precautionary principle" which aims to ensure the protection of the environment by the adoption of the most environmentally sensitive construction approach in the face of uncertainty with regard to the environmental implications of construction.

I / we have signed the Declaration of Understanding with respect to the Environmental Management Programme.

I / we acknowledge and accept the right of the Employer to deduct, should they so wish, from any amounts due to me / us, such amounts (hereinafter referred to as fines) as the Construction Manager shall certify as being warranted in view of my / our failure to comply with the terms of the Contract dealing with protection of the environment, subject to the following:

The Project Manager, in determining the amount of such fine, shall take into account inter alia, the nature of the offence, the seriousness of its impact on the environment, the degree of prior compliance / non-compliance, the extent of the Contractor's overall compliance with environmental protection requirements and, in particular, the extent to which he/she considers it necessary to impose a sanction in order to eliminate / reduce future occurrences.
The Construction Manager shall, with respect to any fine imposed, provide me / us with a written statement giving details of the offence, the facts on which the Construction Manager has based their assessment and the terms of the Contract (by reference to the specific clause) which has been contravened.

Signed _____________________________
Date ________________________

RHENGU ENVIRONMENTAL SERVICES
P O Box 1046 **Cell: 082 414 7088**
MALELANE **Fax: 086 685 8003**
1320 **E–mail: rhengu@mweb.co.za**

ACCEPTANCE OF EMPr:
Lows Creek Dam Project:
Project Reference: 1/3/1/16/1E-294

DECLARATION

I/We, the undersigned as the proponent/s/person/s responsible for the above-proposed activity undertake to abide by the above-designated EMP and associated conditions.

Name: ______________________________

Signature: ______________________________

Date: ______________________________

Name: ______________________________

Signature: ______________________________

Date: ______________________________

CHECKED BY ENVIRONMENTAL CONTROL OFFICER

Name: ______________________________

Signature: ______________________________

Date: ______________________________