WETLAND ASSESSMENT

Proposed Roan PV 2, Portions 4,5,9 & 16 of the farm Rhenosterhoek 299, Hartbeesfontein, North West Province

In-channel dam, Dam 1, at the site.
Photo: Reinier F. Terblanche.

APRIL 2022

COMPILED BY:

Reinier F. Terblanche

(M.Sc, *Cum Laude*; Pr.Sci.Nat, Reg. No. 400244/05)

TABLE OF CONTENTS

I) SPECIALIST EXPERTISE

SYNOPTIC CV: REINIER. F. TERBLANCHE

Reinier is an ecologist and in particular a habitat specialist with an exceptional combination of botanical and zoological expertise which he keeps fostering, updating and improving. He is busy with a PhD for which he registered at the Department of Conservation Ecology at the University of Stellenbosch. The PhD research focuses on the landscape ecology of selected terrestrial and wetland butterflies in South Africa. Reinier's experience includes being a lecturer in ecology and zoology at the North West University, Potchefstroom Campus (1998-2008). Reinier collaborates with a number of institutes, organizations and universities on animal, plant and habitat research.

Qualifications:

Qualification	**Main subject matter**	**University**
M.Sc *Cum Laude*, **1998:** Botany: Ecology	Quantitative study of invertebrate assemblages and plant assemblages of rangelands in grasslands.	North-West University, Potchefstroom
B.Sc Honns *Cum Laude*, **1992** Botany: Taxonomy	Distinctions in all subjects: Plant Anatomy, Taxonomy, Modern Systematics, System Modelling, Plant Ecology, Taxonomy Project. Also included: Statistics Attendance Course.	North-West University, Potchefstroom
B.Sc Botany, Zoology	Main subjects: Botany, Zoology.	North-West University, Potchefstroom
Higher Education Diploma, 1990	Numerous subjects aimed at holistic training of teachers.	North-West University, Potchefstroom

In research Reinier specializes in conservation biology, threatened butterfly species, vegetation dynamics and ant assemblages at terrestrial and wetland butterfly habitats as well as enhancing quantitative studies on butterflies of Africa. He has published extensively in the fields of taxonomy, biogeography and ecology in popular journals, peer-reviewed scientific journals and as co-author and co-editor of books (see 10 examples beneath).

Reinier practices as an ecological consultant and has been registered as a Professional Natural Scientist by SACNASP since 2005: Reg. No. 400244/05. His experience in consultation includes: Flora and fauna habitat surveys, Threatened species assessments, Riparian vegetation index surveys, Compilation of Ecological Management Plans, Biodiversity Action Plans and Status quo of biodiversity for Environmental Management Frameworks, Wetland Assessments, Management of Rare Wetland Species.

Recent activities/ awards: Best Poster Award at Oppenheimer De Beers Group Research Conference 2015, Johannesburg. One of the co-authors of Guidelines for Standardised Global Butterfly Monitoring, 2015, Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany (UNEP-WCMC), GEO BON Technical Series 1. Awarded the prestigious Torben Larsen Memorial Tankard in October 2017; one is awarded annually to the person responsible for the most outstanding written account on Afrotropical Lepidoptera. Lectured as Conservationist-in-Residence in the Wildlife Conservation Programme of the African Leadership University, Kigali, Rwanda, 9-23 February 2019. Reinier won a photographic competition which resulted his photograph of the Critically Endangered *Erikssonia edgei* (Waterberg Copper) being on the front cover of the Synthesis Report of the National Biodiversity Assessment (2018) prepared by SANBI. Reinier is a Research Fellow at the University of South Africa (Unisa) from 1 January 2020.

EXPERIENCE

Lecturer: Zoology 1998-2008	Main subject matter and level	Organization
Lectured subjects	- 3rd year level Ecology, Plantparasitology - 2nd year level Ethology - *Master's degree* Evolutionary Ethology, Systematics in Practice, Morphology and Taxonomy of Insect Pests, Wetlands.	North-West University, Potchefstroom and University of South Africa
Co-promoter	PhD: Edge, D.A. 2005. Ecological factors that influence the survival of the Brenton Blue butterfly	North-West University, Potchefstroom
Study leader/ assistant study leader	Six MSc students, One BSc Honn student: Various quantitative biodiversity studies (terrestrial and aquatic).	North-West University, Potchefstroom
Teacher 1994-1998	Biology and Science, Secondary School	Afrikaans Hoër Seunskool, Pretoria
Owned Anthene Ecological CC 2008 – present	- Flora and Fauna habitat surveys - Highly specialized ecological surveys - Riparian vegetation index surveys - Ecological Management Plans - Biodiversity Action Plans - Biodiversity section of Environmental Management Frameworks - Wetland assessments	Private Closed Corporation that has been subcontracted by many companies
Herbarium assistant 1988-1991	- Part-time assistant at the A.P. Goossens herbarium, Botany Department, North-West University, 1988, 1989, 1990 and 1991 (as a student).	North-West University, Potchefstroom

10 EXAMPLES OF PUBLICATIONS OF WHICH R.F. TERBLANCHE IS AUTHOR/ CO-AUTHOR
(Three books, two chapters in books and five articles are listed here as examples)

1. HENNING, G.A., **TERBLANCHE, R.F.** & BALL, J.B. (eds) **2009.** *South African Red Data Book: butterflies*. *SANBI Biodiversity Series* 13. South African National Biodiversity Institute, Pretoria. 158p. ISBN 978-1-919976-51-8
2. MECENERO, S., BALL, J.B., EDGE, D.A., HAMER, M.L., HENNING, G.A., KRÜGER, M, PRINGLE, E.L., **TERBLANCHE, R.F.** & WILLIAMS, M.C. (eds). 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and atlas.* Saftronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
3. VAN SWAAY, C., REGAN, E., LING, M., BOZHINOVSKA, E., FERNANDEZ, M., MARINI-FILHO, O.J., HUERTAS, B., PHON, C.-K., KŐRÖSI, A., MEERMAN, J., PE'ER, G., UEHARA-PRADO, M., SÁFIÁN, S., SAM, L., SHUEY, J., TARON, D., **TERBLANCHE, R.F**. & UNDERHILL, L. 2015. Guidelines for Standardised Global Butterfly Monitoring. Group on Earth Observations Biodiversity Observation Network, Leipzig, Germany. GEO BON Technical Series 1.
4. **TERBLANCHE, R.F.** & HENNING, G.A. **2009.** *A framework for conservation management of South African butterflies in practice.* In: Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds). *South African Red Data Book: Butterflies. SANBI Biodiversity Series 13.* South African National Biodiversity Institute, Pretoria. p. 68 – 71.
5. EDGE, D.A., **TERBLANCHE, R.F**., HENNING, G.A., MECENERO, S. & NAVARRO, R.A. 2013. Butterfly conservation in southern Africa: Analysis of the Red List and threats. In: Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M., Pringle, E.L., Terblanche, R.F. & Williams, M.C. (eds). *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas.* pp. 13-33. Saftronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
6. **TERBLANCHE, R.F.**, SMITH, G.F. & THEUNISSEN, J.D. **1993.** Did Scott typify names in *Haworthia* (Asphodelaceae: Alooideae)? *Taxon* **42**(1): 91–95. (International Journal of Plant Taxonomy).
7. **TERBLANCHE, R.F.**, MORGENTHAL, T.L. & CILLIERS, S.S. **2003.** The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* **46**(1): 73-90.
8. EDGE, D.A., CILLIERS, S.S. & **TERBLANCHE, R.F. 2008**. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* **104**: 505 - 510.
9. GARDINER, A.J. & **TERBLANCHE, R.F. 2010.** Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae) *African Entomology* **18**(1): 171-191.
10. **TERBLANCHE, R.F.** 2016. *Acraea trimeni* Aurivillius, [1899], *Acraea stenobea* Wallengren, 1860 and *Acraea neobule* Doubleday, [1847] on host-plant *Adenia repanda* (Burch.) Engl. at Tswalu Kalahari Reserve, South Africa. *Metamorphosis* 27: 92-102.

* A detailed CV with more complete publication list is available.

II) SPECIALIST DECLARATION

I, Reinier F. Terblanche, as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), hereby declare that I:

- I act as the independent specialist in this application;
- I 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 applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and 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 NEMA, the Environmental Impact Assessment Regulations, 2014 (as amended) and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant 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; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Name of Specialist: Reinier F. Terblanche

Signature of the specialist

Date: 19 April 2022

1 INTRODUCTION

A wetland assessment is required for proposed development at Portions 4, 5, 9 & 16 of the farm Rhenosterhoek 299, approximately 3 km south of Hartbeesfontein, North West Province South Africa (elsewhere referred to as the site), and if wetlands are present an assessment of these wetlands will take place. Such an assessment would then focus on the hydro-geomorphic setting, an estimate of the properties of the wetlands, an assessment of the functional aspects of wetlands and an impact assessment to wetlands, should the development be approved.

1.1 Wetlands in South Africa

Wetlands are defined by the National Water Act (Act 36 of 1998) as:
"land which is transitional between terrestrial and aquatic ecosystems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil".

According to *A practical field procedure for identification and delineation of wetlands and riparian areas* (DWAF 2005) wetlands must have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation
- The presence, at least occasionally, of water loving plants (hydrophytes)
- A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50cm of the soil

Wetlands, according to the definition of DWAF (2005) are at the interface of aquatic systems and the terrestrial environment. As such the characteristics of the surface water or near surface water in space and time at this interface between the terrestrial and aquatic environment are fundamental to understand the functioning of a particular wetland. At the higher elevations of South Africa surface water at wetlands are characterised by considerable contrasts between seasons and periodic precipitation events. Generally accepted definitions of wetlands which focus on the wetland attributes of soil and vegetation are therefore useful because of its consistency despite seasonal fluctuations.

The Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al.*, 2013) includes wetland ecosystems defined by the National Water Act (Act 36 of 1998) as well as those “wetland sytems” defined in the Ramsar Convention. The broader definition of wetlands, according to the Ramsar Convention is that wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water to the depth of which at low tide does not exceed six metres (cited by Ramsar Convention Secretariat 2011). This Ramsar definition of “wetlands” overlaps broadly with the definition of aquatic systems according to the South African system of classifying wetlands and other aquatic ecosystems. In South Africa an aquatic ecosystem is an ecosystem that is permanently or periodically inundated by flowing or standing water, or which has soils that are permanently or periodically saturated within 0.5 m of the soil surface (Ollis *et al*., 2013). Therefore an important consideration of the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*., 2013) is that a wetland (narrow definition according to water act and not Ramsar definition) is taken to be a unique type of aquatic system.

1.2 Importance of wetlands

The importance of wetlands for human well-being and the conservation of biodiversity are recognised world-wide. Ecosystem services which directly or indirectly benefit human well-being are of particular importance when wetlands are considered. Wetlands play a major role to enhance supporting services such as nutrient cycling and primary production, which in turn is the basis for other ecosystem services. Wetlands are very important to regulating services such as maintaining water flow and water quality by processing water and regulating water run-off, provisioning services such as providing freshwater, cultural services such as appreciating the landscape and biodiversity. Overall wetlands play a major role in the sustainability of land use from socio-economic and biodiversity conservation perspectives. The setting and function of wetlands at each site should therefore be evaluated to inform land use management.

Wetland vegetation is of significant importance for wetlands to play a role in valuable ecosystem services. Vegetation plays an important role in natural wetland ecosystems. It holds soil together and slows down the flow of water, reducing the risk of erosion and promoting sediment deposition.

Plants are the source of organic material in wetland soils, and form the organic soil in peat wetlands. Vegetation also has an impact on the quality of surface and subsurface water as it (1) provides organic soil matter required by microbes in order to assimilate nutrients and toxicants (2) provides habitat for the microbes in the soil immediately surrounding the roots, and (3) contributes through direct uptake of nutrients and toxicants and incorporation of these into plant tissues (Sieben *et al.* 2009).

1.3 Aims and objectives of the survey

A survey consisting of three visits to investigate key elements of habitats on the site, relevant to the conservation of wetlands are conducted. The importance and significance of the site with special emphasis on the current status of biodiversity and ecological services of the wetland are evaluated. Literature investigations are integrated with field observations to identify potential ecological impacts that could occur as a result of the development and to make recommendations to reduce or minimise impacts, should the development be approved.

The objectives of the wetland habitat assessment are to provide:

- An indication of the existence of wetlands at the site and if so:
- An identification of major aspects of the hydro-geomorphic setting and terrain unit at which the wetland occur;
- An estimate of the size and roughness of the wetland
- An indication of the hydric soils at the site;
- An indication of erodability;
- An indication of the presence or absence of peat at the site;
- An outline of hydrological drivers that support the existence and character of the wetland;
- An assessment of the possible presence or absence of threatened or localised plant species, vertebrates and invertebrates of the region, at the site;
- A description of the functions provided by the wetland at the site;
- An interpretation of the priority of the wetland for local communities in the area;
- An interpretation of the priority of the wetland to biodiversity at the site;

2 STUDY AREA

The study area is at at Portions 4, 5, 9 & 16 of the farm Rhenosterhoek 299, approximately 3 km south of Hartbeesfontein, North West Province South Africa (elsewhere referred to as the site). Grassland at the site is represented by two vegetation types the Vaal-Vet Sandy Grassland (Gh 10) and the Klerksdorp Thornveld (Gh 13).

Gh 10 Vaal-Vet Sandy Grassland

Distribution: In South Africa the Vaal-Vet Sandy Grassland is present in the North-West Province and Free State Province. Vaal-Vet Sandy Grassland ranges from south of Lichtenburgand Ventersdorp to Klerksdorp, Leeudoringstad, Bothaville and to the Brandfort areas north of Bloemfontein. Altitude ranges from 1 220 – 1560 m for the entire vegetation type (Mucina & Rutherford 2006).

Vegetation and landscape features: Plains-dominated landscape with some scattered, slightly undulating plains and hills. Mainly low-tussock grasslands with an abundant karroid element are present. Dominance of *Themeda triandra* is an important feature of this vegetation unit. Locally low cover of *Themeda triandra* and the associated increase in *Elionurus muticus*, *Cymbopogon pospischilii* and *Aristida congesta* is attributed to heavy grazing and/or erratic rainfall. Geology and soils: Aeolian and colluvial sand overlying sandstone, mudstone, and shale of the Karoo Supergroup (mostly the Ecca group) as well as older Ventersdorp Supergroup and basement gneiss in the north (Mucina & Rutherford 2006).

Climate: Warm-temperate, summer-rainfall climate, with overall mean annual precipitation of 530 mm. High summer temperatures. Severe frost (37 days per year on average) occurs in winter (Mucina & Rutherford 2006).

Important taxa of the Vaal-Vet Sandy Grassland listed by Mucina & Rutherford (2006): Graminoids: *Anthephora pubescens, Aristida congesta, Chloris virgata, Cymbopogon caesius, Cynodon dactylon, Digitaria argyrograpta, Elionurus muticus, Eragrostis chloromelas, Eragrostis*

lehmanniana, Eragrostis plana, Eragrostis trichophora, Heteropogon contortus, Panicum gilvum, Setaria sphacelata, Themeda triandra, Tragus berteronianus, Brachiaria serrata, Cymbopogon pospischilii, Digitaria eriantha, Eragrostis curvula, Eragrostis obtusa, Eragrostis superba, Panicum coloratum, Pogonarthria squarrosa, Trichoneura grandiglumis, Triraphis andropogonoides. Herbs: *Stachys spathulata, Barleria macrostegia, Berkheya onopordifolia* var. *onopordifolia, Chamaesyce inaequilatera, Geigeria aspera* var. *aspera, Helichrysum caespititium, Hermannia depressa, Hibiscus pusillus, Monsonia burkeana, Rhynchosia adenodes, Selago densiflora, Vernonia oligocephala.* Geophytic Herbs: *Bulbine narcissifolia*, *Ledebouria marginata*. Succulent Herb: *Tripteris aghillana* var. *integrifolia.* Low shrubs: *Felicia muricata, Pentzia globosa, Anthospermum rigidum* subsp. *pumilum, Helichrysum dregeanum, Helichrysum paronychioides, Ziziphus zeyheriana.*

Klerksdorp Thornveld (Gh 13)

Distribution: In South Africa the Klerksdorp Thornveld is present in the North West Province in two sets of patches, one in the Wolmaransstad, Ottosdal and Hartbeesfontein region, and the other from the Botsalano Game Park north of Mafikeng in the vicinity of Madibogo in the south. Altitude for the entire vegetation type is 1260 – 1580 m (Mucina & Rutherford 2006).

Vegetation and landscape features: Plains or slightly irregular undulating plains with open to dense *Acacia karroo* bush clumps in dry grasslands (Mucina & Rutherford 2006). Geology and soils: Shale, slate and quartzite of the Pretoria Group with interlaid diabase sills and Hekpoort lava supporting relatively shallow and rocky soils (Glenrosa and Mispah forms). Equally represented are eutrophic red plinthic soils (Hutton form) derived mainly from a thick succession of volcanics and sediments of the Ventersdorp Supergroup (Mucina & Rutherford 2006).

Climate: Warm-temperate, summer-rainfall region, with overall mean annual precipitation of 533 mm. Summer temperatures are high. Frequent frosts occur in winter (Mucina & Rutherford 2006).

Important taxa of the Klerksdorp Thornveld listed by Mucina & Rutherford (2006): Small Trees: *Acacia karroo, Acacia caffra, Celtis africana, Searsia lancea, Ziziphus mucronata.* Tall Shrubs: *Acacia hebeclada, Diospyros lycioides* subsp. *lycioides, Ehretia rigida, Grewia flava, Gymnosporia buxifolia, Searsia pyroides, Tarchonanthus camphoratus.* Woody Climber: *Asparagus africanus*.

Low Shrubs: *Asparagus laricinus, Asparagus suaveolens, Felicia muricata, Anthospermum hispidulum, Anthospermum rigidum* subsp. *pumilum, Aptosimum elongatum, Gnidia capitata, Gomphocarpus fruticosus subsp. fruticosus, Helichrysum dregeanum, Leucas capensis, Pavonia burchellii, Pentzia globosa, Solanum supinum* var. *supinum, Triumfetta sonderi, Ziziphus zeyheriana*. Graminoids: *Aristida congesta, Cynodon dactylon, Eragrostis lehmanniana, Eragrostis trichophora, Microcloa caffra, Panicum coloratum, Sporobolus fimbriatus, Themeda triandra, Andropogon shirensis, Anthephora pubescens, Aristida junciformis* subsp. *galpinii, Aristida stipitata* subsp. *graciliflora, Brachiaria nigropedata, Brachiaria serrata, Bulbostylis burchellii, Cymbopogon pospischilii, Digitaria eriantha, Diheteropogon amplectens, Elionurus muticus, Eragrostis curvula, Eragrostis obtusa, Eragrostis racemosa, Eragrostis superba, Eustachys paspaloides, Heteropogon contortus, Setaria sphacelata, Sporobolus africanus, Tragus berteronianus, Trichoneura grandiglumis, Triraphis andropogonoides.* Herbs: *Acalypha angustata, Acanthospermum australe, Berkheya onopordifolia* var. *onopordifolia, Berkheya setifera, Blepharis integrifolia* var. *clarkei, Chamaesyce inaequilatera, Chascanum adenostachyum, Dicoma macrocephala, Helichrysum nudifolium* var. *nudifolium, Hermannia lancifolia, Hibiscus pusillus, Justicia anagalloides, Lippia scaberrima, Nidorella microcephala, Nolletia ciliaris, Pollichia campestris, Rhyncosia adenodes, Salvia radula, Selago densiflora, Teucrium trifidum, Tolpis capensis.* Geophytic Herbs: *Bulbine narcissifolia, Ledebouria marginata, Ornithogalum tenuifolium* subsp. *tenuifolium, Raphionacme hirsuta.* Herbaceous Climber: *Rhynchosia venulosa.*

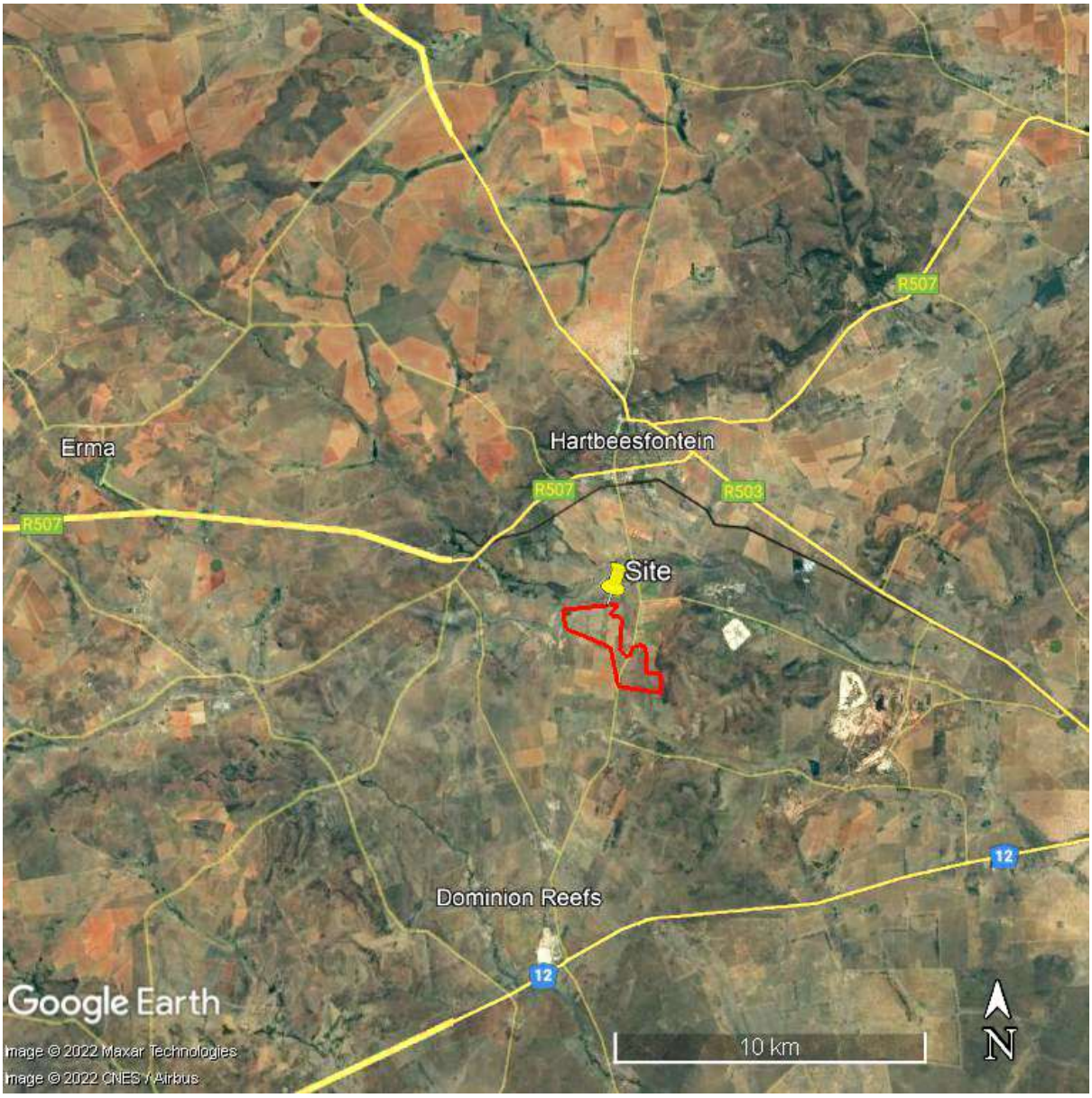

Figure 1 Map with an indication of the location of the site.
Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2021).

3 METHODS

A desktop study comprised not only an initial phase, but also it was used throughout the study to accommodate and integrate all the data that became available during the field observations.

Surveys by R.F. Terblanche were done in January 2022 and February 2022 to note key elements of habitats on the site, relevant to wetland indicators and the conservation of wetland fauna and flora.

Classification of any inland wetland systems that could be present at the site is according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al*., 2013). One of the major advantages of the Classification System for South Africa (Ollis *et al*., 2013) is that the functional aspects of wetlands are the focal point of the classification. Wetlands are very dynamic systems and their functionality weighs high against the rapid changes in their appearance (Terblanche *In prep*). In this document the main guideline for the delineation and identification of wetlands where present is the practical field procedure for identification and delineation of wetlands by DWAF (2005).

The following sections highlight the materials and methods applicable to different aspects that were observed.

3.1 Classification of wetlands (SANBI: Ollis *et al*., 2013)

3.1.1 System, regional setting and landscape unit (Levels 1, 2 and 3)

Three broad types of Inlands Systems are dealt with in the Classification System namely rivers, open waterbodies and wetlands. These Inland Systems are then classified according to a six-tiered structure that includes six levels.

At the systems level (Level 1) of wetland classification, a distinction is made between Marine, Estuarine and Inland ecosystems using the level of connectivity to the open ocean as discriminator of the biophysical character of each (Ollis *et al*., 2013). Inland wetland systems are aquatic ecosystems with no no existing connection to the ocean (i.e. characterised by the complete absence of marine exchange and/ or tidal influence (Ollis *et al*., 2013). In this case if any wetland is present it obviously qualifies as an Inland wetland system.

At Level 2 the regional setting is a spatial framework that is preferred by the investigator to allow for gaining an understanding of the broad ecological context within which an aquatic system occurs (Ollis *et al*., 2013). A regional setting can be identified according to the DWA ecoregion classification of Kleynhans *et al.* (2005).

A distinction is made between four landscape units at Level 3 of the Classification System for Inland Systems on the basis of the landscape setting (i.e. topographical position) (Ollis *et al*., 2013). Four landscape units are recognized: slope, valley floor, plain and bench.

3.1.2 Hydrogeomorphic units (Level 4)

Seven primary hydrogeomorphic (HGM) units are recognised for Inland Systems at Level 4A of the Classification System for Wetlands and other Aquatic Ecosystems in South Africa, on the basis of hydrology and geomorphology (Ollis *et al*., 2013). These are a River, Channeled valley-bottom wetland, Unchannelled valley-bottom wetland, Floodplain wetland, Depression, Seep and Wetland flat.

3.1.3 Hydrological regime (Level 5)

While the hydrogeomorphic unit (HGM) is influenced by the source of water and how it moves into, through and out of an Inland System, the hydrological regime (as catergorised by the Classification System) describes the behaviour fo the water within the system and, for wetlands, in the underlying soil (Ollis *et al.,* 2013). Together with the hydrogeomorphology the hydrological regime is used to describe the wetland as a functional unit (Ollis *et al.*, 2013). In the case of Inland wetlands which are classified as rivers, perenniality is an important characteristic to describe the hydrological regime. For Inland Systems other than rivers, five categories relating to the frequency and duration

of inundation have been provided: Permanently inundated, Seasonally inundated, Intermittently inundated, Never inundated/ rarely inundated and unknown (Ollis *et al*., 2013). Period of saturation within the upper 0.5 m of the soil is a very important discriminator that also links to the wetland delineation system of DWAF (2005). The following categories for saturation of wetland soils are recognised: Permanently saturated, Seasonally saturated, Intermittently saturated and unknown. These categories of period of saturation correspond to the permanent, seasonal and temporary zones of wetlands respectively.

3.1.4 Wetland descriptors (Level 6)

At Level 6 several “descriptors” are included for the structural/ chemical/ biological characterisation of Inland Systems (Ollis *et al.,* 2013). These descriptors are non-hierarchical to one another and can be applied in any order depending on the purpose of a study and the availability of information. Descriptors include natural vs. artificial, salinity, substratum type, pH, geology and vegetation cover (Ollis *et al*., 2013). Various definitions are given for the descriptors which are likely to increase the consistency and use of the system.

3.2 Delineation of wetland

Together with terrain unit, indirect indicators of prolonged saturation by water: wetland plants (hydrophytes) and wetland (hydromorphic) soils are identified and used to delineate the wetland (DWAF 2005). Three zones, which may not all three be present in all wetlands, namely the permanent zone of wetness, the seasonal zone and the temporary zone are identified. The temporary zone is the outer zone and is saturated for only a short period of the year that is sufficient, under normal circumstances, for the formation of hydromorphic soils and the growth of wetland vegetation (DWAF 2005). Hydromorphic soils must display signs of wetness within 50cm of the soil to qualify as wetland soil that can support hydrophytic vegetation. Grid references and altitudes are taken on site with a GPS Garmin E-trex 20 ® instrument. Map information are analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2015).

3.3 Vegetation at and near wetland

Though vegetation is a key component of the wetland definition in the Water Act, using vegetation as a primary indicator requires undisturbed conditions and expert knowledge (DWAF 2005). Modern wetland classification systems in South Africa therefore place more emphasis on the soil wetness indicators. It remains however, that plant assemblages undergo distinct changes in species composition from the centre of a wetland to the edge, and into adjacent terrestrial areas (DWAF 2005). This change in species composition of vegetation provides valuable clues for determining the wetland boundary and wetness zones (DWAF 2005).

Apart from botanical aspects which are integrated into the description of a wetland it is imperative to note the existence or not of threatened plant species or other plant species of conservation concern, such as near-threatened, data deficient or declining species at a wetland. Floristic composition is therefore also considered during the wetland assessment. Voucher specimens of plant species are only taken where the taxonomy is in doubt or where the plant specimens are of significant relevance for invertebrate conservation. Field guides such as those by Germishuizen (2003), Manning (2003), Manning (2009), Van Oudtshoorn (1999), Van Wyk (2000), Van Wyk & Malan (1998) and Van Wyk & Van Wyk (1997) were used to confirm the taxonomy of the species. Works on specific plant groups (often genera) such as those by Goldblatt (1986), Goldblatt & Manning (1998), Jacobsen (1983), McMurtry, Grobler, Grobler & Burns (2008), Smit (2008), Van Jaarsveld (2006) and Van Wyk & Smith (2003) were also consulted to confirm the identification of species. An important source of identifications of plant species for the wetland survey is Van Ginkel, Glen, Gordon-Gray, Cilliers, Muasya & Van Deventer (2011). In this case no plant specimens were needed to be collected as voucher specimens or to be send to a herbarium for identification. For the most recent treatise of scientific plant names and broad distributions, Germishuizen, Meyer & Steenkamp (2006) or Raimondo *et al*. (2009) or updated lists on SANBI websites are followed to compile the lists of species.

3.4 Fauna at and near wetland

Species composition of fauna is not used in wetland characterization and assessments. However, it is important to note species that favour wetlands and especially whether threatened animal species are present at a wetland or not.

Mammals are noted as sight records by day. For the identification of species and observation of diagnostic characteristics Smithers (1986), Skinner & Chimimba (2005), Cillié, Oberprieler and Joubert (2004) and Apps (2000) are consulted. Sites are been walked, covering as many habitats as possible. Signs of the presence of mammal species, such as calls of animals, animal tracks (spoor), burrows, runways, nests and faeces are recorded. Walker (1996), Stuart & Stuart (2000) and Liebenberg (1990) are consulted for additional information and for the identification of spoor and signs. Trapping is only done if necessary. Habitat characteristics are also surveyed to note potential occurrences of mammals. Many mammals can be identified from field sightings but a number of bats, rodents and shrews can only be reliably identified in the hand, and even then, some species needs examination of skulls, or even chromosomes (Apps, 2000).

Birds are noted as sight records, mainly with the aid of binoculars (10x30). Nearby bird calls of which the observer was sure of the identity were also recorded. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Ryan (2001) is followed. For information on identification, biogeography and ecology Barnes (2000), Hockey, Dean & Ryan, P.G. (2005), Cillié, Oberprieler & Joubert (2004), Tarboton & Erasmus (1998) and Chittenden (2007) are consulted. Ringing of birds falls beyond the scope of this survey. Sites are walked, covering as many habitats as possible. Signs of the presence of bird species such as spoor and nests are additionally been recorded. Habitat characteristics are surveyed to note potential occurrences of birds.

Reptiles are noted as sight records in the field. Binoculars (10x30) can also be used for identifying reptiles of which some are wary. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques, Branch (1998), Marais (2004), Alexander & Marais (2007) and Cillié, Oberprieler and Joubert (2004) are followed. Sites are walked, covering as many habitats as possible. Smaller reptiles are sometimes collected for identification, but this practice was not necessary in the case of this study. Habitat characteristics are surveyed to note potential occurrences of reptiles.

Frogs and toads are noted as sight records in the field or by their calls. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Carruthers (2001), Du Preez (1996), Conradie, Du Preez, Smith & Weldon (2006) and the recent complete guide by Du Preez & Carruthers (2009) are consulted. CD's with frog calls by Carruthers (2001) and Du Preez & Carruthers (2009) are used to identify species by their calls when applicable. Sites

are walked, covering as many habitats as possible. Smaller frogs are often collected by pitfall traps put out for epigeal invertebrates (on the soil), but this practice falls beyond the scope of this survey. Habitat characteristics are also surveyed to note potential occurrences of amphibians.

Invertebrates of which enough information is available to be integrated into an assessment, such as butterflies, are recorded as sight records, photographic records or voucher specimens. Voucher specimens are mostly taken of those species of which the taxa warrant collecting due to taxonomic difficulties or in the cases where species can look similar in the veldt. Many butterflies use only one species or a limited number of plant species as host plants for their larvae. Myrmecophilous (ant-loving) butterflies such as the *Aloeides*, *Chrysoritis*, *Erikssonia, Lepidochrysops* and *Orachrysops* species (Lepidoptera: Lycaenidae), which live in association with a specific ant species, require a unique ecosystem for their survival (Deutschländer & Bredenkamp, 1999; Terblanche, Morgenthal & Cilliers, 2003; Edge, Cilliers & Terblanche, 2008; Gardiner & Terblanche, 2010). Known food plants of butterflies are therefore also recorded. Other invertebrate groups such as fruit chafer beetles and mygalomorph spiders are also investigated where relevant.

3.5 Present Ecological Status

Ecological status of wetlands are based on models such as the modified Habitat Integrity approach developed by Kleynhans (1996, 1999). Present ecological status PES methodology is then largely based on criteria for assessing the habitat integrity of floodplain wetlands and notes for allocating a score to attributes and rating the confidence level associated with each score (DWAF 1999). Such criteria are selected on the assumption that anthropogenic modification can generally be regarded as the primary causes of degradation of the ecological integrity of a wetland (see DWAF 1999). This is done by using Table W4-1 given by DWAF (1999):

- Score each attribute according to the guidelines provided in the footnote.
- Calculate a mean score for Table W4-1 using the individual scores for all attributes.
- Provide a confidence rating for each score according to the guidelines provided in the footnote to indicate the areas of uncertainty in the determination.

Table W4-2 provides guidelines for the determination of the Present Ecological Status Class (PESC), based on the mean score determined for Table W4-1. If any of the attributes scores < 2 (i.e., it is

considered to be seriously or critically modified) this score and not the mean should be taken into consideration. This approach is based on the assumption that extensive degradation of any of the wetland attributes may determine the Present Ecological Status Category (PESC). In any case, the mean on which the assessment of the PESC is based should be regarded as a guideline and should also be tested against the opinion of local experts (DWAF 1999).

Biological integrity is not directly estimated through this approach though in some systems or parts of systems, information on biological integrity is available. In such cases, the information on biological integrity can be used as a check of the PES Category determination. The mean is used to relate the ecological state of the wetland to a particular PES Category (Table W4-2) (DWAF 1999).

3.6 Ecological Importance and Sensitivity

The assessment of the ecological importance and sensitivity is according to DWAF (1999) which in turn is adapted from Kleynhans (1996) and Kelynhans (1999). "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and sensitivity (EIS) provide a guideline for determination of the Ecological Management Class (EMC) DWAF (1999).

In the method outlined here, a series of determinants for EIS according to Table W5-1 of DWAF (1999) are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The method is used as a guideline for the professional judgement of individuals familiar with an area and its wetlands. The assessors must substantiate and document their judgement as far as possible for future reference and revision (DWAF 1999).

3.7 Risk Rating

The risk matrix is based on the DWS publication: Section 21 c and 1 water use Risk Assessment Protocol and Notice 509 of 2016 (Government Gazette No. 40229: 105-133; Republic of South Africa). Risk is determined after considering all listed control and/ or mitigation measures. Borderline low/ moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures considered and listed in red font. Construction is here interpreted in accordance with the definition provided in Notice 509 of 2016 (Government Gazette No. 40229, p.107) to mean “any works undertaken to initiate or establish impeding or diverting or modifying resource quality, for the first time, including vegetational removal, site preparation and ground levelling”.

3.8 Limitations

Wetlands are very dynamic systems and owing to time constraints a glimpse of conditions at wetlands are taken, even though the hydrogeomorphological setting, soil wetness characteristics and established vegetation constitute some longterm features of a wetland. For each site visited, it should then be emphasized that surveys can by no means result in an exhaustive list of wetland plants and animals present on the site, because of the time constraint. The onsite wetland surveys were conducted during visits by R.F. Terblanche in January 2022 and February 2022 which are an optimal time to note key elements of habitats on the site, relevant to the conservation of wetlands and fauna and flora. Weather conditions during the surveys were favourable for recording fauna and flora. The focus of the survey remains a habitat survey that concentrates on the hydrogeomorphological, hydrological and additional descriptors to classify and assess the wetland.

4 RESULTS AND DISCUSSION

Photo 1 In-channel dam (Dam 1) at the northwestern part of the site. Areas in the background are outside the site.
Photo: R.F. Terblanche.

Photo 2 Small in-channel dam (Dam 2) at the central part of the site.
Photo: R.F. Terblanche

Photo 3 The wetland grass species, *Echinochloa holubii*, at the watercourse at the site.
Photo: R.F. Terblanche.

Photo 4 The sedge *Cyperus longus* at the watercourse at the site.
Photo: R.F. Terblanche

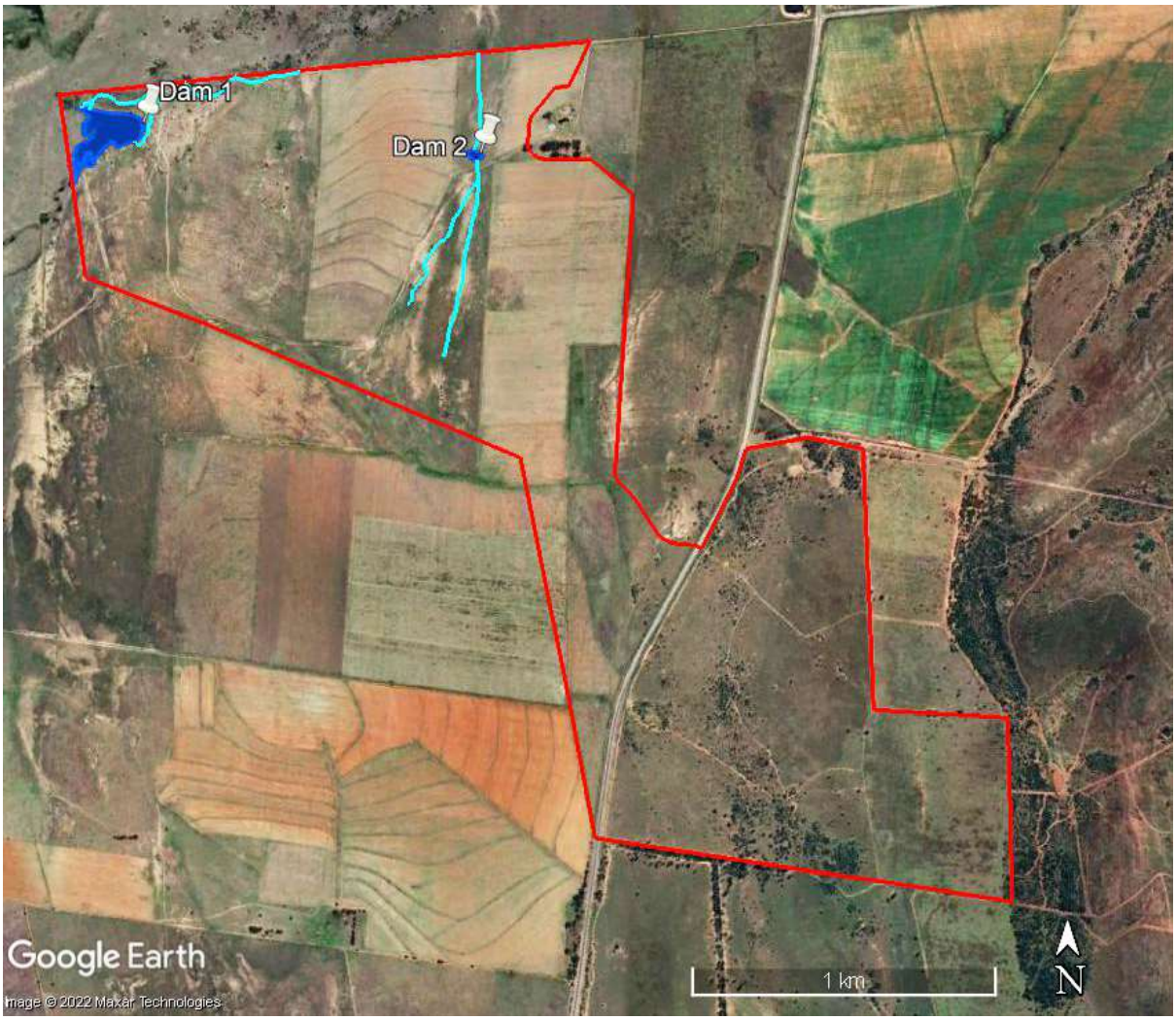

Figure 2 Indication the narrow non-perennial rivers and in-channel dams, at the site.

Light blue outline	Route of active channel at the site
Darker blue outline and shading	Artificial Waterbody (In-channel Dam)

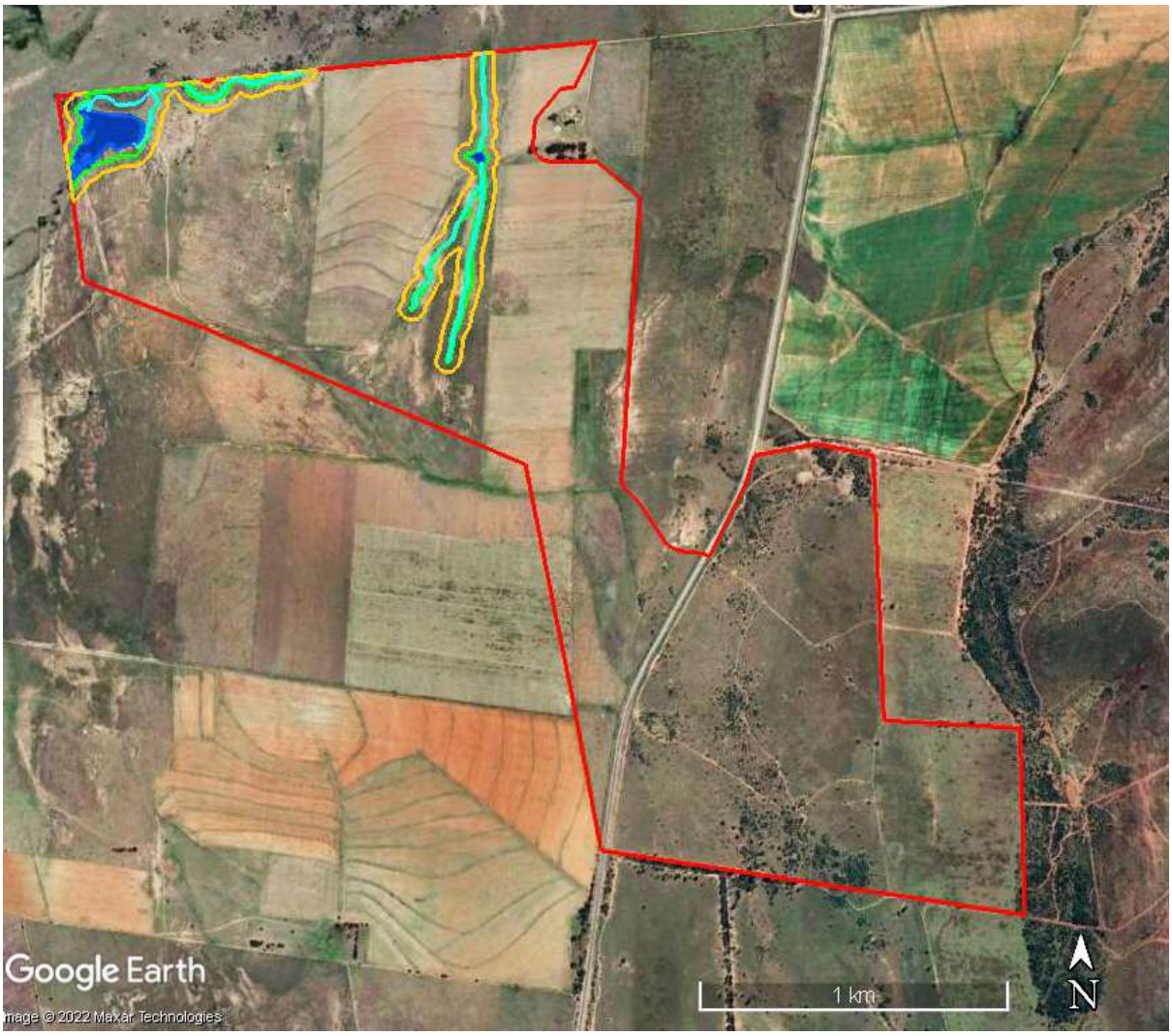

Figure 3 Indication of non-perennial rivers, in-channel dams, with their riparian zones and buffer zones (30 m), at the site.

Light blue outline	Route of active channel at the site
Green outline and shading	Outer edge of riparian zone
Orange outline	Outer edge of buffer zone
Darker blue outline and shading	Artificial Waterbody (In-channel Dam)

4.1 Absence of wetlands at site

Wetlands that could be classified as Floodplain Wetlands, Channelled Valley-bottom Wetlands, Unchannelled Valley-bottom Wetlands, Depressions (Pans), Seeps or Wetland Flats appear to be absent at site.

4.2 Two non-perennial rivers (with active channels and riparian zones) at the site

A narrow non-perennial river, with its active channel and riparian zone, is present at the northwestern part of the site. An in-channel dam (Dam 1), is present at the northeastern part of the site. Another poorly defined active channel and riparian zone are present at the central part of the site. There is a very small dam (Dam 2) at this poorly defined active channel.

Riparian zones have distinctive characteristic vegetation which is often visibly distinct from the surrounding vegetation. It is often clearly adapted to different levels of frequency and inundation and distributed accordingly within the broad riparian zone. The more water loving or mesic species are therefore located close to the river channel, while species which are less dependent on water are located further away. It is the ability of species to tolerate different levels of inundation, the need for excessive water availability, or the need for close river proximity for growth, propagation, temperature control and nutrient enrichment which clearly determinate the structural, compositional and functional characteristics of riparian zones (Kemper, 2001).

Vegetation at the riparian zone and along the fringes of the in-channel dam (Dam 1) at the western part of the site includes the trees *Vachellia karroo* and *Searsia pyroides*. Shrubs such as *Asparagus laricinus* and the herbaceous shrub *Gomphocarpus fruticosus* are conspicuous near and at the riparian zone. The indigenous herbaceous plant species *Berkheya radula* and the alien invasive *Cirsium vulgare* are found at the outer edges of the riparian zone. Sedge species such as *Cyperus longus* and *Eleocharis limosa*, with the grass species *Echinochloa holubii* and herbaceous *Persicaria* species are present at the more permanently inundated soils at the riparian zone. The alien invasive grass species *Paspalum dilatatum* as well as the alien invasive herbaceous species *Oenothera rosea* and *Rumex crispus* occur at the riparian zone and edges of the in-channel dam as well.

The riparian vegetation along the poorly defined active channel at the central part of the site is also poorly defined in many areas. Few trees or shrubs are present at this riparian zone. This area appears to be trampled or eroded. The succulents *Chasmatophyllum muscilinum* and *Ruschia canonotata* are present at some of these bare areas with the karoo element *Pentzia globosa*. The sedge *Kyllinga erecta* is in particular conspicuous at wet areas along the riparian zone. The graminoids *Echinochloa holubii*, *Eleocharis limosa* and *Kyllinga erecta* are visible at the periphery of this small dam (Dam 2).

Present ecological status (PES) of the Non-perennial River (with Dam 1) at the site is CATEGORY C which means the watercourse is moderately modified but with some loss of natural habitats (Table 4.2 and Table 4.3). Ecological Importance and Sensitivity (EIS) of the non-perennial river (with Dam 1) at the site is Category C which is Moderate and refers to watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers (Table 4.4 and Table 4.5).

Present ecological status (PES) of the Non-perennial River (with Dam 2) at the site is CATEGORY C which means the watercourse is moderately modified but with some loss of natural habitats (Table 4.7 and Table 4.8). Ecological Importance and Sensitivity (EIS) of the non-perennial river (with Dam 2) at the site is Category C which is Moderate and refers to watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers (Table 4.9 and Table 4.10).

Table 4.1 Classification and outline of characteristics of **Non-perennial River** (with Dam 1) at the northwestern part of the site according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al.*, 2013).

CHARACTERISTIC TYPE WETLAND DISCRIMINATORS AND DESCRIPTORS	**DESCRIPTION**
System (level 1)	Inland watercourse
Regional setting (level 2)	Western Bankenveld (Kleynhans *et al.,* 2005)
Landscape unit (level 3)	Valley
Hydrogeomorphic unit (level 4)	River
Hydrological regime (Level 5)	A narrow non-perennial river, with its active channel and riparian zone, is present at the northwestern part of the site. An in-channel dam (Dam 1), is present at the northeastern part of the site.
Additional descriptors (Levels 5,6)	Vegetation at the riparian zone and along the fringes of the in-channel dam (Dam 1) at the western part of the site includes the trees *Vachellia karroo* and *Searsia pyroides*. Shrubs such as *Asparagus laricinus* and the herbaceous shrub *Gomphocarpus fruticosus* are conspicuous near and at the riparian zone. The indigenous herbaceous plant species *Berkheya radula* and the alien invasive *Cirsium vulgare* are found at the outer edges of the riparian zone. Sedge species such as *Cyperus longus* and *Eleocharis limosa*, with the grass species *Echinochloa holubii* and herbaceous *Persicaria* species are present at the more permanently inundated soils at the riparian zone. The alien invasive grass species *Paspalum dilatatum* as well as the alien invasive herbaceous species *Oenothera rosea* and *Rumex crispus* occur at the riparian zone and edges of the in-channel dam as well.

Table 4.2 Scoresheet with criteria for assessing habitat integrity of the **Non-perennial River** (with Dam 1) at the northwestern part of the site according to DWAF (1999) such as adapted from Kleynhans (1996).

Criteria and attributes	**Relevance**	**Score**	**Confidence**
Hydrologic			
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	2	4
Permanent inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	2	4
Water Quality			
Water quality modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.	3	3
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	3	3
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	3	4
Topographic alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or change wetland habitat directly or through changes in inundation patterns.	3	4
Biota			
Terrestrial encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	3	4
Indigenous vegetation removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	3	4
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	3	4
Alien fauna	Presence of alien fauna affecting faunal community structure.	3	4
Overutilisation of biota	Overgrazing, over-fishing etc.	3	4
TOTAL **MEAN**		**31** **x=2.8**	42 x=3.8

Scoring guidelines per attribute:
natural, unmodified = 5; Largely natural = 4, Moderately modified = 3; largely modified = 2; seriously modified = 1; Critically modified = 0.
Relative confidence of score:
Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1.

Table 4.3 Interpretation of scores for determining present ecological status **(PES)** of the **Non-perennial River** (with Dam 1) at the northwestern part of the site according to DWAF (1999) such as adapted from Kleynhans (1999). Present ecological status of watercourse is indicated in blue font.

Interpretation of Mean* of Scores for all Attributes: Rating of Present Ecological Status Category (PES Category)
WITHIN GENERALLY ACCEPTABLE RANGE
CATEGORY A >4; Unmodified, or approximates natural condition.
CATEGORY B >3 and <=4; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C **>2 and <=3; moderately modified, but with some loss of natural habitats.**
CATEGORY D =2; largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E >0 and <2; seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F 0; critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

* If any of the attributes are rated <2, then the lowest rating for the attribute should be taken as indicative of the PES category and not the mean.

Table 4.4 Scoresheet for determining ecological importance and sensitivity for floodplains of **Non-perennial River** (with Dam 1) at the northwestern part of the site (DWAF 1999, adapted from Kleynhans 1996, 1999).

Determinant	**Score**	**Confidence**
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	0	3
2. Populations of Unique Species	2	3
3. Species/taxon Richness	2	3
4. Diversity of Habitat Types or Features	2	3
5. Migration route/breeding and feeding site for wetland species	3	3
6. Sensitivity to Changes in the Natural Hydrological Regime	2	3
7. Sensitivity to Water Quality Changes	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	2	3
MODIFYING DETERMINANTS		
9. Protected Status	2	4
10. Ecological Integrity	2	4
TOTAL	**20**	32
MEAN	**2.0**	3.2

Score guideline Very high = 4; High = 3, Moderate = 2; Marginal/Low = 1; None = 0
Confidence rating Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1

Table 4.5 Ecological importance and sensitivity categories. Interpretation of median scores for biotic and habitat determinants (DWAF 1999, adapted from Kleynhans 1996, 1999). Ecological Importance and Sensitivity (EIS) of **Non-perennial River** (with Dam 1) at the northwestern part of the site is indicated in blue font.

Ecological Importance and Sensitivity Category (EIS)	**Range of Median**	**Recommended Ecological Management Class**
Very high Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate **Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.**	**>1 and <=2**	**C**
Low/marginal Floodplains which are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and =1	D

Table 4.6 Classification and outline of characteristics of **Non-perennial River** (with Dam 2) at the site according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et al.*, 2013).

CHARACTERISTIC TYPE WETLAND DISCRIMINATORS AND DESCRIPTORS	**DESCRIPTION**
System (level 1)	Inland watercourse
Regional setting (level 2)	Western Bankenveld (Kleynhans *et al.,* 2005)
Landscape unit (level 3)	Valley
Hydrogeomorphic unit (level 4)	River
Hydrological regime (Level 5)	A poorly defined active channel and riparian zone are present at the central part of the site. There is a very small dam (Dam 2) at this poorly defined active channel.
Additional descriptors (Levels 5,6)	The riparian vegetation along the poorly defined active channel at the central part of the site is also poorly defined in many areas. Few trees or shrubs are present at this riparian zone. This area appears to be trampled or eroded. The succulents *Chasmatophyllum muscilinum* and *Ruschia canonotata* are present at some of these bare areas with the karoo element *Pentzia globosa*. The sedge *Kyllinga erecta* is in particular conspicuous at wet areas along the riparian zone. The graminoids *Echinochloa holubii*, *Eleocharis limosa* and *Kyllinga erecta* are visible at the periphery of this small dam (Dam 2).

Table 4.7 Scoresheet with criteria for assessing habitat integrity of the **Non-perennial River** (with Dam 2) at the site according to DWAF (1999) such as adapted from Kleynhans (1996).

Criteria and attributes	**Relevance**	**Score**	**Confidence**
Hydrologic			
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	2	4
Permanent inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	2	4
Water Quality			
Water quality modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.	3	3
Sediment load modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	2	3
Hydraulic/Geomorphic			
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	3	4
Topographic alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or change wetland habitat directly or through changes in inundation patterns.	2	4
Biota			
Terrestrial encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	2	4
Indigenous vegetation removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.	3	4
Invasive plant encroachment	Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	3	4
Alien fauna	Presence of alien fauna affecting faunal community structure.	2	4
Overutilisation of biota	Overgrazing, over-fishing etc.	3	4
TOTAL **MEAN**		**27** **x=2.4**	42 x=3.8

Scoring guidelines per attribute:
natural, unmodified = 5; Largely natural = 4, Moderately modified = 3; largely modified = 2;
seriously modified = 1; Critically modified = 0.
Relative confidence of score:
Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1.

Table 4.8 Interpretation of scores for determining present ecological status **(PES)** of the **Non-perennial River** (with Dam 2) at the site according to DWAF (1999) such as adapted from Kleynhans (1999). Present ecological status of watercourse is indicated in blue font.

Interpretation of Mean* of Scores for all Attributes: Rating of Present Ecological Status Category (PES Category)
WITHIN GENERALLY ACCEPTABLE RANGE
CATEGORY A >4; Unmodified, or approximates natural condition.
CATEGORY B >3 and <=4; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C **>2 and <=3; moderately modified, but with some loss of natural habitats.**
CATEGORY D =2; largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E >0 and <2; seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F 0; critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

* If any of the attributes are rated <2, then the lowest rating for the attribute should be taken as indicative of the PES category and not the mean.

Table 4.9 Scoresheet for determining ecological importance and sensitivity for floodplains of **Non-perennial River** (with Dam 2) at the site (DWAF 1999, adapted from Kleynhans 1996, 1999).

Determinant	**Score**	**Confidence**
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	0	3
2. Populations of Unique Species	1	3
3. Species/taxon Richness	2	3
4. Diversity of Habitat Types or Features	2	3
5. Migration route/breeding and feeding site for wetland species	1	3
6. Sensitivity to Changes in the Natural Hydrological Regime	2	3
7. Sensitivity to Water Quality Changes	3	3
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	2	3
MODIFYING DETERMINANTS		
9. Protected Status	2	4
10. Ecological Integrity	2	4
TOTAL	**17**	32
MEAN	**1.7**	3.2

Score guideline Very high = 4; High = 3, Moderate = 2; Marginal/Low = 1; None = 0
Confidence rating Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1

Table 4.10 Ecological importance and sensitivity categories. Interpretation of median scores for biotic and habitat determinants (DWAF 1999, adapted from Kleynhans 1996, 1999). Ecological Importance and Sensitivity (EIS) of **Non-perennial River** (with Dam 2) at the site is indicated in blue font.

Ecological Importance and Sensitivity Category (EIS)	**Range of Median**	**Recommended Ecological Management Class**
Very high Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate **Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.**	**>1 and <=2**	**C**
Low/marginal Floodplains which are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and =1	D

5 IMPACTS, MITIGATION AND RATING OF RISKS

5.1 Identification of potential impacts and risks

The potential impacts identified are:

Construction Phase

- Potential impact 1: Loss of riparian habitat owing to the removal of vegetation at the proposed footprint for development.
- Potential impact 2: Changes in flow regime.
- Potential impact 3: Exposure of soil leading to soil compaction and/ or erosion.
- Potential impact 4: Loss of sensitive wetland/ riparian species (Threatened, Near Threatened, Rare, Declining or Protected species) during the construction phase.
- Potential impact 5: Loss of riparian connectivity and conservation corridor networks in the landscape.
- Potential impact 6: Contamination of riparian soil during construction in particular by hydrocarbon spills.
- Potential impact 7: Contamination of habitat by littering and dumping of rubble/ construction material.

Operational Phase

- Potential impact 8: An increased infestation of exotic or alien invasive plant species owing to disturbances associated with the proposed development.
- Potential impact 9: Poor recovery of soils that were exposed and compacted during the construction phase.

5.2 Site specific considerations of risks and impacts

The developer has considered the sensitive watercourse features and associated buffers recommended and has further ensured avoidance by considering 30 m buffers proposed in this

report. This is considered to reduce the risk of impact to the sensitive features and is considered as an opportunity for further mitigation and reduction in the significance of the expected impact.

5.2.1 Riparian vegetation and habitat

Climate at the vegetation types of which site is part comprises warm-temperate, summer-rainfall region, with overall mean annual precipitation of around 530 mm. Summer temperatures are high. Frequent frosts occur in winter (Mucina & Rutherford 2006). The implications of the climate are that construction could take place at the non-perennial stream at a certain time of the year when there is a high probability that temporary diverting the stream would not be necessary. For much of the time the active channels (in particular the non-perennial river containing Dam 2) could be dry. Management options such as fire breaks are rarely considered in such semi-arid areas.

Present ecological status (PES) of the Non-perennial River (with Dam 1) at the site is CATEGORY C which means the watercourse is moderately modified but with some loss of natural habitats (Table 4.2 and Table 4.3). Ecological Importance and Sensitivity (EIS) of the non-perennial river (with Dam 1) at the site is Category C which is Moderate and refers to watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers (Table 4.4 and Table 4.5).

Present ecological status (PES) of the Non-perennial River (with Dam 2) at the site is CATEGORY C which means the watercourse is moderately modified but with some loss of natural habitats (Table 4.7 and Table 4.8). Ecological Importance and Sensitivity (EIS) of the non-perennial river (with Dam 2) at the site is Category C which is Moderate and refers to watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers (Table 4.9 and Table 4.10).

5.2 2 Flow Regime

The non-perennial rivers at the site, with small in-channel dams and with their riparian zones and buffer zones, are likely to be impacted by the proposed developments, but to a very limited extent. If the development is approved the construction should be planned in such a manner that surface

flow function well while erosion is limited. There is no distinct indication that interflow plays an important role in the maintenance of the non-perennial river. The geomorphological setting and flow regime should be as similar as possible post development as to prior the development, if the development is approved (in this case there could be some positive impact on the flow regime). Loss of any wetland animal or plant species of particular conservation importance is not expected.

5.2.3 Likely absence of sensitive species

Loss of Threatened or Near-Threatened wetland Plants, Mammals, Reptiles, Amphibians and Invertebrates at the proposed footprint appears to be unlikely (for birds kindly refer to the specialist Avifaunal study of van Rooyen, 2022).

5.2.4 Connectivity

The non-perennial rivers, with their riparian zones and buffer zones, at the site are corridors of particular conservation importance. These non-perennial rivers, with their riparian zones and buffer zones, are excluded from the development as far as practical. The area needed for working and moving of construction vehicles, machinery and equipment to operate should be fenced off with appropriate material beyond which no activities should be allowed.

5.2.5 Pollution

Rubble or waste could lead to infiltration of unwanted pollutants into the soil. Spilling of petroleum fuels and unwanted chemicals onto the soils that infiltrate these soils could lead to pollution of soils and also impact on water quality when the stream flows. Rubble or waste that could accompany the construction effort, if the development is approved, should be removed during and after construction. Measures should be taken to avoid any spills and infiltration of petroleum fuels or any chemical pollutants into the soil during construction phase.

5.2.6 Alien invasive plant species

A rehabilitation plan which include the combating of alien invasive plant species at the watercourse is essential. Infestation by alien invasive species could replace indigenous vegetation or potential areas where indigenous vegetation could recover. Once established combatting these alien invasive plant species may become very expensive in the long term, especially if species such as *Prosopis* (Mesquite) and *Melia azedarach* (Syringa Berry-tree) are allowed to establish. Continued monitoring and eradication of alien invasive plant species are imperative.

5.3 RISK RATING ASSESSMENT

Potential impacts, mitigations and site-specific considerations have been taken into account to arrive at risk ratings relevant to the site which follow.

The risk matrix is based on the DWS publication: Section 21 c and (i) water use Risk Assessment Protocol and Notice 509 of 2016 (Government Gazette No. 40229: 105-133; Republic of South Africa). Risk is determined after considering all listed control and/ or mitigation measures. Borderline low/ moderate risk scores can be manually adapted downwards up to a maximum of 25 points (from a score of 80) subject to listing of additional mitigation measures considered and listed in red font. Construction is here interpreted in accordance with the definition provided in Notice 509 of 2016 (Government Gazette No. 40229, p.107) to mean “any works undertaken to initiate or establish impeding or diverting or modifying resource quality, for the first time, including vegetational removal, site preparation and ground levelling”.

Table 5.3.1 A summary of the phases, activities, aspects, impacts and mitigation measures for the proposed development at the site. This summary is part of the breakdown analyses to inform the risk matrix (based on Section 21 c and (i) water use Risk Assessment Protocol and Notice 509 of 2016 (Government Gazette No. 40229: 105-133; Republic of South Africa). The relevant mitigations are added to register the availability of practical solutions to minimize any negative impacts and because the residue following the mitigation is important in the risk assessment.

Phase	Activity	Aspect	Impact	Mitigation
Construction	Clearing of vegetation at and in close proximity of watercourse at proposed footprints for stream crossings via bridge structures.	Clearing of vegetation at proposed footprint in preparation for construction and during construction.	Loss of vegetation and riparian habitat.	Non-perennial rivers, with their riparian zones and 30 m buffer zones, are excluded from the development as far as practical. If the development is approved there will be small restricted parts of the non-perennial river and its buffer zone that will be impacted. Any such developments, if approved, should be restricted to a minimum and followed up by rehabilitation.
			Exposed soil at riparian zone; then soil prone to compaction or potential erosion.	Non-perennial rivers, with their riparian zones and 30 m buffer zones, are excluded from the development as far as practical. If the development is approved there will be a part of the non-perennial river and its buffer zone that will be impacted. Any such developments, if approved, should be restricted to a minimum on which rehabilitation of vegetation should follow.
	Moving vehicles and working of equipment/ machinery at and in close	Moving vehicles and working of machinery and equipment at bridge crossings and extra strip for manoeuvring.	Further loss of vegetation and riparian habitat.	Non-perennial rivers, with their riparian zones and 30 m buffer zones, are excluded from the development as far as practical. If the development is approved there will be a part of the non-perennial river and its

	proximity of watercourse.			buffer zone that will be impacted. The footprint area with the area needed for moving of construction vehicles, machinery and equipment to operate should be fenced off with appropriate material beyond which no activities should be allowed.
			Further exposure and compaction of soils.	Non-perennial rivers, with their riparian zones and 30 m buffer zones, are excluded from the development as far as practical. If the development is approved there will be a part of the non-perennial river and its buffer zone that will be impacted. The footprint area with the area needed for moving of construction vehicles, machinery and equipment to operate should be fenced off with appropriate material beyond which no activities should be allowed.
		Vehicles and machinery could leak which then result in spilling of hydrocarbons.	Pollution of soils by hydrocarbon and unwanted chemical spills.	Equipment to avoid any spills of fuels/ oils/ hydrocarbons should be available and at once implemented where necessary at the site. Regular inspections of machinery and equipment are essential to observe any leaks and should be serviced outside the proposed footprint.
	Generation of waste or building rubble materials at proposed	Waste or building rubble are generated during the construction phase.	Potential contamination of the watercourse habitat by generated waste or building rubble.	Manage waste and take waste away to appropriate waste-disposal sites outside the watercourse.

	footprint at watercourse.			
	Clearing of vegetation at and in close proximity of access roads to construction site.	Creating access road(s) to construction area.	Loss of vegetation and habitat at and along access roads.	Existing access roads are used. Any alternative access roads, if approved, should be restricted to a minimum.
			Exposure and compaction of soils.	Existing access roads are used. Any alternative access roads, if approved, should be restricted to a minimum.
Operational	Establishment of alien invasive plant species at hitherto cleared areas.	Cleared areas where alien invasive plant species establish.	Alien invasive plant species infest hitherto cleared areas and occupy habitat which is then unavailable for indigenous species.	Continued monitoring and eradication of alien invasive plant species are imperative. A rehabilitation plan would be necessary which include the combating of alien invasive plant species.
	Poor recovery of soils that were exposed and compacted during the construction phase.	Compacted and exposed soils do not recover easily without rehabilitation.	Compacted and exposed soils are prone to further degradation and erosion.	Rehabilitation should take place which could include shallow ripping in appropriate direction and spacing. Mulch of indigenous widespread plant species or brushpacks of indigenous widespread species could also be included. Considerations such as too much ripping which could enhance erosion during high rainfall events should also be taken into account in the rehabilitation plan.

Table 5.3.2 Negative ratings of aspects for severity (flow regime, water quality, habitat, biota), spatial scale, duration and consequence. This table is part of a risk matrix (based on Section 21 c and (i) water use Risk Assessment Protocol and Notice 509 of 2016 (Government Gazette No. 40229: 105-133; Republic of South Africa).

		Severity							
Phase	**Aspect**	**Flow Regime**	**Water Quality**	**Habitat** Geomorph & Vegetation	**Biota**	**Severity**	**Spatial Scale**	**Duration**	**Consequence**
Construction	Clearing of vegetation at proposed footprint in preparation for construction and during construction.	1	1	2	2	**1,5**	1	2	**4,5**
	Moving vehicles and working of machinery and equipment at bridge crossings and extra strip for manoeuvring.	1	1	2	2	**1,5**	1	2	**4,5**
	Vehicles and machinery could leak which then result in spilling of hydrocarbons.	1	2	1	2	**1,5**	1	2	**4,5**
	Waste or building rubble are generated during the construction phase.	2	2	2	2	**2**	1	2	**5**
	Creating access road(s) to construction area.	1	1	1	1	**1**	1	1	**3**
Operational	Cleared areas where alien invasive plant species establish.	1	1	2	2	**1,5**	1	2	**4,5**
	Compacted and exposed soils do not recover easily without rehabilitation.	1	2	2	1	**1,5**	1	2	**4,5**

Table 5.3.2 Negative ratings of aspects for frequency of activity, frequency of impact, legal issues, detection, likelihood, significance and finally the Risk Rating. This table is part of a risk matrix (based on Section 21 c and (i) water use Risk Assessment Protocol and Notice 509 of 2016 (Government Gazette No. 40229: 105-133; Republic of South Africa).

Phase	Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
Construction	Clearing of vegetation at proposed footprint in preparation for construction and during construction.	1	2	5	1	9	**40,5**	**Low**
	Moving vehicles and working of machinery and equipment at bridge crossings and extra strip for manoeuvring.	4	2	5	1	12	**54**	**Low**
	Vehicles and machinery could leak which then result in spilling of hydrocarbons.	2	1	5	2	12	**54**	**Low**
	Waste or building rubble are generated during the construction phase.	3	2	5	1	11	**55**	**Low**
	Creating access road(s) to construction area.	1	1	5	1	8	**24**	**Low**
Construction	Cleared areas where alien invasive plant species establish.	2	2	5	2	11	**49,5**	**Low**
	Compacted and exposed soils do not recover easily without rehabilitation.	2	2	5	2	11	**49,5**	**Low**

Consequence = Severity + Spatial Scale + Duration

Likelihood = Frequency of the activity + Frequency of the impact + Legal issues + Detection

Risk = Consequence X Likelihood

Table 5.3.3 Summary of Negative Risk Ratings overall for all the aspects as well as the PES and EIS of the watercourses (two non-perennial rivers) at the site.

Risk Rating	Confidence Level	PES of watercourse	EIS of watercourse
24-55 **Low**	80-90%	Category C Category C	Category C Category C

6 CONCLUSION

- Wetlands that could be classified as Floodplain Wetlands, Channelled Valley-bottom Wetlands, Unchannelled Valley-bottom Wetlands, Depressions (Pans), Seeps or Wetland Flats appear to be absent at site.
- Two non-perennial rivers (of which the active channel of one is poorly defined at places) are identified at the site. A narrow non-perennial river, with its active channel and riparian zone, is present at the northwestern part of the site. An in-channel dam (Dam 1), is present at the northeastern part of the site. Another poorly defined active channel and riparian zone is present at the central part of the site. There is a very small dam (Dam 2) at this poorly defined active channel.
- Vegetation at the riparian zone and along the fringes of the in-channel dam (Dam 1) at the western part of the site includes the trees *Vachellia karroo* and *Searsia pyroides*. Shrubs such as *Asparagus laricinus* and the herbaceous shrub *Gomphocarpus fruticosus* are conspicuous near and at the riparian zone. The indigenous herbaceous plant species *Berkheya radula* and the alien invasive *Cirsium vulgare* are found at the outer edges of the riparian zone. Sedge species such as *Cyperus longus* and *Eleocharis limosa*, with the grass species *Echinochloa holubii* and herbaceous *Persicaria* species are present at the more permanently inundated soils at the riparian zone. The alien invasive grass species *Paspalum dilatatum* as well as the alien invasive herbaceous species *Oenothera rosea* and *Rumex crispus* occur at the riparian zone and edges of the in-channel dam as well.
- The riparian vegetation along the poorly defined active channel at the central part of the site is also poorly defined in many areas. Few trees or shrubs are present at this riparian zone. This area appears to be trampled or eroded. The succulents *Chasmatophyllum muscilinum* and *Ruschia canonotata* (terrestrial species) are present at some of these bare areas with the karoo element *Pentzia globosa* (terrestrial species). The sedge *Kyllinga erecta* is in particular conspicuous at wet areas along the riparian zone. The graminoids *Echinochloa holubii*, *Eleocharis limosa* and *Kyllinga erecta* are visible at the periphery of this small dam (Dam 2).
- Present ecological status (PES) of the Non-perennial River (with Dam 1) at the site is CATEGORY C which means the watercourse is moderately modified but with some loss of natural habitats (Table 4.2 and Table 4.3). Ecological Importance and Sensitivity (EIS) of

the non-perennial river (with Dam 1) at the site is Category C which is Moderate and refers to watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers (Table 4.4 and Table 4.5).

- Present ecological status (PES) of the Non-perennial River (with Dam 2) at the site is CATEGORY C which means the watercourse is moderately modified but with some loss of natural habitats (Table 4.7 and Table 4.8). Ecological Importance and Sensitivity (EIS) of the non-perennial river (with Dam 2) at the site is Category C which is Moderate and refers to watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers (Table 4.9 and Table 4.10).
- Site is part of the Middle Vaal Water Management Area (WMA 9). The site is not part of a Freshwater Ecosystem Priority Area (FEPA) or wetland cluster (Nel et al., 2011a, 2011b).
- The non-perennial rivers at the site, with small in-channel dams and with their riparian zones and buffer zones, are likely to be impacted by the proposed developments, but to a very limited extent. Apart from existing roads for access, these watercourses are excluded from the development. If the development is approved the construction should be planned in such a manner that surface flow function well while erosion is limited. There is no distinct indication that interflow plays an important role in the maintenance of the non-perennial river. The geomorphological setting and flow regime should be as similar as possible post development as to prior the development, if the development is approved (in this case there could be some positive impact on the flow regime). Loss of any wetland animal or plant species of particular conservation importance is not expected.
- Loss of wetland Threatened or Near Threatened Plants, Mammals, Reptiles, Amphibians and Invertebrates at the proposed footprint appears to be unlikely.
- Rubble or waste could lead to infiltration of unwanted pollutants into the soil. Spilling of petroleum fuels and unwanted chemicals onto the soils that infiltrate these soils could lead to pollution of soils and also impact on water quality when the stream flows. Rubble or waste that could accompany the construction effort, if the development is approved, should be removed during and after construction. Measures should be taken to avoid any spills and

infiltration of petroleum fuels or any chemical pollutants into the soil during construction phase.

- A rehabilitation plan which include the combating of alien invasive plant species at the watercourse is essential. Infestation by alien invasive species could replace indigenous vegetation or potential areas where indigenous vegetation could recover. Once established combatting these alien invasive plant species may become very expensive to combat in the long term, especially if species such as *Prosopis* (Mesquite) and Melia azedarach (Syringa Berry-tree) is allowed to establish. Continued monitoring and eradication of alien invasive plant species are imperative.
- The Negative Risk Rating in accordance with a risk matrix based on Section 21 c and (i) water use Risk Assessment Protocol and Notice 509 of 2016 (Government Gazette No. 40229: 105-133; Republic of South Africa) at the site is Low.

*** Kindly note that an Avifaunal specialist study (van Rooyen, 2022) and an Ecological Habitat Survey Report (Terblanche, 2022) with some detail on certain ecological aspects, the assessment of likely presence or absence of threatened species and also a description of the terrestrial zone at the site, accompany this report

7 REFERENCES

Alexander, G. & Marais, J. 2007. A guide to the reptiles of Southern Africa. Struik, Cape Town.

Anderson, M.D. & Anderson, T.A. 2001. Too much, too quickly? Doubts about the sustainability of the camelthorn wood harvest. *African Wildlife* 55(3): 21-23.

Apps, P. 2012. Smithers' mammals of Southern Africa 4th ed: A field guide, revised and updated by Peter Apps. Struik Nature, Cape Town.

Armstrong, A.J. 1991. On the biology of the marsh owl, and some comparisons with the grass owl. *Honeyguide* 37:148-159.

Barnes, K.N. *ed*. 2000. The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (eds). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. *Suricata* 1. South African National Biodiversity Institute, Pretoria.

Boon, R. 2010. *Pooley's trees of eastern South Africa: a complete guide 2nd ed.* Flora and Fauna Publications Trust, Durban.

Branch, B. 1998. Field guide to snakes and other reptiles of southern Africa. 3rd ed. Struik, Cape Town.

Branch, B. 2008. Tortoises, Terrapins & Turtles of Africa. Struik Nature, Cape Town.

Branch, W.R. & Patterson, R.W. 1975. Notes on the ecology of the Giant Girdled Lizard, *Cordylus giganteus*. *Journal of Herpetology* 9(4): 364-366.

Branch, W.R., Tolley, K.A., Cunningham, M., Bauer, A.M., Alexander, G., Harrison, J.A., Turner, A.A. & Bates, M.F. *eds*. 2006. A plan for phylogenetic studies of southern African reptiles: proceedings of a workshop held at Kirstenbosch, February 2006. Biodiversity Series 5. South African National Biodiversity Institute, Pretoria.

Bronner, G. 2011. *Mammals.* In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective.* Struik Nature, Cape Town, p 22-35.

Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza Publications, Pretoria.

Carruthers, V. & Du Preez, 2011. Frogs and froging in southern Africa 2nd ed. Struik, Cape Town.

Chittenden, H. 2007. Roberts Bird Guide. John Voelcker Book Fund, Cape Town.

Cillié, B., Oberprieler, U. & Joubert, C. 2004. Animals of Pilanesberg: an identification guide. Game Parks Publishing, Pretoria.

Cilliers, S.S., Müller, N. & Drewes, E. 2004. Overview on urban nature conservation: situation in the western-grassland biome of South Africa. *Urban forestry and urban greening* 3: 49-62.

Coetzee, N. & Monadjem, A. 2008. *Mystromys albicaudatus*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>.

Conradie, W., Du Preez, L.H., Smith, K. & Weldon, C. 2006. Field guide to the frogs and toads of the Vredefort Dome World Heritage Site. School of Environmental Sciences and Development, Potchefstroom.

Court, D. 2010. *Succulent Flora of Southern Africa*. Struik Nature, Cape Town.

Crouch, N.R., Klopper, R.R., Burrows, J.E. & Burrows, S.M. 2011. Ferns of Southern Africa: a comprehensive guide. Struik Nature, Cape Town.

Del Hoyo, J., Elliot, J. & Sargatal, J. 1992. Handbook of the birds of the world, Vol. 1. Lynx Editions, Barcelona.

Deutschländer, M.S. & Bredenkamp, C.J. 1999. Importance of vegetation analysis in the conservation management of the endangered butterfly *Aloeides dentatis* subsp. *dentatis* (Swierstra) (Lepidoptera: Lycaenidae). *Koedoe* 42(2): 1-12.

Dippenaar-Schoeman, A.S. 2002. Baboon and trapdoor spiders in southern Africa: an identification manual. Plant Protection Research Institute Handbook No. 13. Agricultural Research Council, Pretoria.

Dippenaar-Schoeman, A.S. & Jocqué, R. 1997. African spiders: an identification manual. Plant Protection Research Institute Handbook No. 9. Agricultural Research Council, Pretoria.

Drinkwater, T.W., Bate, R. & Du Toit, H.A. 1998. A field guide for identification of maize pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.

Du Preez, L.H. 1996. Field guide and key to the frogs and toads of the Free State. Department of Zoology and Entomology, University of the Orange Free State, Bloemfontein.

Du Preez, L.H. & Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Struik Nature, Cape Town. CD with calls included.

DWAF (Department of Water Affairs and Forestry). 1997. South African Water Quality Guidelines for Aquatic Ecosystems.

DWAF (Department of Water Affairs and Forestry). 1999. Resource Directed Measures for Protection of Water Resources: Wetland Ecosystems: W4. Department of Water Affairs and Forestry, Pretoria.

DWAF (Department of Water Affairs and Forestry). 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

Edge, D.A. 2005. Ecological factors influencing the survival of the Brenton Blue butterfly, *Orachrysops niobe* (Trimen) (Lepidoptera: Lycaenidae). North-West University, Potchefstroom, South Africa (Thesis - D.Phil.).

Edge, D.A., Cilliers, S.S. & Terblanche, R.F. 2008. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* 104: 505 - 510.

Ellery, W., Grenfell, M., Grenfell, S., Kotze, D., McCarthy, T., Tooth, S., Grundling, P-L., Beckedahl, H., Le Maitre, D. & Ramsay, L. 2009. WET-origins: controls on the distribution and dynamics of wetlands in South Africa.

Ferguson-Lees, J. & Christie, D.A. 2001. *Raptors of the world.* Christopher Helm, London.

Filmer, M.R. 1991. Southern African spiders: an identification guide. Struik, Cape Town.

Gardiner, A.J. & Terblanche, R.F. 2010. Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae). *African Entomology* 18(1): 171 – 191.

Germishuizen, G. 2003. Illustrated guide to the wildflowers of northern South Africa. Briza, Pretoria.

Germishuizen, G., Meyer, N.L. & Steenkamp (*eds*) 2006. A checklist of South African plants. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.

Goldblatt, P. 1986. The Moraeas of Southern Africa. Annals of Kirstenbosch Botanic Gardens, Volume 14. National Botanic Gardens, Cape Town.

Goldblatt, P. & Manning, J. 1998. Gladiolus in Southern Africa.

Henderson, L. 2001. *Alien weeds and alien invasive plants: a complete guide to the declared weeds and invaders in South Africa.* Plant Protection Research Institute Handbook No. 12. ARC: Plant Protection Research Institute, Pretoria.

Henderson, L. & Cilliers, C.J. 2002. *Invasive aquatic plants: a guide to the identification of the most important and potentially dangerous invasive aquatic and wetland plants in South Africa.* Plant Protection Research Handbook No. 16. Agricultural Research Council, Pretoria.

Henning, G.A. & Roos, P.S. 2001. Threatened butterflies of South African wetlands. *Metamorphosis* 12(1): 26-33.

Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds) 2009. South African Red Data Book: butterflies. *SANBI Biodiversity Series No 13.* South African National Biodiversity Institute, Pretoria.

Henning, S.F. 1983. Biological groups within the Lycaenidae (Lepidoptera). *Journal of the Entomological Society of Southern Africa* 46(1): 65-85.

Henning, S.F. 1987. Outline of Lepidoptera conservation with special reference to ant associated Lycaenidae. *Proceedings of the first Lepidoptera conservation Symposium, Roodepoort*: *Lepidopterists' Society of southern Africa*: 5-7.

Henning, S.F. & Henning, G.A. 1989. South African Red Data Book: butterflies. *South African National Scientific Programmes Report* No. 158. CSIR, Pretoria.

Herman, P.P.J. 2002. Revision of the *Tarchonanthus camphoratus* complex (Asteraceae-Tarchonantheae) in southern Africa. *Bothalia* 32,1: 21-28.

Hill, C.J. 1995. Conservation corridors and rainforest insects. (*In* Watt, A.D., Stork, N.E. & Hunter, M.D. (*eds*.), Forests and Insects. Chapman & Hall, London. p. 381-393.)

Hockey, P. 2011. *Birds.* In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective.* Struik Nature, Cape Town, p 36-44.

Hockey, P.A.R., Dean, W.J.R. & Ryan, P.G. (*eds*.). 2005. Roberts Birds of Southern Africa. John Voelcker Bird Book Fund, Cape Town.

Holm, E. & Marais, E. 1992. Fruit chafers of southern Africa. Ekogilde, Hartebeespoort.

Impson, D. & Swartz, E. 2007. *Labeobarbus kimberleyensis*. The IUCN Red List of Threatened Species. 2007: e. 63292A12638641. http://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T63292A12638641.en. Downloaded on 26 April 2017.

IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

IUCN. 2012. IUCN Red list of Threatened Species. Version 2012.1)

Jacobsen, W.B.G. 1983. The ferns and fern allies of Southern Africa. Butterworths, Durban.

Kemper, N.P. 2001. RVI: Riparian Vegetation Index, final report, WRC Report No. 850/3/1. Institute for Water Research, Pretoria.

Kok, J.C. 1998. Vrystaatse bome, struike en klimplante Kontak-uitgewers, Pretoria.

Kleynhans, C.J. 1999. A procedure for the determination of the ecological reserve for the purposes of the national water balance model for South African River. Institute of Water Quality Studies, Department of Water Affairs & Forestry, Pretoria.

Kleynhans, C.J., Thirion, C. & Moolman, J. 2005. A level 1 ecoregion classification system for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria.

Kotze, D., Marneweck, G., Batchelor, A., Lindley, D. and Collins, N. 2008. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. Wetland Management Series. Water Research Commission Report TT339/08, Water Research Commission, Pretoria.

Larsen, T.B. 1995. Butterfly biodiversity and conservation in the Afrotropical region. (*In* Pullin, A.S. *ed*. Ecology and conservation of butterflies. London: Chapman & Hall. p. 290-303.)

Le Roux, A. 2015. Wild flowers of Namaqualand. Struik Nature (Penguin), Cape Town.

Liebenberg, L. 1990. A field guide to the animal tracks of Southern Africa. David Philip Publishers, Cape Town.

Leeming, J. 2003. Scorpions of southern Africa. Struik, Cape Town.

Leroy, A. & Leroy, J. 2003. Spiders of southern Africa. Struik, Cape Town.

Louw, W.J. 1951. *An ecological account of the vegetation of the Potchefstroom Area*. Botanical Survey of South Africa, Memoir No. 24. Government Printer, Pretoria.

Low, A.B. & Rebelo, A.G. (Eds.) 1996. Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria.

Lubke, R.A., Hoare, D., Victor, J. & Ketelaar, R. 2003. The vegetation of the habitat of the Brenton Blue Butterfly, *Orachrysops niobe* (Trimen), in the Western Cape, South Africa. *South African Journal of Science* 99: 201-206.

Mannheimer, C., Maggs-Kölling, G., Kolberg, H. & Rügheimer, S. 2008. Wild flowers of the southern Namib. MacMillan, Windhoek.

Manning, J. 2003. Photographic guide to the wild flowers of South Africa. Briza, Pretoria. .

Manning, J. 2009. Field guide to the wild flowers of South Africa. Struik, Cape Town.

Marneweck, G.C. & Batchelor, A. 2002. Wetland inventory and classification. In: Ecological and economic evaluation of wetlands in the upper Olifants River catchment. Palmer, R.W., Turpie, J., Marneweck, G.C. and Batchelor, A. (eds). Water Research Commission Report No. 1162/02.

McMurtry, D., Grobler, L., Grobler, J. & Burns, S. 2008. Field guide to the orchids of northern South Africa and Swaziland. Umdaus Press, Hatfield.

Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M, Pringle, E.L., Terblanche, R.F. & Williams, M.C. 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas.* Saftronics, Johannesburg & Animal Demography

Unit, Cape Town.

Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J. & Kloepfer, D. *eds.* 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB series 9, Smithsonian Institution, Washington DC.

Mucina, L. & Rutherford, M.C. *eds*. 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. Pretoria: South African National Biodiversity Institute.

Mucina, L., Rutherford, M.C., and Powrie, L.W. *eds*. 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. Pretoria: South African National Biodiversity Institute.

Nel, J.L., Driver, A., Strydom, W.F., Maherry, A.M., Petersen, C.P., Hill, L., Roux, D.J., Nienaber, S., Van Deventer, H., Swartz, E.R. & Smith-Adao, L.B. 2011. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. WRC Report No. TT 500/11. Water Research Commission, Pretoria.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. & Nienaber, S. 2011. Technical Report for the Freshwater Ecosystem Priority Areas Project. WRC Report No. TT 1801/2/11. Water Research Commission, Pretoria.

New, T.R. 1993. *ed*. Conservation biology of *Lycaenidae* (butterflies). *Occasional paper of the IUCN Species Survival Commission* No. 8.

New, T.R. 1995. Butterfly conservation in Australasia – an emerging awareness and an increasing need. (*In* Pullin, A.S. *ed*. Ecology and conservation of butterflies. London: Chapman & Hall. p. 304 – 315.)

Ollis, D.J., Snaddon, C.D., Job, N.M. & Mbona, N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. *SANBI Biodiversity Series 22.* South African National Biodiversity Institute, Pretoria.

Peacock, F. 2006. Pipits of Southern Africa. Published by the author, Pretoria. www.pipits.co.za.

Pfab, M.F. 2002. Priority ranking scheme for Red Data plants in Gauteng, South Africa. *South African Journal of Botany* (68): 299-303.

Pfab, M.F. & Victor, J.E. 2002. Threatened plants of Gauteng, South Africa. *South African Journal of Botany* (68): 370-375.

Picker, M. & Griffiths, C. 2011. Alien & Invasive animals: a South African perspective. Struik Nature, Cape Town.

Picker, M., Griffiths, C. & Weaving, A. 2004. Field guide to insects of South Africa. 2nd ed. Cape Town: Struik.

Pooley, E. 1998. A field guide to wild flowers of KwaZulu-Natal and the eastern region. Natal Flora Publications Trust, Durban.

Pringle, E.L., Henning, G.A. & Ball, J.B. *eds.* 1994. Pennington's Butterflies of Southern Africa. Struik Winchester, Cape Town.

Pryke, S.R. & Samways, M.J. 2001. Width of grassland linkages for the conservation of butterflies in South African afforested areas. *Biological Conservation* 101: 85-96.

Pullin, A.S. *ed*. 1995. Ecology and conservation of butterflies. Chapman & Hall, London.

Rautenbach, I.L. 1982. The mammals of the Transvaal. Ecoplan monograph 1: 1-211.

Retief, E. & Herman, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characteristics. Strelitzia 6. National Botanical Institute, Pretoria.

Rutherford, M.C. & Westfall, R.H. 1994. Biomes of southern Africa: An objective categorisation, 2nd ed. Memoirs of the Botanical Survey of South Africa, Vol. 63, pp. 1-94. National Botanical Institute, Pretoria.

Ryan, P. 2001. Practical Birding: A guide to birdwatching in southern Africa. Struik, Cape Town.

Samways, M.J. 2005. Insect diversity conservation. Cambridge University Press, Cambridge.

Sieben, E.E., Kotze, D.C., Ellery, W.N. & Russell, W.B. 2009. Chapter 6: Using vegetation in wetland rehabilitation. In: Russel, W. 2009. *WET-RehabMethods: National guidelines and methods for wetland rehabilitation.* WRC Report TT 341/09, Water Research Commission, Pretoria, pp. 54-94.

Skelton, P. 2001. A complete guide to the freshwater fishes of Southern Africa. Struik, Cape Town.

Skelton, P. & Weyl, O. 2011. *Fishes.* In: Picker, M. & Griffiths, C. 2011. *Alien & Invasive animals: a South African perspective.* Struik Nature, Cape Town, p 36-44.

Skinner, J.D. & Chimimba, C.T. 2005. The mammals of the southern African subregion. Cambridge University Press, Cape Town.

Sliwa, A. 2008. *Felis nigripes*. In: IUCN 2012. IUCN Red List of Threatened Species.

Smit, N. 2008. Field guide to the *Acacias* of South Africa. Briza, Pretoria.

Smithers, R.H.N. 1986. South African Red Data Book: Terrestrial mammals. *South African National Scientific Programmes Report* No. 125. CSIR, Pretoria.

South Africa. 2004. National Environmental Management: Biodiversity Act No. 10 of 2004. Government Printer, Pretoria.

Stuart, C. & Stuart, T. 2006. Field guide to the larger mammals of Africa 3rd ed. Struik Nature, Cape Town.

Stuart, C. & Stuart, T. 2013. A field guide to the tracks and signs of Southern, Central and East African wildlife 4th ed. Struik Nature, Cape Town.

Tarboton, W. & Erasmus, R. 1998. Owls and owling in southern Africa. Struik, Cape Town.

Taylor, J.C., Janse Van Vuuren, M.S. & Pieterse , A.J.H. 2007. The application and testing of diatom-based indices in the Vaal and Wilge Rivers, South Africa. *Water SA* 33(1): 51-59.

Terblanche, R.F. & Edge, D.A. 2007. The first record of an *Orachrysops* in Gauteng. *Metamorphosis* 18(4): 131-141.

Terblanche, R.F., Morgenthal, T.L. & Cilliers, S.S. 2003. The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* 46(1): 73-90.

Terblanche, R.F. & Van Hamburg, H. 2003. The taxonomy, biogeography and conservation of the myrmecophilous *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 46(2): 65-81.

Terblanche, R.F. & Van Hamburg, H. 2004. The application of life history information to the conservation management of *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 47(1): 55-65.

Thomas, C.D. 1995. Ecology and conservation of butterfly metapopulations in the fragmented British landscape. (*In* Pullin, A.S. *ed*. Ecology and conservation of butterflies. London: Chapman & Hall. p. 46-64.)

Van den Berg, J. & Drinkwater, T.W. 1998. Field guide to identification of sorghum pests in South Africa. Agricultural Research Council: Grain-crops Institute, Potchefstroom.

Van Ginkel, C.E., Glen, R.P., Gordon-Gray, K.D., Cilliers, C.J., Muasya, M. & van Deventer, P.P. 2011. Easy identification of some South African Wetland Plants. WRC Report No TT 479/10. Water Research Commission, Gezina.

Van Jaarsveld, E.J. 2006. The Southern African *Plectranthus* and the art of turning shade to glade.

Van Oudtshoorn, F. 1999. Guide to grasses of southern Africa. Briza, Pretoria.

Van Wyk, B. 2000. A photographic guide to wild flowers of South Africa. Struik, Cape Town.

Van Wyk, B. & Malan, S. 1998. Field Guide to the Wild Flowers of the Highveld. Struik, Cape Town.

Van Wyk, A.E. & Smith, G.F. 2001. Regions of floristic endemism in Southern Africa: a review with emphasis on succulents, Umdaus Press, Pretoria.

Van Wyk, B.E. & Smith, G.F. 2003. Guide to the aloes of South Africa. 2nd ed. Briza, Pretoria.

Van Wyk, B. & Van Wyk, P. 1997. Field guide to trees of southern Africa. Struik, Cape Town.

Walker, C. 1996. Signs of the Wild. 5th ed. Struik, Cape Town.

Watt, A.D., Stork, N.E. & Hunter, M.D. (*eds*.), Forests and Insects. London: Chapman & Hall. (p. 381-393.)